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Comparison of consumption of two strains of diatoms grown in laboratory, *Chaetoceros calcitrans* and *Isochrysis aff. galbana* by the mangrove oyster, *Crassostrea tulipa* (Lamarck, 1819)

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ABSTRACT

Objective: The challenges experienced in obtaining oysters in the laboratory despite the different temperatures likely to cause it, led to the implementation of an experimental device on the contribution of two strains of diatoms in the nutrition of this species in a controlled environment.
Methodology and Results : Eighteen (18) oysters with an average weight of 51.3±26.2g were harvested in March 1999 in Missirah, a local community nested in the Saloum Delta in Senegal. They were placed in a 66-litre tank receiving water filtered through a 2-micron filter and stored in a 500-litre plastic tank**.** The concentration of the two species of diatoms in the algae tank was calculated by counting the algal cells contained in 10 squares of a Malassez tank (depth 0.2 mm). The water is heated using an electric heating element connected to a temperature regulator. In order to prevent the ambient light in the study room from impacting on the nutrient intake of the oysters, the tank containing the specimens is covered with a black tarpaulin. The diatom filtration is evaluated by calculating the difference between the quantities lost during water renewal in the oyster tank and the estimation made during the operation of the pump. For each operation, the moving averages of the values recorded over a period of 30 minutes are calculated. Experiments on feeding *Crassostrea tulipa* oysters with diatoms, *Isochrysis aff. galbana* and *Chaetoceros calcitran* point to the fact that this mollusc has a certain preference for the first species. This filtration reaches its highest threshold at 26ºC.
Conclusion and Application of results: The results obtained show a greater intake of *Isochrysis aff. galbana* than of *Chaetoceros calcitrans*. Regardless of the strain of diatoms in use, the optimal temperature for the intake of both strains is around 26°C. This scientific knowledge on the use of these two strains of diatom is useful for maturing the mangrove oyster *Crassostrea tulipa* in laboratory.

Keywords: Senegal, mangrove oyster, *Crassostrea tulipa*, feeding, *Chaetoceros calcitrans* and *Isochrysis aff. Galbana.*

INTRODUCTION

Oyster production is estimated at around 16,000 tons by fresh weight, of which 15,600 tonnes come from harvesting (97.5 per cent) and 400 tons from oyster farming (2.5 per cent) (Kourgansky et al., 2023). This is an essentially seasonal activity, carried out mainly during the dry season, from December to the end of May. Oysters are their second most important source of protein after fish (7 per cent of volumes are self-consumed). The industry therefore has a high social value in brackish areas, which are sometimes isolated, and is still linked to subsistence. The development of its value chain is envisaged as part of an initiative by the Organization of African, Caribbean and Pacific States (OACPS) to support the sustainable development of fisheries and aquaculture by 2020. The deterioration of environmental factors led to an increase in the salinity of the waters of the Casamance estuary and the Saloum delta in the 1980s. This situation had a negative impact on the quality of the oysters, with many small-size specimens in the natural populations identified in both areas (Marius, 1985; Pages *et al.,* 1986; Diouf, 1996). This situation has forced indigenous harvesters to look for other harvesting sites far away from their local communities. This shift resulted in additional expenditure for these workers (hiring of pirogues, purchase of fuel) and in some instances had triggered conflicts. Some villages considered that the oyster beds on their land belonged to them. In such cases, negotiations were conducted with the inhabitants of these villages to facilitate access to the oyster beds. In such context, it becomes increasingly difficult to develop mangrove oyster farming in Senegal. A description of the different developmental stages of oyster larvae is needed to optimize spat collection with a view to developing oyster farming. This can be achieved through the controlled reproduction of oysters in laboratory. To achieve this, one must master the conditioning of oysters for reproduction. Proper feeding of the oysters enables the gonads to mature and larvae to be produced. Controlling the optimum filtration temperature of an effective feed is a step in the right direction (Flassch, 1991).

MATERIALS AND METHODS

A sample of 18 oysters (mean weight = 51.3+26.2g) from the Sokone-Missira area (**Figure 1**) was used to carry out this study. The experimental set-up used in this study enabled the consumption of two diatom species, *Chaetoceros calcitrans* and *Isochrysis aff. galbana*, to be measured. In the laboratory, the oysters are placed in a 66-liters tank. A volume of seawater filtered to 2 microns was introduced in the tank. The water is supplied through a controlled pump.

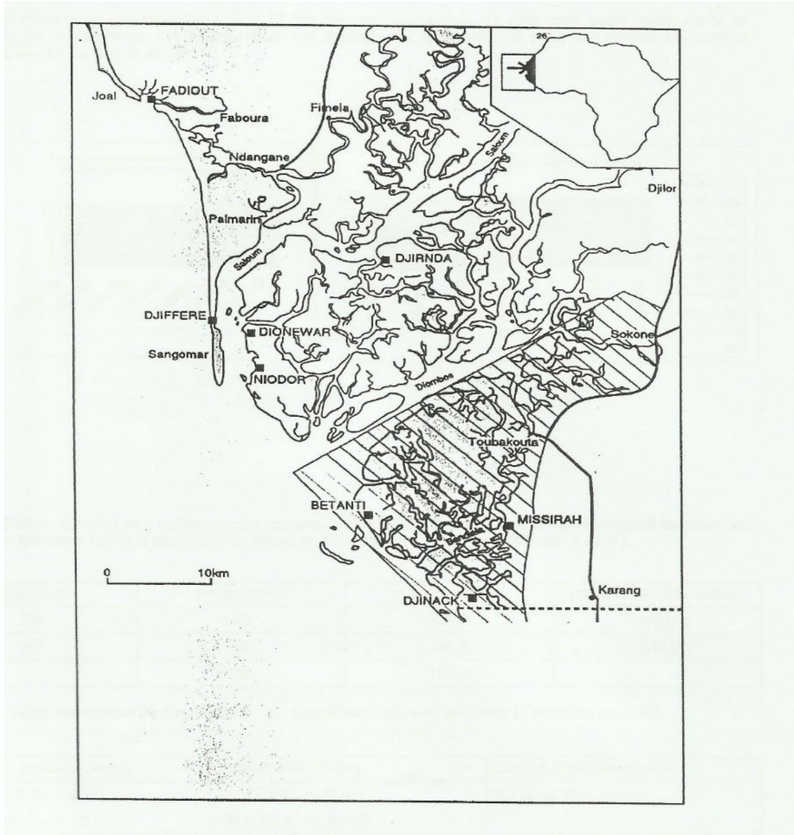
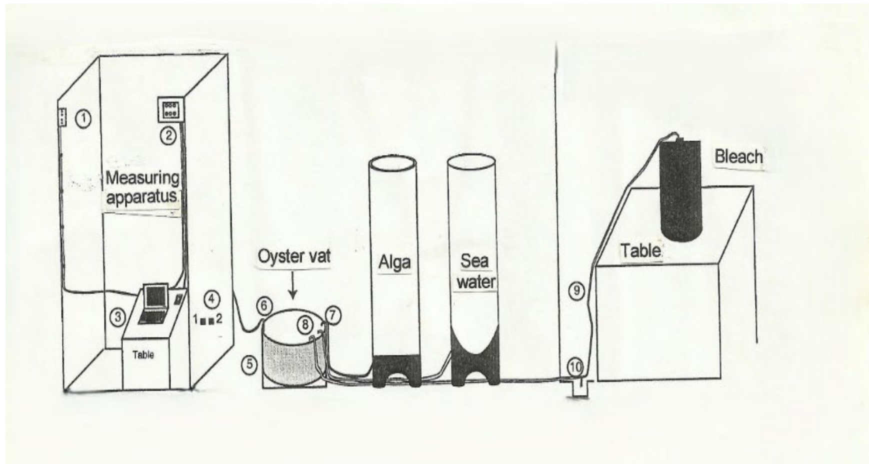


Figure 1: Oyster harvesting area in the Saloum delta in central eastern Senegal.

A. Photo of the device



B. Drawing of the device

<u>Legend</u>: 1.Socket-outlets, 2. Controller of the measuring instruments, 3. Computer; 4.1. Alga stocking pump. 4.2. Water pump, 5.Container designed to receive the oysters, 6.Thermometer, 7. Algae transport pipe, 8.Sea Water transport Pipe; 9. Pipe bringing bleach, 10. Water from the container with oysters.

Figure 2. Diagram of the experimental device used (A: photo of the device. B: Drawing of the device).

The water is discharged through a pipe containing 10% bleach. This kills the pathogenic germs in the water before its discharge into the sea. The seaweed is fed to the oysters through another pipe that runs into the oyster tank. The seawater pipe is connected to a pump and to a measuring device (a turbidimeter). The algae concentration in the algae tank is calculated by counting the cells at the bottom of a MALASSEZ tank (0.2mm deep) (**Figure 3**).

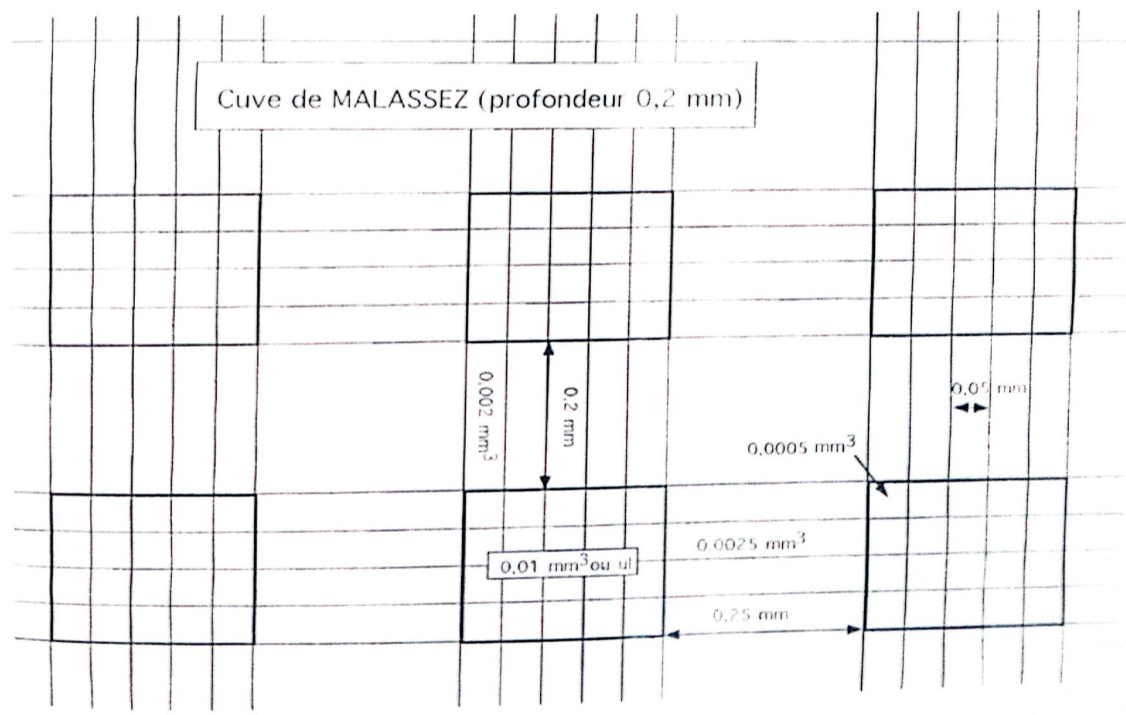


Figure 3. A Malassez tank (0.2mm deep)

The same operation is carried out in the oyster tank once the turbidity threshold has stabilized at the pre-set value (0.15 in the case of our study). As well as counting the algae, the pump flow rate was calculated by collecting the quantity of water that flowed out of the pump for one minute. The experiment was stopped each day to clean the oysters, the tank, the animals, the algae tank, and the seawater tank. The oyster tank was heated by two heating elements connected to a regulator. A metal cover was placed over the tank to prevent the temperature in the oyster tank from being affected by the temperature in the room. The filtration of the oysters is evaluated using the difference between the quantity of algae lost during the renewal of the water in the tank containing the oysters and the quantity used to operate the pump. For each recording, the moving average of the values recorded during 30 minutes of pump operation is calculated. The values recorded correspond to the consumption of diatoms by the oysters. This change of water in the tank leads to the release of a new supply of algae by the algae pump. The phenomenon is recorded on the computer connected to the turbidimeter (Orbeco Hellige model 965-10 A Direct Reading Digital Turbidimeter) using SPC 801 software (Signaloger PC LAPLACE Instruments version 1-4). The particle concentration was determined using a Coultronics TA2 Coulter Counter. Both species of diatom used in the study come from the algal culture room of the C.0.P (Caisey, 1994) at IFREMER Plouzane. The species were as follow:

- *Isochrysis a# galbarza* (3-5 pm) Haptophyceae
- *Chaetoceros calcitrans* (4-10 pm) Bacillariophyceae.

Isochrysis galbana affinis Tahiti (T -iso) is a marine microalga used as food for mollusc larvae and live prey for aquaculture fish in many hatcheries producing juveniles of these species (Bougaran Gael, Le Dean Loic, Lukomska Ewa, Picquet Marie-Lise, Kaas Raymond, Muller-Feuga Arnaud, 2001, Peter J. Cranford, 2001). Today, many mollusk and fish hatcheries use it in association with other species such as Pavlova lutheri, *Chaetoceros calcitrans* and *Skeletonema costatum*. This fast-growing alga has become an established larval food for shrimps and molluscs due to its rapid growth in tropical conditions and its nutritional qualities, particularly its high content of long-chain polyunsaturated fatty acids. *Chaetoceros calcitrans* is used as food in many marine hatcheries to feed shrimp larvae. This species rich in natural polyunsaturated fatty acids (PUFAs), a chemical substance that plays an important role in the growth and health protection of shrimp larvae (Belay, 1997, Borowitzka, 1999, Chiou et al., 2001).

RESULTS AND DISCUSSION

This experiment on the diet of the oyster *C tulipa* (Lamarck, 1819) in relation to temperature and the type of algae used to feed the animals indicates a certain preference of the animals for the clone *Isochrysis galbana* T-Iso over *Chaetoceros calcitrans* (Figures 4, 5 et 6).

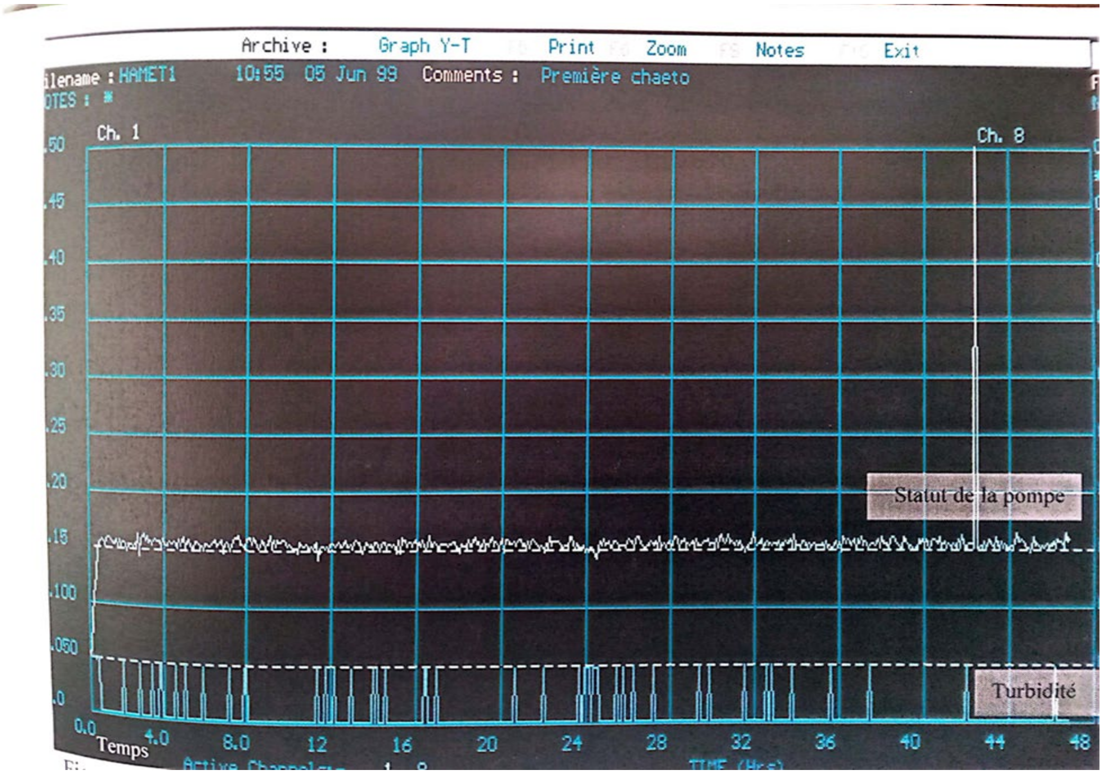


Figure 4. Computer recordings of algal cell filtration.

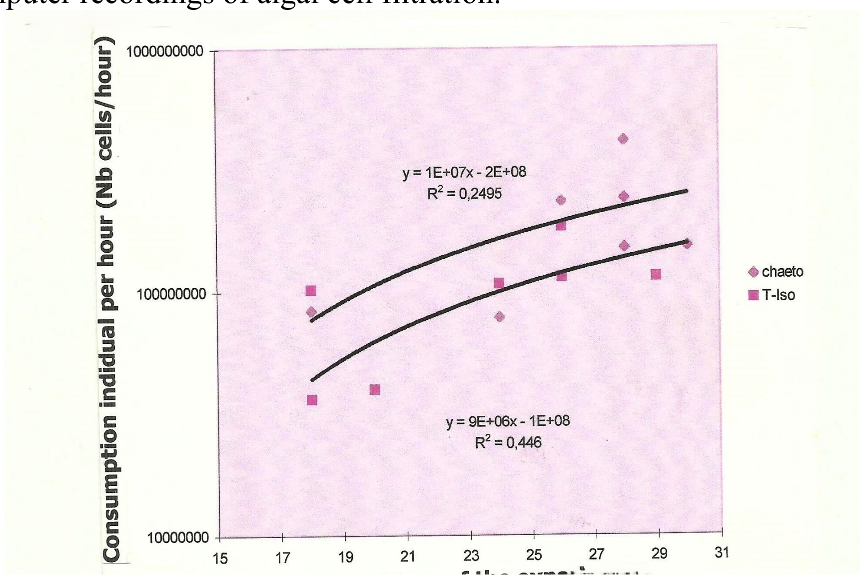


Figure 5. Importance of filtration of the two strains of diatoms over time.

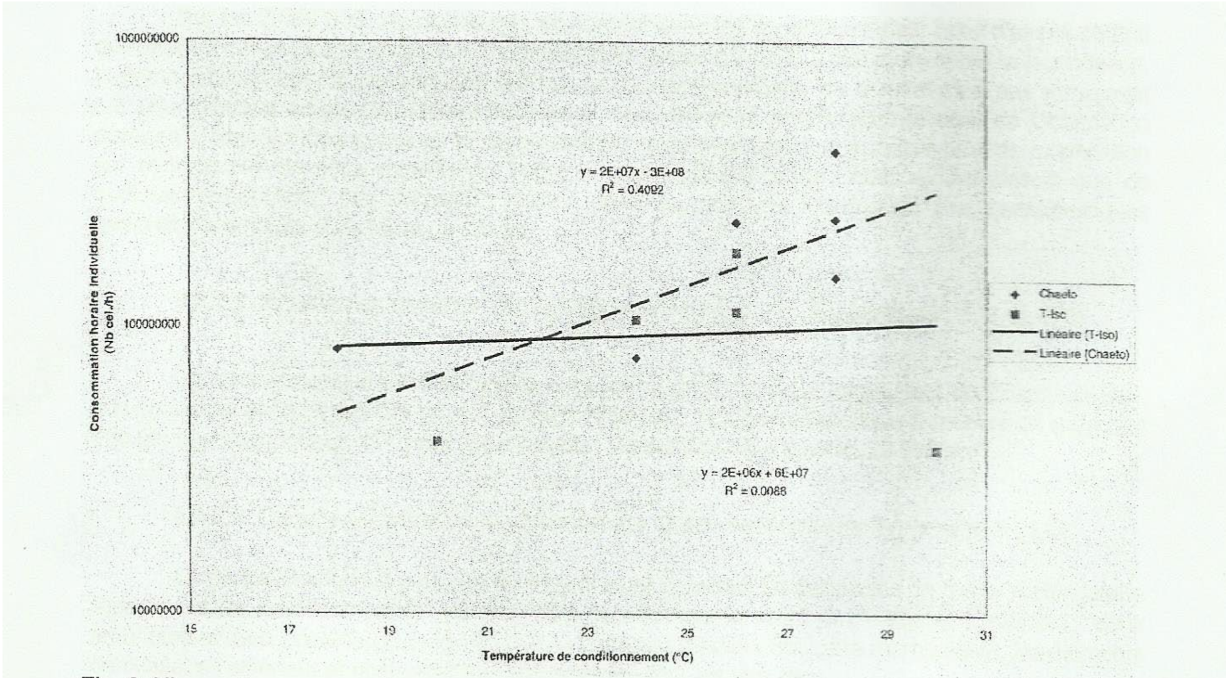


Figure 6. Comparison of the filtration of *Isochrysis galbana* and *Chaetoceros calcitrans* by *C. tulipa*

In Lake Nokoué in Benin, the diet of this marine mollusc also includes a diatom *Gyrosigma hyppocampus* (Akélé *et al.,*2022). This diet consists mainly of phytoplankton (96.04%) and zooplankton (1.80%). This study showed significant variations between months and between class sizes of this species. The difference in algal filtration under equivalent experimental conditions is seemingly due to the intrinsic characteristics of the species (size, food value). The influence of these characteristics on their consumption by lamellibranch mollusks is well documented (Robert and Trintignac, 1997; Powell et al., 1992; Winter 1978; Mason, 1975; Pequignat, 1973; Tammes and Dral, 1955). An experimental study on the Japanese oyster *Crassostrea gigas* was carried out. This study aimed at assessing the influence on the feeding functions of this specimen during the filtration, consumption, ingestion and absorption of different strains of microalgae in presence of quantities of suspended solids (SS =2 to 20 mg.l-I) associated with a high percentage of particulate organic matter with an average value of 54%. The experiment did not reveal any significant difference between the three sizes of microalgae tested (Barillé *et al.,* 1993). This research shows that in the Japanese oyster, the regulatory mechanisms tend to maintain a constant rate of organic uptake. The effects of particulate concentration on the feeding behavior of bivalves have been the subject of numerous studies reviewed by Winter (1978), Bayne, Newell (1983) and Barillé *et al*. (1993). The recent introduction of the food quality factor by Bayne *et al.* (1987) has provided a better understanding of the compensations and regulations of the different feeding functions. The parameters most used by physiologists to define and quantify the quality of a diet are particle size, the organic fraction of total seston and the organic ration per unit particle volume (Bayne *et al.,* 1987). The influence of diet quality appears to be mainly on ingestion, absorption efficiency and residence time of the food in the digestive system (Bayne, 1992), but does not appear to affect filtration (Newell *et al.,* 1995;

The role of temperature on oyster feeding has been reported by authors such as Ranson (1956), who links it to salinity. The optimum temperature found in *Crassostrea tulipa* is close to that described by Ranson for certain oyster species such as C. virginica, which show maximum activity at 25°C. A more detailed study of the phenomenon by reducing the concentrations of algae to their dry weight or their energetic composition would be interesting to better determine the importance of algae consumption in this species.

CONCLUSION AND APPLICATION OF RESULTS

This study of the filtration of *Chaeotoceos calcitrans* and *Isochrysis aff. galbana* by mangrove oysters *Crassostrea tulipa* from Senegal using the turbidimetry method has made it possible to define a suitable feeding level for this species. However, to determine the best conditions for oyster maturation, further investigations are needed to study the influence of the physiological state of the animals (oysters in sexual rest or at the start of maturation) on filtration.

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