Investigating survival conditions of the commercial oyster *Saccostrea cucullata* in a barachois-based aquaculture farm in Mauritius

Deepeeka Kaullysing1,2*, Nawsheen Taleb-Hossenkhan1, Riad Sultan3, Arvindev Erriah1, Ranjeet Bhagooli1,2,4

1Department of Biosciences and Ocean Studies, Faculty of Science and Pole of Research Excellence in Sustainable Marine Biodiversity University of Mauritius, Réduit 80837, Republic of Mauritius
2The Biodiversity and Environment Institute, Réduit, Republic of Mauritius
3Department of Economics and Statistics, Faculty of Social Sciences and Humanities, University of Mauritius, Réduit 80837, Republic of Mauritius
4Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia

*Corresponding author: de.kaullysing@uom.ac.mu

Abstract:

The aquaculture industry is developing significantly throughout the world, thus becoming a viable alternative to sustain the decline in capture fisheries. The Government of Mauritius contemplates on making coastal- and ocean- related activities major contributors in developing and expanding the Ocean Economy of the island, and has identified aquaculture as one of such activities in the foreseeable future. At present, owing to the growing population of Mauritius and increasing arrival of tourists, demand for seafood is expected to increase. Artisanal collection by hand-picking of adult bivalves from the coastal waters of Mauritius has been practiced since long back. Recently, the culture of edible bivalves such as oysters, clams and mussels in barachois is gradually gaining momentum in our local waters. However, not many are involved in the culture of bivalves and limited scientific information on the favourable site and growth conditions remains available on bivalve culture in Mauritius. It is thus imperative to understand the local conditions under which bivalves have optimum energy available to maximize their growth.

This study therefore aimed at determining the growth and survivorship of the oyster *Saccostrea cucullata*, which is consumed locally, in order to support local entrepreneurs and to ensure a sustainable barachois-based oyster culture industry. The objectives were 1) to characterize a local barachois-based oyster farm in terms of seawater physico-chemical properties and to investigate whether the survivorship of *S. cucullata* is influenced by those conditions; and 2) to assess the distribution and density of micro-phytoplankton, and chlorophyll *a* concentration in the barachois in order to determine the relationship between the growth of *S. cucullata* and food availability. This study was carried out at Le Petit Barachois, a local barachois located along the north-east coast of Mauritius at Poudre d’Or, at three stations (S1, S2 and S3) with depths less than 1.5 m. At present, along with *S. cucullata*, mussels (*Modiolus* sp.), clams (*Gafrarium* sp.) and mud crabs (*Scylla serrata*) are also being cultured in the barachois. S1 is located adjacent to the oyster culture area. S2 is situated near a water outlet where adjacent sea water enters and leaves during flood and low tides, respectively. This station was subject to more vigorous and constant water movement. S3 was found towards the end of the oyster culture zone where there is the presence of an outlet which allows water circulation within the barachois.
44, 72 and 40 *S. cucullata* spats were placed at stations S1, S2 and S3, respectively, in June 2018 and monitored over four months (at an interval of approximately 4 weeks) from August to December 2018, in terms of *S. cucullata* growth rate (shell length, width and height), percentage survivorship, sea surface temperature (SST) and dissolved oxygen (DO) and nutrient levels (phosphate, nitrate and silicate). In December 2018, micro-phytoplankton density and chlorophyll *a* concentration were evaluated for each station using spectrophotometric methods.

At the end of the four months, *S. cucullata* survivorship order among the three stations from highest to lowest was S2 (87.69%) > S1 (85.71%) > S3 (85.00%). SST recorded during the study period ranged from 25°C to 34°C. In November 2018, all stations experienced a peak in SST in the order of S3 (34°C) > S1 (32°C) > S2 (31°C). For S1 and S3, highest DO (8.35 and 10.64 ppm, respectively) was recorded in September 2018 and lowest (4.49±0.04 and 4.80±0.05 ppm, respectively) in November 2018. For S2, DO was highest (8.16±0.04 ppm) in August 2018 and lowest (3.89±0.04 ppm) in November 2018. Consequently, mortality rates were in the order of S3 (15.0%) > S1 (10.0%) > S2 (3.4%) from November to December 2018.

Highest nitrate level was recorded at S2 (0.070±0.007 mgL⁻¹), followed by S1 (0.055±0.006 mgL⁻¹) and S3 (0.040±0.006 mgL⁻¹), highest phosphate at S1 (0.527±0.090 μmol/cm³), followed by S2 (0.453±0.058 μmol/cm³) and S3 (0.435±0.039 μmol/cm³), and highest silicate at S3 (3.988±0.820 μmolL⁻¹), followed by S2 (3.045±0.536 μmolL⁻¹) and S1 (2.945±0.108 μmolL⁻¹). Micro-phytoplankton densities varied as 2.72±0.07 x 10⁵ cellsL⁻¹ at S1, 1.25±0.12 x 10⁵ cellsL⁻¹ at S2 and 1.89±0.12 x 10⁵ cellsL⁻¹ at S3. Chlorophyll *a* concentrations were positively correlated with micro-phytoplankton densities. After four months, the monthly growth rates for *S. cucullata* shell length, width and height were 0.092, 0.030 and 0.063 cmmo⁻¹ at S1, and 0.057, 0.041 and 0.103 at cmmo⁻¹ at S3. Growth rate calculations at S2 resulted in negative values which may have arisen due to the mortality of larger samples over the study period, and thus were not considered.

The results indicate that nutrient availability was not a limiting factor in controlling micro-phytoplankton densities. Not all stations in a barachois may provide the optimal conditions for oyster survival. Micro-phytoplankton density of 1.25±0.12 x 10⁵ cellsL⁻¹ is adequate enough to sustain oyster survivorship, while SST of more than 32°C may significantly and adversely impact survivorship. Temperature determines the solubility of oxygen in water. In November 2018, the lowest DO values were recorded at all stations when SST peaked. It has been reported that oyster heart rate increases with increasing temperatures and valvular activity becomes abnormal, affecting feeding and gas exchange. This may lead to oyster mortality. Thus, while demarcating potential barachois-based oyster culture sites, it is crucial to consider an area which has a good amount of flushing, which helps in maintaining an optimum SST for oyster survivorship. A combination of the aforesaid factors is required to attain a high level of survivorship. The outcome of this study may assist oyster culturists to opt for the most favourable barachois-based culture conditions in order to optimize the yield. Moreover, the findings may support further demarcation of most suitable barachois-based oyster culture sites around Mauritius.

Keywords: barachois, chlorophyll *a*, micro-phytoplankton, oysters, *Saccostrea cucullata*