The black clam (*Villorita cyprinoides*) is a commercially important bivalve species in India, accounting for more than 64% of clam landings in Kerala. The major harvesting grounds are located in the Vembanad and Ashtamudi lakes (Suja and Mohamed, 2010). However, important shellfish harvesting areas such as the Cochin Estuary, which forms part of the Vembanad wetland system and is recognised as a Ramsar site, are increasingly affected by anthropogenic pollution, including domestic sewage discharge, municipal runoff, and industrial effluents (Chinnadurai et al., 2020; Chinnadurai et al., 2023; Nandakrishnan and Prasad, 2024).

Several studies have reported microbial contamination in estuarine waters and shellfish from the Cochin region, raising serious public health concerns. Earlier research documented the presence of diarrheagenic strains of *Escherichia coli* and *Salmonella* spp. in the Cochin Estuary, highlighting the risks associated with untreated sewage discharge (Peralta and Andalecio, 2011). Similarly, the bacteriological quality of green mussels (*Perna viridis*) from the same estuary has revealed elevated levels of faecal indicator bacteria and *Vibrio* species (Padua et al., 2023). Clams from the adjacent Vembanad Lake have also been reported to contain faecal indicator bacteria, *Vibrio* species, and *Aeromonas spp.*, posing significant health risks to consumers and seafood handlers (Vaiyapuri et al., 2021; Silvester et al., 2022).

Apart from microbial contamination, the Cochin Estuary is increasingly affected by nutrient enrichment, chemical pollution, habitat degradation, overfishing, and unregulated coastal development, all of which have contributed to the deterioration of water quality (Thasneem et al., 2018). These environmental stressors further increase microbiological risks associated with shellfish consumption, thereby emphasising the need for stringent food safety regulations and effective sanitary measures (European Food Safety Authority [EFSA], 2010).

Globally, regulatory frameworks in regions such as the European Union, the United States, and Australia mandate routine monitoring of microbiological water quality in shellfish-growing areas to safeguard public health and ensure the safety of bivalve molluscs for consumption (European Commission, 2019; U.S. Food and Drug Administration [FDA], 2023). In the European Union, legislation requires competent authorities to classify production and relaying areas for live bivalve molluscs and to routinely monitor faecal contamination using established standards for *E. coli* levels. Harvesting is temporarily suspended when these standards are not met, until corrective actions such as relaying or depuration are carried out (Ciccarelli et al., 2022; Pinn and Le Vay, 2023).

Depuration is a widely adopted post-harvest process in which live bivalves are maintained under controlled conditions in tanks containing clean, treated water, allowing them to naturally purge accumulated contaminants (Martínez-Albores et al., 2020). The efficiency of depuration depends on several factors, including water quality, system design (flow-through or recirculating systems), duration of depuration, and the use of disinfection methods such as ultraviolet irradiation or biofiltration (Oliveira et al., 2011; Küniļi, 2024).

Among the various depuration methods, closed water depuration systems have emerged as a promising alternative to conventional open-flow systems. These systems utilise recirculating water coupled with biological filtration to remove microorganisms while conserving water and allowing greater control over environmental conditions (Campbell et al., 2022; Chinnadurai et al., 2023). Such systems are particularly beneficial in areas where access to clean water is limited or unreliable. During depuration, clams expel ingested microorganisms and contaminants in mucus-coated faecal pellets, which may lead to recontamination if not effectively removed from the system. Therefore, an efficient biofilter is essential for trapping and reducing expelled microorganisms in closed-water depuration systems.

Despite these advantages, closed water depuration systems face challenges such as the formation of biofilms on tank surfaces and filtration units. Biofilms consist of complex microbial communities embedded within an extracellular polymeric substance (EPS) matrix, which provides protection against environmental stressors such as ultraviolet radiation, salinity fluctuations, and antimicrobial agents (Flemming et al., 2016). Biofilm formation begins with bacterial attachment to submerged surfaces, followed by colonisation, EPS secretion, and maturation.