Biochar from seaweed: A sustainable tool for ensuring the microbial water quality from the seafood industry

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The seafood industry is upcoming as a fast-paced growing sector around the world for the past few decades. Worldwide, seafood consumption increased drastically as a healthy choice of animal protein with enhanced nutritional quality in terms of easily digestible proteins, poly-unsaturated fatty acids and various vitamins and minerals. Indian seafood production indicates 21-fold growth in the last seven decades with an average annual growth rate of 10.88% and ranks second after China with an export quantity of 1.4 mmt worth 7.76 billion US dollars (SOFIA, 2022). Seafood processing is an industry which has a substantial requirement of water. (Tomsczak-Wandzel et al., 2015). Positives apart, seafood water footprint and pollution remain as significant stand-out challenges among various seafood industry-related issues. A large volume of wastewater is generated from the seafood industry. Almost all steps in the seafood industry require water; from preprocessing (raw material washing, cleaning), processing (freezing, thawing, cooking, brine preparation, glaze preparation), and post-processing (Storage and transportation) (Murali et al., 2021). In addition, water is used in large quantities to maintain hygienic conditions such as equipment and floor cleaning, proper toilet and washing facilities, foot and hand dips etc (Henriksson et al., 2018). According to the Export Inspection Council (EIC) of India, on average, a minimum of 10 L of water is necessary to process 1 kg of fish (EIC, 2005). As water is a finite source, wise usage is always necessary. Minimization of water usage and reuse of water after proper treatment is necessary to overcome the expected water shortage.

Biochar is a charcoal-like carbonised form of biomass (grass, agricultural and forest residues) formed by pyrolysis under controlled conditions (Vijay et al., 2021). Generally, biochar act as a soil conditioner possessing properties like water retention, nutrient retention, and stable storage of carbon (Murtaza et al., 2023). In addition, biochar also holds large adsorption surfaces with different functional groups which can capture and filter water pollutants including heavy metals. Therefore, switching from conventional to green-safe methodologies like biochar-aided water treatment is of great advantage not only to the industry but also to the environment. Therefore, this study evaluates the efficiency of biochar developed from seaweed in the treatment

of wastewater generated from the seafood industry.

Wastewater samples from the seafood industry of Taloja, Navi Mumbai region were collected aseptically in sterile bags. Biochar from brown seaweed Sargassum wightii was prepared according to Rehana et al., 2023. Water samples were enriched in trypticase soy broth (TSB) and biochar was added at different concentrations from 1% to 10% followed by incubation at 37˚C for 24 h. To evaluate the initial viable microbial load, all the test samples were subjected to total plate count studies by plating 0.1ml of serial dilution from 10^{-1} to 10^{-13} prepared in normal saline over plate count agar (PCA). The plates were further incubated at 37˚C for 42 hours (BAM Method). Similarly, the total viable count of the enriched treatments from T0 to T7 was also carried out. After incubation, plates with 30-300 colonies were selected for the expression of viable bacterial count. Results were expressed in CFU/g.

In this study, it was found that biochar developed from brown seaweed Sargassum wightii could remove microbial contamination at a 10 % incorporation level (Figure 1 and Table 1). The clear water after treatment in this study reveals that seaweed-based biochar is highly effective in water clarification by filtering and adsorbing (Figure 2). Therefore, seaweed-based biochar developed from Sargassum wightii can be adopted as a suitable eco-friendly method for treating wastewater developed from the seafood processing industry. Further studies are required to understand the impact of seaweed-based biochar on water quality along with other existing and emerging water quality amendment practices.

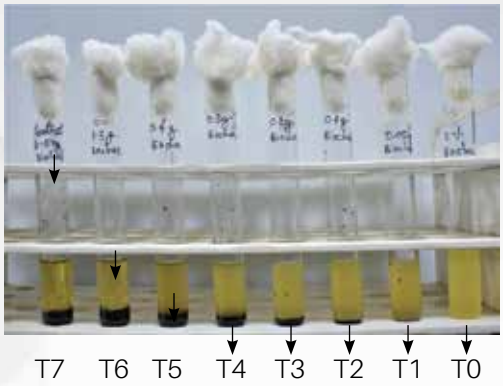

Fig 1. Change in visible turbidity in different treatments from T7 to T0

Table 1. Average bacterial load at different treatment conditions

Sl No	Treatments	Conditions	Average viable count in CFU/g
1	T0	Control (5ml TSB + 500µl waste water)	TNTC
2	T1	5ml TSB + 500µl waste water+ 0.05g biochar	TNTC
3	T2	5ml TSB + 500µl waste water + 0.1g biochar	TNTC
4	T3	5ml TSB + 500µl waste water + 0.2g biochar	$1.9 \times 10^3 \pm 0.03$
5	T4	5ml TSB + 500µl waste water + 0.3g biochar	$6.8 \times 10^3 \pm 0.03$
6	T5	5ml TSB + 500µl waste water + 0.4g biochar	$2.3 \times 10^2 \pm 0.04$
7	T6	5ml TSB + 500µl waste water + 0.5g biochar	Less than 10
8	T7	5.5 ml TSB + 0.5g biochar	Nil

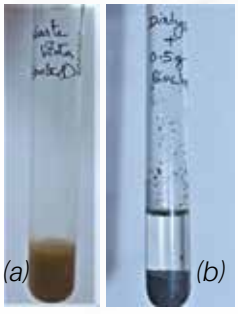

Fig 2. Turbidity reduction in waste water without biochar (a) and with 0.5g biochar (b)