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Reducing red color intensity of seafood wastewater in facultative pond

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Abstract

Studies were carried out on the growth of *Chromatium* sp. on seafood wastewater (SFWW), which under facultative conditions and light exposure produced red pigment. The strain grew and utilized organic matter in both dark and light exposure conditions, but it produced red pigment when exposed to light. The growth was repressed by aerobic condition. The red color intensity was reduced by about 32.5 ± 1.5 and 70.8 ± 2.8% when kept under dark and static conditions, or aerobic and light exposure conditions, respectively. The COD of SFWW and the number of cells of *Chromatium* sp. were also rapidly reduced by about 78.6 ± 2.7 and 92.0 ± 1.0%, respectively, under aerobic and light exposure condition. KNO_3 and $FeCl_3$ also reduced red color intensity and maximum removal of organic matter and red color were 30 and 4 mg/l, respectively. Aerobic conditions increased the color removal efficiency with 30 mg/l KNO_3 and 4 mg/l $FeCl_3$ treatments up to 96.5 ± 1 and 98.9 ± 1%, respectively.

Keywords: Seafood wastewater; Facultative pond; KNO_3; $FeCl_3$; Purple sulfur photosynthetic bacteria; *Chromatium* sp.

1. Introduction

Food processing industries, especially the seafood industry, is one of the most important exporting-industries of Thailand. This industry uses large volumes of water for many purposes such as washing, thawing, cutting, and butchering (Sirianuntapiboon and Nimnu, 1999). Seafood processing wastewater contains a large amount of organic matter and nitrogenous compounds. Thus, the biological treatment process might be suitable to treat such wastewater (Metcalf and Eddy Inc., 1991; Roeckel and Aspe, 1996). The combined aerobic pond and aerated lagoon system was popular because of its easy operation, low operation costs, and resistance to fluctuation of organic or hydraulic loadings (Metcalf and Eddy Inc., 1991; Veenstra et al., 1995; Houghton and Mara, 1992). However, if the system is operated under facultative conditions, the wastewater color becomes red due to the growth of purple sulfur photosynthetic bacteria (Freedman et al., 1983; Alabaster, 1991; Houghton and Mara, 1992; Veenstra et al., 1995; Villanueva et al., 1994). The effluent quality was lower than expected with color intensity (red color), smell and high-suspended solid concentrations (Nair, 1992). Houghton and Mara (1992) found that the increasing of organic loading in primary stabilization pond reduced the number of algae and increased the number of purple sulfur photosynthetic bacteria. The hydrogen sulfide concentration in the high-rate photosynthetic wastewater treatment plant was increased due to the death of algae and the domination of purple sulfur photosynthetic bacteria (Villanueva et al., 1994; Guyoneaud et al., 1998; Sinha and Banerjee, 1997). The number of purple sulfur bacteria in the oxidation pond increased while the

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sulfide and volatile fatty acid concentrations in the wastewater decreased (Veenstra et al., 1995; Angelica et al., 1993; Sinha and Banerjee, 1997). Thus, it could be concluded that the major problem in the facultative pond is the growth of red color producing bacteria (RCPB). In this study, the chemical properties of the red colored seafood wastewater were investigated together with the characterization of RCPB. The physical and chemical treatment processes were tested for reduction of red color substances in wastewater and improving the quality of effluent.

2. Methods

2.1. Wastewater and wastewater treatment plant

The wastewater treatment plants of a frozen seafood factory (factory No. CS-10) and a fish-canning factory (factory No. CN-03) in Samuthsakhorn province, Thailand were investigated. The wastewater sample (red color wastewater: RCWW) from pond CS-10-P3 and pond CN-03-P2 (Fig. 1) were collected for isolation of red color producing bacteria (RCPB) and sample from pond CS-10-P3 was used for testing the efficiencies of chemical and physical treatment processes.

2.2. Physical and chemical treatment processes

All experiments were carried out using 2-L flask containing 500 ml of wastewater from pond CS-10-P3. For physical treatment, each flask was fully aerated under dark and light exposure (sunlight exposure) conditions and without aeration (static) under light exposure condition (control) at 30 °C for 12 days. For chemical treatment, KNO_3 at 10, 20, 30, 40 and 50 mg/l and $FeCl_3$ at 1, 2, 3, 4, and 5 mg/l were used. The cultivation conditions of chemical treatment were static (without aeration) and aerobic (aerated) under light exposure at 30 °C for 12 days. The culture broth from each flask was collected for determination of chemical and biological properties and red color intensity.

2.3. Chemical analysis

The biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), suspended solids (SS), total kjeldahl nitrogen (TKN), chlorine residue (Cl_2), total

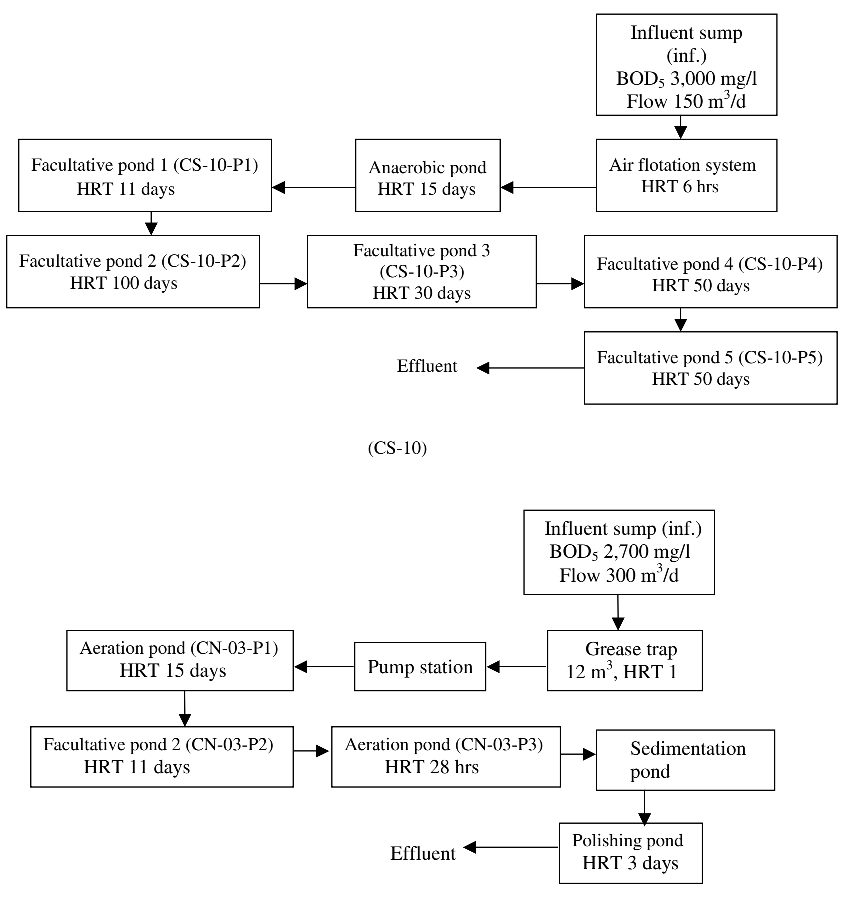

Fig. 1. Flow diagram of wastewater treatment plants of the frozen shrimp factory (No. CS-10) and the fish canning factory (No. CN-03).