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Beneficial Microbes-2015: Beneficial microbes for the treatment of dyes contaminated wastewater- Zaharah Ibrahim- University Teknologi Malaysia

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Abstract
The removal of colour, especially from coloured wastewater containing azo dyes has been a great challenge over the last decade and until now; there is no single and economically treatment method. A good example is the textile wastewater, classified as the most polluted industrial wastewater, may contain dyes, dye break down products, plant materials, organic solvents and detergents that are detrimental to the environment and pose health threats to the human population. To meet the regulatory compliance, the industries have to spend several million dollars in capital investment and hundreds of thousands of dollars in annual operating costs. As effective treatment plant is generally expensive and unaffordable, the application of beneficial microbes able to decolourise and transform coloured compounds into simpler and non-hazardous compounds is a good alternative and timely solution. The research challenge was to develop mixed culture of microorganisms capable of removing colour from dye containing effluents. Under the sequential facultative anaerobic-aerobic process, the selected mixed culture of bacteria which were later identified as Brevibacillus panacihumi strain ZBI, Lysinibacillus puciformis strain ZB2 and Enterococcus faecal is strain ZL when used for the treatment of real wastewater showed up to 80-90% of decolourisation followed by detection of smaller and readily degradable molecules for safe discharge of effluent. The wastewater was also analysed for its water quality parameters and Eco toxicity tests. Utilising this mixed culture of bacteria offers alternative green solution to replace or complement the use of chemicals in conventional methods for treatment of coloured wastewater.

INTRODUCTION

Self-immobilization of microorganisms to form flocs has so far been considered as the most favourable method in anaerobic and aerobic wastewater treatment processes. For the past 20 years, their application in wastewater treatment had been developed using the uptown anaerobic sludge blanket (UASB), with the granular sludge being one of the important characteristics of UASB reactors. The Subsystem is also being considered as the best reactor system to generate reliable granule formation particularly for waste-water with high carbohydrate content (Uyanik et al. 2002).These types of reactor are desirable in biological wastewater treatment as high number of organisms can be maintained in the reactor, allowing highly concentrated or large volumes of wastes to be treated.

In general, the uptown velocity in the UASB creates selective pressure to cause the organisms either to be washed out or to bind together (Guiot et al. 1992).Methanogen microorganisms found in the flocs which exhibit natural tendencies to aggregate were also reported being the cause of the flocs formation (Fang et al. 1994).Exopolymeric substances (EPS) secreted by these bacteria may have roles in bridging the bacterial cells and hold theflocs together while the composition of the substrate is also an important factor for the flocs formation (Shen et al. 1993;Dolfing et al. 1998). It was also hypothesized that Ca2þandFe2þmay have roles in creating a matrix in the flocs(Van der Hoek 1987). The formation of flocs and changes in the physical properties with longer treatment process causes the flocs to become more compact, higher density and higher settling velocity. These flocs are often referred to as granules. Generally granules are benefited by low hydraulic retention time (HRT) and high organic loading rate (OLR) (Wirtz & Dague 1996). Low HRT causes poor-settling biomass to wash out while high OLR ensures sufficient new biomass growth. Characteristics of the granules are dependent on the type of wastewater and inoculum used besides the operating conditions during the primary start-up. In this study, flocs were reported to be formed in different type of an uptown reactor known as the aerobicbiofilm reactor (ABR). The reactor was maintained under aerobic condition and was filled with support materials. Selected bacterial decolourizers were inoculated into the reactor for the treatment of textile wastewater. In addition to the formation of biofilm on the support materials, prolonged operation of the system brought about the formation of suspended flocs in the reactor which when further tested showed their potential use in the removal of colour and COD of raw textile wastewater. Subsequent changes in the flocs physical properties were observed with longer operational time. The flocs became more compact with higher density and settling velocity resulting in lower sludge volume index (SVI). These characteristics which are similar to those of granules have distinct advantages for complete degradation of waste materials. Hence, it would of great interest to study the microbial consortia making up the flocs and their physical properties. This in turn may provide impetus for further research in microbial granulation technology for the treatment of wastewater enhancing the current biological treatment processes. This study was undertaken to characterize the flocs in terms of their physical properties, conditions that induced their formation and their potential use in the treatment of textile wastewater.

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MATERIALS AND METHOD

Preparation of bacterial inoculum. The bacteria used in this study were isolated from the textile wastewater samples. These isolates were initially grown aspure and mix cultures in liquid medium containing various types of pure ago dyes (100 ppm) and raw textile wastewater at 378C. A series of experiments were then conducted to screen for bacteria capable of decolourising the dyes and textile wastewater. Bacteria with the best abilities to decolourise the pure dyes and textile wastewater were selected. They were grown as a mix culture using textile wastewater as the growth medium prior to transferring them as inoculum (10%, v/v) during their active growth phase into the reactor. In addition, nutrient broth (1 g/L)was also added as co-metabolite.

Operations of the aerobic biofilm reactor system Two Aerobic Biofilm Reactors (ABR) arranged in series formed the main component of a pilot scale prototype treatment system (Figure 1). They are made of organic polymer materials with capacity of 1 m3and 2 m3 respect-ively. The reactors were filled with spherical inert carrier made from high density polyethylene (HDPE) which functions as support material for the development of biofilm. This support material has a specific surface area of 160 m2/m2and 73.7 cm3 (Comment: which one isspecific surface area and may want to check the unit).Prior to the treatment process, the microbes were acclimatized in the textile wastewater. For this purpose, mix cultures of the selected bacteria were inoculated (10%v/v) into both ABRs. Besides, characteristics of the raweffluent were also analysed for pH, BOD, COD, TSS and colour according to Standard Methods (APHA 1995). The raw wastewater (influent), with average organic loading rate (OLR) of 73.6 kg/m3h was pumped batch wise directly from the treatment plant into the collection sump basin of the prototype treatment system. From this basin, the waste-water was fed into the ABRs at a flow rate of 2 m3/d to provide HRT of 12 hrs. And 24 hrs. in each reactor respect-ively. The wastewater entered each ABR at the bottom and exit at the top. In the first ABR, mixing was provided by installing a circulation pump at the bottom. This also maintained the DO level at below 2.0 mg/L. The second ABR was equipped with an aeration device to maintain the DO level up to 4 mg/L. The effluent from the second ABR entered into a clarifier before discharging to a nearby drain. The reactor system was operated for a period of 90 –100days. The microbial flocs were collected from the clarifierat the end of the study period.