

**A NOVEL ACINETOBACTER SP. FOR TREATING HIGHLY ACIDIC
RUBBER LATEX CENTRIFUGATION EFFLUENT**

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Summary

A novel Acinetobacter sp. BTJR-10 isolated from highly acidic (pH 2.5-4.5) rubber latex centrifugation effluent with high COD (22000 mg/L) and BOD (5000 mg/L). This strain could effect 39.5% COD reduction on free cell inoculation of effluent without incorporation of additional nutrients after 8 days. Calcium alginate immobilized cells showed 16.4% and 25% COD reduction after 6 hrs. without aeration and after 1 hr. with mild aeration under batch process respectively. Whereas 44.0% COD reduction could be achieved after 6 hrs. on continuous treatment in a packed bed reactor with mild aeration. Further, even after 3 cycles 37% COD reduction was recorded with continuous treatment.

Introduction

Latex concentrate is obtained by centrifugation during the processing of natural rubber. The effluent generated during the different unit operations is highly acidic, has high COD and BOD and sustain some microbial growth. Disposal of these effluents without proper treatment leads to anaerobiosis and consequent death of the aerobic ecosystem and destruction of water course in terms of social and amenity value (Rubber and its Cultivation, 1992). Several methods such as treatment of latex centrifugation effluent in aerobic pond coupled with stabilisation pond (Muthurajah et al., 1973); with Chlorella vulgaris (Ponnaiah et al., 1975); seeding the effluent with Chlorella vulgaris and maintaining the tank aerated in light (Jacob Mathew et al., 1988); with a two stage anaerobic system (Ashok Pandey et al., 1988) are reported. All these methods are not only

inefficient to rapidly bring down the COD to optimum level but also time consuming and need a large landspace. Application of immobilized cells have not been reported for the treatment of latex effluent. In this paper we report on the efficiency of the immobilized Acinetobacter sp. BTJR-10, isolated from acidic latex effluent to treat the latex effluent rapidly under batch as well as continuous process.

Materials and Methods

Sample: Raw effluent from the latex centrifugation plant was collected in clean containers from the settling tank in the early hours of the day when the wastewater from the skim latex coagulation unit was pumped into it from a nearby rubber processing factory. Samples were used immediately after collection.

Strain: Acinetobacter sp. BTJR-10 isolated from highly acidic (pH 2.5-4.5) rubber latex centrifugation effluent and available in the culture collection of the Centre for Biotechnology was used in the present study. The strain was maintained on Nutrient Agar (HI Media).

Preparation of Immobilized cells: Acinetobacter sp. grown in nutrient broth for 24 hrs. at room temperature ($28\pm 2^\circ\text{C}$) was harvested by centrifugation at 10000 rpm for 30 min. and immobilized in calcium alginate beads (Mohandass, 1992).

Treatment of latex effluent by Batch Process:

By Free Cells: One litre of effluent taken in 3L Hoffkins flask was inoculated with the 18 hrs. old cell suspension (5% v/v level) (Mohandass, 1992) and incubated at room temperature ($28\pm 2^\circ\text{C}$) for a period of 10 days. Samples were withdrawn at regular intervals of 24 hrs. and analysed for COD, cell protein and total sugar. Efficiency of treatment is expressed in terms of percentage reduction of COD.

By Immobilized cells: Treatment was carried out in conical flasks and in packed bed column reactor at room temperature ($28\pm 2^\circ\text{C}$). 200 beads of immobilized cells were taken in 500 ml conical flask and subjected to activation for 6 hrs. (after optimisation) with latex effluent. Later the activated immobilized cells were exposed to latex effluent for different residence periods and the treated effluent was analysed for residual COD and protein.

Effect of aeration on the activity of the immobilized cells during batch process treatment of latex effluent was tested in a packed bed column reactor. Immobilized cells in beads were packed to a height of 150 mm in a glass column (dia. 41 mm) with glass wool at the bottom and stabilised with latex effluent. After eliminating the air bubbles formed in the column during packing by gently tapping the

glass column, void volume in the packed bed was determined. After activation for 6 hrs. with latex effluent the immobilized cells in the packed bed were exposed to latex effluent for varying retention periods. During the treatment mild aeration at the rate of 0.5 VVM was given to the packed bed column by passing air from the bottom. The effluent samples were analysed for residual COD and protein at regular intervals.

Treatment of latex effluent by continuous process

Continuous treatment of latex effluent employing immobilized cells was tested in a packed bed reactor by allowing the effluent to flow from the bottom of the column upwards using a peristaltic pump (Miclins, India) with mild aeration (0.5 VVM) at room temperature ($28\pm 2^\circ\text{C}$). Packed bed column with immobilized cells (150mm x 41mm) was prepared as mentioned above and activated with latex effluent initially for 6 hrs. Later the effluent was continuously passed into the column at the flow rate of 7 mL/hr. Samples were collected from the top at intervals of 3 hrs. upto a total period of 18 hrs. and analysed for residual COD. Three cycles of the process were repeated. Control experiment was also performed. Results are expressed in terms of percentage reduction of COD.

Analytical Methods: Effluent was analysed for Chemical Oxygen Demand (ASTM, 1974), Biological Oxygen Demand (APHA, 1975), Suspended Solids (APHA, 1975), Total Dissolved Solids (APHA, 1975), Protein (Lowry et al., 1951) and Total sugar (Dubois et al., 1956).

Results and Discussion

Fresh latex effluent recorded a high level of COD (22000 mg/L), BOD (5000 mg/L), Suspended Solids (7000 mg/L), Total Dissolved Solids (2000 mg/L) and pH 2.5-4.5 indicating a heavy load of organic substances. This effluent on treatment with free cell inoculation could effect 39.5% of COD reduction after 8 days of incubation at static culture conditions (Fig.1). According to Montgomery (1967) estimation of BOD is not ideally suited for studies of process design and treatability, control of treatment plants, setting standards for treated effluents and assessing the effect of polluting discharges on the oxygen resources of receiving water. Hence in the present study only COD was measured to determine the impact of activity of the organism in the effluent during treatment. During the batch process treatment of effluent in conical flasks the immobilized cells showed a rapid reduction of 16.4% reduction in COD within 6 hrs. without

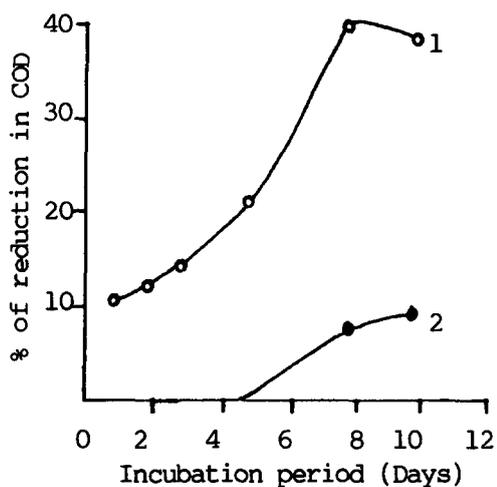


Figure 1: Percentage reduction of COD during treatment of latex effluent with free cells of Acinetobacter sp.

- 1 - Treated effluent,
- 2 - Control (untreated).

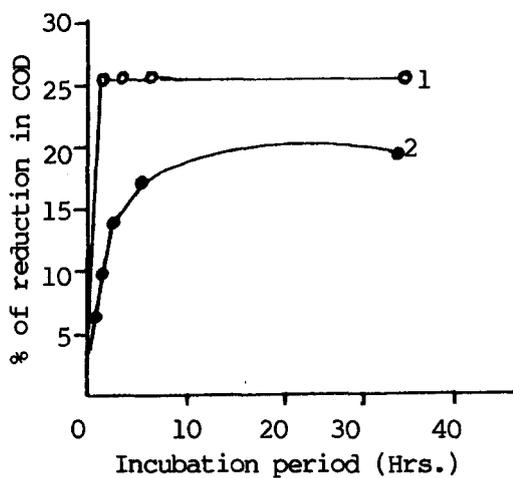


Figure 2: Treatment of latex effluent with Acinetobacter sp. BTJR-10 entrapped in calcium alginate beads--Batch process.

- 1 - With mild aeration - packed bed column.
- 2 - Without aeration - conical flask.

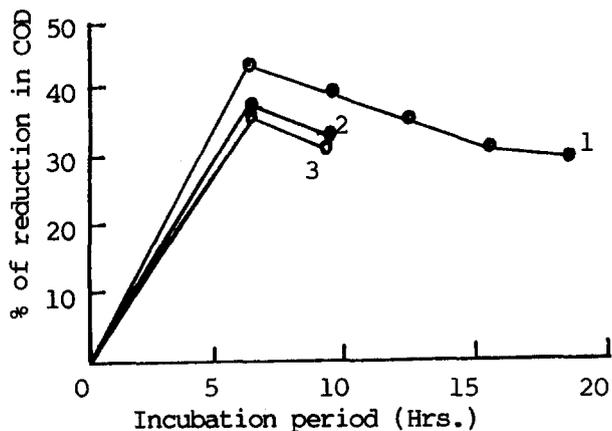


Figure 3: Treatment of latex effluent with Acinetobacter sp. BTJR-10 entrapped in calcium alginate beads--Continuous process.

- 1 - I cycle,
- 2 - II cycle,
- 3 - III cycle.

aeration compared to the 25% COD reduction in packed bed reactor and under mild aeration within 60 min. (Fig.2). In both the reactors, further reduction in percentage of COD was not significant though immobilized cells in the column reactor definitely had better contact with the effluent compared to conical flask. The mild aeration would have accelerated the process of bioconversion and consequent increase in the percentage of COD reduction. It is evident from Fig.3 that continuous treatment of effluent with immobilized cells is more suitable and ideal since a maximal of 44% reduction in COD could be achieved in 6 hrs. of flow with a flow rate of 7 mL/hr. in the first cycle. Interestingly, even after 3 cycles of repeated run of effluent through the column the immobilized cells were active and yielded 37% reduction in COD. Enhanced activity in COD reduction under continuous treatment process compared to batch process might be due to the slow movement of effluent along the column which could have facilitated more contact and activity by all cells and cumulatively contributed to the total reduction in COD. In fact immobilized Acinetobacter sp. is reported to remove high concentration of phosphate (Deinema et al., 1980). Hence the results of the present study indicate that immobilized Acinetobacter sp. cells could facilitate safe disposal of rubber effluent without the need for larger land space and longer treatment periods towards healthier environment once appropriate technology is developed for large scale treatment of effluent.

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