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Use of crushed olive kernels as carrier in malathion biodegradation

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ABSTRACT

Immobilization of microorganisms on inert supports is widely used for wastewater treatment since this strategy leads to a more efficient process. In this study, the biodegradation of malathion using acclimated activated sludge culture was achieved. The performance of a laboratory scale reactor (Packed Bed Reactor) treating malathion using crushed olive kernels as carrier for cell immobilization was investigated. The activated sludge was found to be able to use the malathion as the sole carbon source. The degradation capacity of the Packed Bed Reactor was higher than the performance obtained with the batch reactor. Reactor packed with crushed olive kernels permitted a complete degradation of malathion (10mg/ dm^3) within 12h.

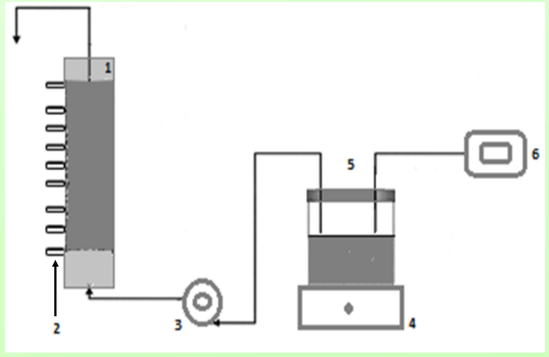
MATERIALS AND METHODS

A) Microorganism and culture conditions

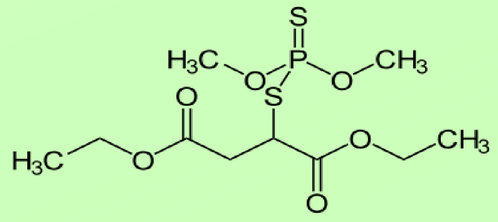
Synthetic wastewater was consisted of 0.038g KH_2PO_4, 0.05g $MgSO_4$, 0.05g $CaCl_2$ and 0.2g urea, dissolved in 1dm3 of distilled water. A mixed activated sludge culture, obtained from the aeration unit of wastewater treatment plant in Staouali -Algiers, was used in this study. The activated sludge culture was grown in the aeration tank using the same synthetic wastewater in the presence of increasing malathion concentrations (5 to 140 mg/dm^3) for adaptation purposes. The culture was performed at room tem perature (25°C, max. deviation ± 1°C) with a moderate agitation (100 rpm) using magnetic stirrer and was supplied with oxygen by fine bubble air diffuser (2.5dm^3/min/dm^3).

B) Reactor and operation conditions

The laboratory scale Packed Bed Reactor (PBR) was used with an aeration tank containing synthetic wastewater. It was made using PVC tube with an internal diameter of 2 cm, an overall height of 100 cm, wall thickness of 3mm and 9 sampling ports. The reactor was streamed by upflow in the column to increase the degradation efficiency and was working in room temperature (25°C, max. deviation ± 1°C). The total volume of packed bed reactor was 314 cm3. Crushed Olive Kernels, a by-product of olive oil production, were used as carrier material and were packed at 90% of the working volume. Microorganisms were then adsorbed onto the carrier. Five dm^3 of synthetic wastewater solution containing 10mg/dm^3 malathion used as the sole source of carbon and energy was pumped into the bottom of the column at different flow rates, ranging from 0.2 to 2 cm^3/min using a peristaltic pump.



Schematic diagram of PBR with aeration tank. 1 – Packed bed reactor, 2 – sampling outlets, 3 – peristaltic pump, 4 – magnetic stirrer, 5 – aeration tank, 6 – air pump



Structure of Malathion

C) Analytical procedures

-Malathion determination

Samples were removed at various time intervals. Malathion concentrations were carried out using colorimetric method proposed by Naidu et al. (1990).

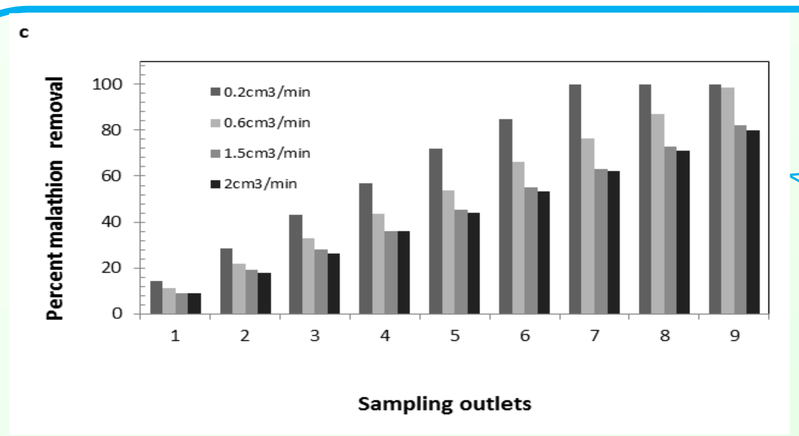
-Estimation of biomass concentration

Biomass concentrations were determined, by measuring Mixed Liquor Volatile Suspended Solids (MLVSS) as follows: MLSS (Mixed Liquor Suspended Solids) was carried out by drying the residue on filter paper (Millipore 0.45µm) for 2h at 105ºC and weighted. MLVSS analyses were carried out by igniting the MLSS analysis residue for 1h at 550ºC. The MLVSS (mg/dm3) was calculated as being the weight difference of MLSS before and after the combustion step. The Relative Standard Deviation (R.S.D) was less than 2%.

-Environmental Scanning Electron Microscopy (ESEM) examination of the carrier materials

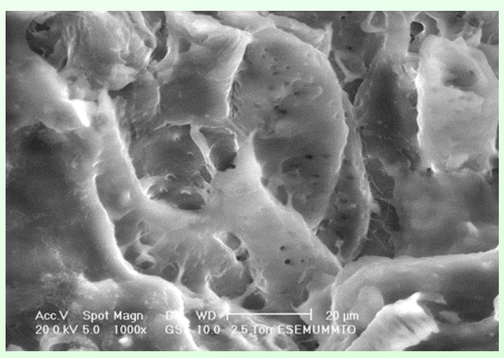
The virgin carrier material surfaces and the carrier material surface containing the microbial biofilm were examined by Environmental Scanning Electron Microscopy (Philips XL-30) with no prior sample preparation.

RESULTS

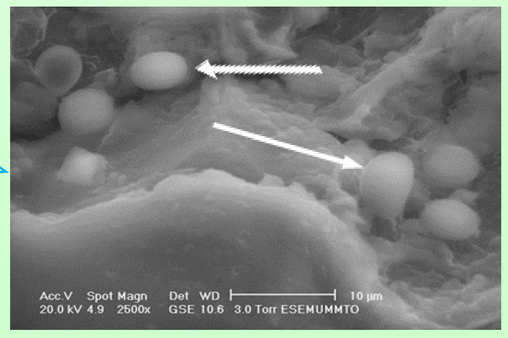


Results obtained in the present study demonstrate that PBR can promote enhanced malathion removal from synthetic wastewater.

According to the data obtained, it is noted that the removal efficiency of malathion for all biofilm carriers tested is affected by the flow rate. This could be explained, by the fact that an increase in flow rate resulted in a decrease in reaction rate because of in-sufficient residence time of the reactants in the column . Results obtained show obvious performances of PBR for malathion degra-dation in which biomass adsorbed on Crushed Olive Kernels was able to completely degrade malathion within 12h.



The ESEM examination of the carrier biofilm showed attached micro-organisms in Crushed Olive Kernels carrier. It was noted that these carrier have a good density of cells attached on their surface



CONCLUSION

The results of this study allowed to demonstrate that:

The acclimated activated sludge was able to degrade malathion and to use it as the sole carbon source, as indicated by the fact that the degradation was accompanied by concurrent bacterial growth, suggesting that the mixed culture used was growing at the expense of mala-thion.

A possible strategy to degrade completely malathion is to use the laboratory scale PBR of which the effectiveness was clearly demonstrated in this study. Crushed olive kernels used as carrier in PBR permitted a complete degradation of malathion within 12h. The advan-tages related to this available by-product (high cell retainment and costless) make it a suitable option as a cell carrier.