Comparative study on the attachment of bacteria consortium MDK.EKO-7 onto different carriers

A.Berzins[1], K. Potapova[1], S.Strikauska[1,2], O.Muter[1]

[1]Institute of Microbiology and Biotechnology, University of Latvia, 4 Kronvalda blvd., LV-1010 Riga, Latvia, andrejs54@inbox.lv
[2]Latvia University of Agriculture, 2 Liela Str., Jelgava, Latvia, LV-3001

Introduction

The processes of bacteria attachment are widely used in environmental biotechnologies. A choice of the carrier for biodegradation process is an important factor in the high degree biodegradation of pollution, and efficient maintenance of the system over a long period.
The aim of this work was to compare the process of bacteria attachment onto different types of carrier and select the most appropriate carriers for the model biofiltration experiments.

Materials & Methods

20 potential carriers for the attachment of bacteria consortium MDK.EKO-7 were compared by biofilm activity, measured as microbial enzymatic activity, the number of colony forming units as well as visualized by light and scanning electron microscopy (Fig.1). Bacteria consortium MDK.EKO-7 was previously isolated from hydrocarbons-contaminated soils and consists of 5 strains of *Stenotrophomonas maltophilia* and 2 strains *Pseudomonas* spp. The performance of five biofiltration columns (total volume 1.58 L each) packed with rape straw and ceramic beads in different composition was compared (Fig.2, Table 1).

Results & Discussion

Among potential carriers tested in this study, the following materials were shown to be the most appropriate for bacteria consortium MDK.EKO-7: peat V; black soil; aluminium oxide; ceramic beads VII; leafs of Eastern galega (Fig.3). Besieds, rape straw was found to be suitable for bacteria attachment (results not shown).

The five-columns model system was designed for removal of diesel volatile hydrocarbons with the use of dual composed carrier material, i.e. ceramic beads and rape straw.

The highest removal efficiency for volatile hydrocarbons among biofiltration columns tested, i.e., 46.7 %, was found to be in the column containing rape stalks. The most intensive compaction of packing material was detected in the columns with ceramic beads and rape pods, i.e., 8.7 and 10.6 %, respectively. Compaction in other columns varied in the range of 3.3 ÷ 4.0 %. The same columns were characterized by the most considerable decrease of cellulose in the rape pods after 44 days experiment (Table 1).

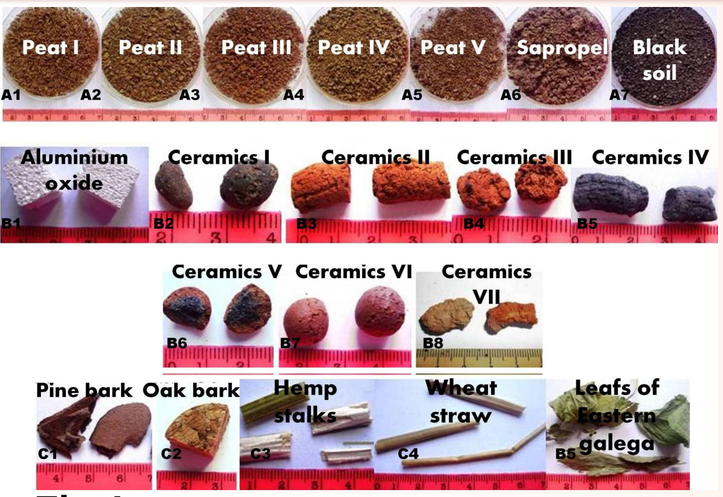

Fig.1. Organic and inorganic materials tested in the experiment on bacteria consortium MDK.EKO-7 attachment on the carrier.

Table 1. OPERATING CONDITIONS OF THE "5 COLUMNS" MODEL SYSTEM

Items or parameters	Columns				
	1	2	3	4	5
Packing material	Ceramic beads / rape pods	Ceramic beads / rape stalks	Rape pods	Rape stalks	Ceramic beads / rape pods
Inlet hydrocarbon concentration, ppm	150	150	150	150	150
Air flow direction	Upflow	Upflow	Upflow	Upflow	Upflow
Air flow rate, m^3/h	0,0312 ÷ 0,0378	0,0360 ÷ 0,0438	0,0276 ÷ 0,0426	0,0414 ÷0,0480	0,0198 ÷ 0,0264
Removal efficiency for volatile hydrocarbons, % (Day 9 / Day 9, repeated measurement after 1h / Day 29)	26,7 / 6,7 / 26,7	33,3 / 20,0 / 33,3	33,3 / 13,3 / 26,7	46,7 / 33,3 / 40,0	20,0 / 13,1 / 20,0
Packing material saturation capacity time for volatile hydrocarbons, s (Empty, Day 1 / Inoculated, Day 2 / Incubated, Day 14)	111 / 150 / 130	152 / 283 / 15	289 / 268 / 297	320 / 291 / 109	240 / 324 / 250
Compaction of the packing material after 44 days experiment, % of the total column height	8,7 (73,9-65,2)	4,0 (84,4-80,4)	3,3 (74,4-71,1)	3,6 (90,0-86,4)	10,6 (72,5-61,9)

Fig.2. The five-columns biofiltration model system filled with packing material.

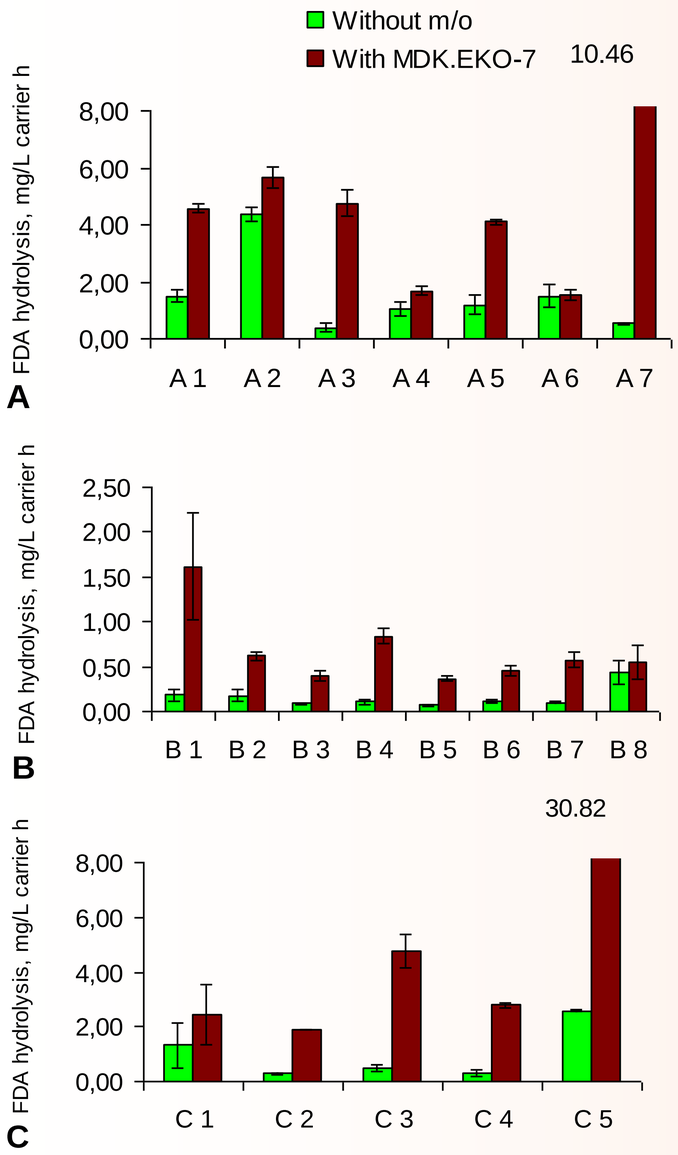

Fig.3. Fluorescein diacetate (FDA) FDA hydrolysis activity of bacteria consortium MDK.EKO-7 attached onto the surface of the carrier after 24h incubation.

Conclusions

1. Different composition of packing material in five tested columns did not result in significant differences of culture growth.
2. Inoculation and cultivation of bacteria consortium led to an increase of the saturation capacity time in the columns with combined packing materials, i.e., ceramic beads and pods or stalks (columns No.1, 2 and 5). At the same time, the columns packed with organic material only (columns No.3 and 4), demonstrated a rather high saturation capacity time for volatile hydrocarbons already at the beginning of the experiment.
3. The most intensive compaction of packing material was detected in the columns No.1 and 5, filled with ceramic beads and rape pods, i.e., 8.7 and 10.6 %, respectively. Compaction in other columns varied in the range of 3.3 ÷ 4.0 %.
4. The results of this study indicate to the significance of the composition of packing material. Further experiments should be performed at the bigger scale.

Acknowledgements

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