FAO European Cooperative
Research Network

RAMIRAN

Recycling of Agricultural, Municipal and Industrial Residues in Agriculture

Network Coordinator: José Martinez, Cemagref, Rennes (France)

RAMIRAN 2002

Proceedings of the 10th International Conference of the RAMIRAN Network

General Theme: Hygiene Safety

Štrbské Pleso, High Tatras, Slovak Republic
May 14 - 18, 2002

Edited by Ján Venglovský and Gertruda Gréserová

ISBN 80-88985-68-4

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TREATMENT OF THE SOLID FRACTION OF PIG EXCRETA WITH 1 AND 2 VOLUME% OF ZEOLITE

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SUMMARY

Excreta produced in piggeries are treated in wastewater treatment plants by aerobic processes. The solid fraction contains high numbers of microorganisms of which several may cause diseases transmissible to humans therefore further treatment of the solid fraction is needed. From the viewpoint of treatment the effects of the addition of 1 and 2 vol% of zeolite to the solid fraction of pig excreta were investigated in an experimental closed dungyard situated outside the stables.

Zeolites are natural sorbents able to inhibit the survival of microorganisms, thus they have good prospects of being used in the treatment of pig excreta. The effects of zeolite added at two concentrations (1 and 2 vol%) became evident in decreased counts of microorganisms in the solid fraction throughout the observation period. Our results show that, in spite of the high temperature of the environment, microorganism counts in the sample obtained before starting the experiment ranged from $6.0x10^6$ to $3.1x10^9$. The most pronounced effects of both 1 and 2 vol% of zeolite were observed after 2-5 days. Microorganism counts in the solid fraction of pig slurry ranged from 1.3×10^5 to $1.8x10^9$ throughout the observation period.

These results point at the real possibilities of using zeolite in pig slurry treatment with the aim of decreasing the counts of pathogenic microorganisms.

Key words: zeolites, solid fraction, pig excreta, microorganisms

INTRODUCTION

If unsuitably handled, excreta of farm animals present a threat to the environment by their microbiological and chemical composition as well as their emissions. On the other hand, if handled properly, they are a rich source of nutrients (AMON, 1997). Excreta produced in piggeries are treated by aerobic processes in wastewater treatment plants. In the solid fraction of pig slurry different microorganisms are present of which several may cause diseases transmissible to humans. For this reason slurry treatment is inevitable. In practice the solid fraction is usually stored in dungyards where maturation takes place under anaerobic conditions.

In agriculture which is one of the principal pollutors of the environment zeolites are used for several purposes (e.g., to increase N levels in the soil, to eliminate odours and todecrease humidity levels in compost and litter, to treat drinking water and remove ammonia from municipal and industrial wastewaters, etc.). Modified, chemically and thermally treated natural zeolites are being increasingly used. Zeolites enriched with Ag

and Ni-ions are used to produce water- and air-cleaning filters with antibacterial effects. Worldwide, zeolites are mostly used to solve the problems with wastes from wastewater treatment plants (sludges) or from different agricultural enterprises.

For the abovementioned reasons considerable attention is being paid to the hygienic and ecological risks connected with the production, elimination and utilization of agricultural wastes. The solid fraction of excreta presents a concentrated organic substrate which can be used either directly or after further processing (composting) and anaerobic fermentation as a concentrated organic fertilizer (STRAUCH and BALLARINI, 1994, ONDRAŠOVIČOVÁ et al., 1994).

MATERIAL AND METHODS

The effects of clinoptilolite, a natural zeolite, upon microorganism counts in the solid fraction of pig excreta were investigated in a closed experimental dungyard for a period of 84 days. Powdered zeolite from Nižný Hrabovec (Slovak Republic) was added to the solid fraction at an amount of 1 or 2 volume %. The solid fraction was stored at 10-30°C for 84 days and a programmable thermometer was used to record the temperature in the nucleus of the substrates. For the specific properties resulting from their structure zeolites present an ecological material which is frequently used in protection of the environment. In East Slovakia a rich ore-yard of zeolite tuff can be found near Nižný Hrabovec where it is mined by the open-cast method. The samples were stored in a closed experimental dungyard divided into compartments by wooden cross-walls. The solid fraction stored in the first compartment contained no zeolite at all and served as a control. In the second and third compartment the samples contained 1 and 2 vol% of zeolite, respectively. In all samples microbiological, physical and chemical parameters were recorded.

Microbiological examinations were carried out according to the Slovak Technical Standard STN 830531 (1978) and Štěpánek (1982) and were used to determine the total counts of psychrophilic, mesophilic, coliform and faecal coliform microorganisms. Meat pepton agar and Endo agar (Imuna Šarišské Michaľany, Slovakia) were used for incubation. The latter was carried out at 20°C, 37°C and 43°C for 24 - 72 hours. Samples for qualitative determinations were diluted in 0.9% saline to a concentration of 10^{-7}. Sampling was carried out on days 1,2,5,7,12,21,28,40,49,61 and 84.

RESULTS

At the start of the experiment microorganism counts in the solid fraction ranged from $6.0x10^6$ to $3.1x10^9$. During the observation period (84d) indicator microorganism counts decreased by 3 and more orders. The most pronounced decrease in the counts of mesophilic and psychrophilic microorganisms occurred after day 7 when the counts decreased by 3 orders in comparison to day 1. Decreased counts of coliform microorganisms were stated already on day 2 when 1 vol% of zeolite caused a decrease by one order and after the addition of 2 vol% of zeolite no microorganisms could be detected. As soon as after 24 hours no faecal coliforms could be yielded. After 7 days microorganisms were only seen in the control sample of coliforms, however, from day 12 on the control sample did not contain any microorganisms. The counts of mesophilic and psychrophilic microorganisms were observed to gradually increase from day 12 on until the end of the experiment to 10^6 - 10^8 by order.

DISCUSSION

The results obtained point at the fact that some microorganisms are able to survive in the solid fraction for a long time and to contaminate the environment. For this reason it is important to pay great attention to proper manipulation and hygienization of the solid fraction (composting) since from the epidemiological viewpoint the solid fraction can be a reservoir of infectious agents (NOVÁK, 1994, VASIĽ, 1996). In practice, manipulation and storage of the solid fraction is often paid only insufficient attention (VENGLOVSKÝ a kol., 1996).

With regard to the possibilities of using natural zeolites in protection of the environment (VARGOVÁ, 1994, 1999) and the effects of zeolites upon the survival of pathogenic microorganisms it can be stated that literary data dealing with the effects of zeolitic substances in the tratment of excreta do not offer evaluations of the effects upon microorganisms. Little attention has so far also been paid to the beneficial role of zeolites in the elimination of different substances and microorganisms from slurry.

The effect of the addition of 1 and 2 vol% of zeolite upon selected microorganisms

Tab. 1	MPA	MPA	EA	EA
	(37°C)	(20° C)	(37° C)	(43° C)
Day 1				
Control	1.80E+09	1.70E+09	6.40E+06	9.00E+05
1% zeolite	6.40E+08	7.00E+08	4.00E+06	3.60E+05
2% zeolite	5.20E+08	6.80E+08	9.00E+05	2.80E+05
Day 2				
Control	8.10E+08	8.20E+08	3.10E+06	4.20E+05
1% zeolite	9.40E+08	6.00E+08	4.40E+05	0
2% zeolite	4.20E+ 07	3.80E+ 07	0	0
Day 5				
Control	1.00E+08	4.30E+08	1.80E+06	0
1% zeolite	9.80E+06	4.60E+07	0	0
2% zeolite	6.40E+06	9.20E+06	0	0
Day 7				
Control	1.30E+06	5.00E+06	1.30E+05	0
1% zeolite	3.90E+05	4.80E+05	0	0
2% zeolite	3.00E+05	4.00E+05	0	0
Day 12				
Control	1.30E+07	3.90E+07	0	0
1% zeolite	3.20E+06	8.00E+06	0	0
2% zeolite	2.80E+06	5.90E+06	0	0
Day 21				
Control	3.70E+07	4.60E+07	0	0
1% zeolite	1.40E+07	5.60E+06	0	0
2% zeolite	9.60E+06	9.00E+07	0	0
Day 28				
Control	9.90E+08	6.80E+08	0	0
1% zeolite	7.00E+07	3.10E+07	0	0
2% zeolite	4.90E+07	3.00E+07	0	0
Day 40				
Control	9.80E+08	9.30E+08	0	0
1% zeolite	7.90E+08	6.80E+08	0	0
2% zeolite	3.60E+08	4.00E+08	0	0
Day 49				
Control	1.00E+08	1.30E+08	0	0
1% zeolite	9.30E+07	9.80E+07	0	0
2% zeolite	5.40E+07	8.50E+07	0	0
Day 61				
Control	9.80E+08	9.10E+08	0	0
1% zeolite	8.00E+07	8.80E+07	0	0
2% zeolite	3.40E+07	8.10E+07	0	0
Day 84				
Control	1.40E+08	1.60E+08	0	0
1% zeolite	1.30E+08	1.40E+08	0	0
2% zeolite	1.30E+08	1.20E+08	0	0

The results of this study revealed the beneficial effects of zeolite upon the hygienically important groups of microorganisms like coliforms and faecal coliforms.

Further experiments are required to investigate the effects of other zeolite concentrations upon the process of elimination of microorganisms from the solid fraction of pig slurry.

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