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Conference paper

THE INFLUENCE OF ADDITION OF NATURAL AND SYNTHETIC ZEOLITE ON MICROBIOLOGICAL PARAMETERS IN THE LIQUID FRACTION OF PIG SLURRY

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Summary

The study focused on problems related to harmless disposal of pig slurry, particularly on the influence of addition of powder zeolite from Nižný Hrabovec, Slovakia, Montanit 300 from Slovenia and synthetic zeolite prepared by hydrothermal alteration of power plant fly ash to the liquid fraction of pig slurry with regard to the microbiological aspects. Plate counts of psychrophilic, mesophilic, coliform and fecal coliform bacteria were determined after different period of contact of the slurry with zeolites (24 h, 48 h, 7, 14 and 28 days). The addition of zeolites resulted in a decrease in plate counts of the observed groups of germs in the supernatant. The decrease, expressed in per cent, differed considerably, particularly with psychrophilic germs (5-89%). The highest decrease was observed in fecal coliform bacteria after adding synthetic zeolite (95.7%). The best mean decrease for all groups of microorganisms studies was reached with Montanit 300. The effect of zeolites may be evaluated positively also in relation to considerable reduction of chemical pollution in the liquid fraction of pig slurry.

Key words : powder zeolite, pig slurry, bacterial plate counts

Introduction

Increasing pollution of the environment is one of serous worlwide problems of the present (5,2). Agriculture and animal production contribute to this problem. Conception of animal husbandry and high concentration of

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animals result in production of excessive quantities of excrements produced in the form of slurry. Some farms have to face situations in which the treatment and disposal of excrements poses existence problem.

Besides chemical components, excrements of farm animals contain high numbers of microorganisms including pathogenic ones. They result in increased load on the environment even in those cases in which they are treated in wastewater treatment plants, particularly by anaerobic processes in the mesophilic zone (30-35°C) because large numbers of them pass through the process without devitalization (3). The effluent from the treatment of excrements is not always subjected to efficient disinfection which increases demands on self-cleaning abilities of the recipient, particularly at increased input loads or in emergency situations (10,1).

Many papers dealt with the possibilities of use of the unique properties of zeolites in the removal of chemical pollutants from wastewaters produced by different branches of industry including agricultural wastes, however, the data about the influence of zeolites on bacterial counts are scarce (9).

Our study of problems related to harmless and inoffensive manipulation with slurry focused on the potential of the use of zeolites in different stages of treatment of pig slurry. Microbiological and chemical examinations were carried out previously to observe the influence of an addition of zeolite to the solid fraction of pig slurry after the mechanical separation. The present study investigated its influence of addition of zeolites to the liquid fraction obtained in this initial treatment stage.

Material and methods

The experiment was carried out using natural powder zeolite (clinoptilolite) from Nižný Hrabovec, Slovakia (grain size: 76.95% between 0.125 - 0.25 mm, 12.3% above 0.25 mm) - sample A, Montanite 300 (clinoptilolite, heulandite, mordenite) from Zaloška Gorica, Slovenia (grain size: 57.5% between 0.125 - 0.25 mm, 33.2% between 0.09 - 0.125 mm) - sample B, and synthetic zeolite (phillipsit), prepared by hydrothermal alteration of power plant fly ash and clinker in VŠCHT Prague, CR (grain size: 17.2% between 0.09 -1.25 mm, 39.8% between 0.125 - 0.25 mm and 33.4% above 0.25 mm) - sample C.

Our investigations included determination of plate counts of psychrophilic, mesophilic, coliform and fecal coliform bacteria in the liquid fraction of pig slurry subjected to treatment in an aerobic wastewater treatment plant. The liquid fraction tested was obtained after mechanical pretreatment. The dry matter content of the liquid fraction was 5.41% and pH 6.91.

Zeolite samples were added to the liquid at a dose of 100 g per 1000 ml. The mixture obtained was agitated for 10 min. and stored without mixing at room temperature. After 24 h, the mixtures were stirred for 1 min, 100 ml of the mixture was removed and used to determine plate counts in the supernatant after 2 h sedimentation. The same procedure was used to determine plate counts after 48 h, 7, 14 and 28 days of contact. Another portion off liquid without addition of zeolite and processed in the same way was used as a control.

The plate counts of psychrophilic, mesophilic, coliform and fecal coliform bacteria were determined by the methods according to STN 83 0531 (6) and Štěpánek (7).

Results and discussion

Psychrophilic germs is a heterogenous group of bacteria with optimum of growth at 20°C. Mesophilic germs determined in our study are organotrophic bacteria with optimum growth at 37°C. They are alochtonous and their finding indicates the so-called general contamination. This group includes also pathogenic germs including coliform bacteria - the indicators of fecal contamination. The group of fecal coliforms consists of bacteria that are present in the digestive tract of man and warm-blooded animals.

The plate counts determined (presented as $\log_{10}$CFU/ml) and the effectiveness of removal of individual groups of bacteria (%) are summarised in Table 1.

The results obtained indicate that the addition of zeolite resulted in a decrease in plate counts in the supernatant after 2 h sedimentation throughout the experiment with all zeolite samples. However, the decrease in plate counts varied considerably depending on the time of contact, particularly in the group of psychrophilic germs.

With regard to the mesophilic germs, the highest decrease was observed after addition of synthetic zeolite and 24 h contact while with Montanite 300 the highest decrease was observed after 7 h of contact and with zeolite from Nižný Hrabovec after 24 h and 14 days of contact. The highest mean decrease (31.2%) in the course of the observation period was recorded with synthetic zeolite and the lowest one (23.1%) with Montanite.

The highest decrease in the form of coliforms was observed with synthetic zeolite after 14 days of contact. The counts of this group of bacteria did not vary so much as with mesophiles except for some results and the decrease followed the sequence Montanite (59.0%), zeolite from Nižný Hrabovec (52.6%), and synthetic zeolite (49.0%).

Table 1.

	Mesophilc	Efficiency	Coliform	Efficiency	Fecal-coliform	Efficiency	Psychro-phic	Efficiency
	37°C MPA	%	37°C EA	%	43°C EA	%	20°C MPA	%
After 24 hours								
A	8,079	42,9	8,477	61,5	7,792	65,6	8,114	38,1
B	8,255	14,3	8,079	84,6	7,863	59,4	8,230	19,0
C	8,699	76,2	8,477	61,5	7,869	58,9	8,279	9,5
K	8,322		8,892		8,255		8,322	
After 48 hours								
A	8,301	16,7	8,477	62,5	7,903	55,6	8,279	5,0
B	8,279	20,8	8,778	25,0	7,568	79,4	7,663	77,0
C	8,322	12,5	8,845	12,5	7,255	90,0	8,279	5,0
K	8,380		8,903		8,255		8,301	
After 7 days								
A	7,322	25,0	6,778	14,3	5,778	14,3	7,114	82,7
B	7,114	53,6	6,230	75,7	5,580	45,7	7,204	78,7
C	7,255	35,7	6,477	57,1	4,477	95,7	7,114	82,7
K	7,447		6,845		5,845		7,875	
After 14 days								
A	7,342	43,6	5,079	45,5	4,415	27,8	7,079	88,0
B	7,544	10,3	5,114	40,9	4,146	61,1	7,041	89,0
C	7,491	20,5	4,477	86,4	4,041	69,4	7,991	2,0
K	7,591		5,342		4,556		8,000	
After 4 weeks								
A	6,230	5,6	3,778	79,3	3,000	88,9	5,301	13,0
B	6,176	16,7	3,954	68,9	3,301	77,8	5,079	47,8
C	6,204	11,1	4,322	27,6	3,778	33,3	5,279	17,4
K	6,255		4,462		3,954		5,362	

Legend : A - powder zeolite from Nižný Hrabovec
B - Montanit 300
C - synthetic zeolite
K - control

The highest effectiveness was observed with fecal coliform bacteria and synthetic zeolite which caused 90 and 95.7% decrease in individual samplings

ant the highest average decrease (69.5%). The mean decrease caused by Montanite was 64,7% and by Slovak zeolite 50.4%.

Psychrophilic plate counts showed higher variability. The highest decrease (48.8%) was caused by Montanite with the highest proportion of fine particles. Synthetic zeolite induced smaller decrease while the effectiveness of Slovak zeolite with bigger proportion of particles above 125 mm was still lower.

It should be mentioned that the sedimentation of particles was best in mixtures with Slovak natural zeolite while synthetic zeolite had very low effect on sedimentation (8).

In this relation one should realise that despite relatively high decrease in plate counts (round 90%) caused by individual types of zeolites the remaining numbers were still high. It should be mentioned that besides decrease in the number of microorganisms the chemical load of the supernatant was also decreased significantly (4).

The study indicates the potential use of zeolites in the initial stage of treatment of excrements towards better quality of both the effluent and the solid fraction in view of the presence of zeolites which may contribute to better utilization of nutrients after application to soil.

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UTJECAJ DODAVANJA PRIRODNOG I SINTETIČKO ZEOLITA NA MIKROBIOLOŠKE PARAMETRE U TEKUĆOJ FRAKCIJI SVINJSKOG GNOJA

Sažetak

Ova studija fokusira se na probleme vezane uz neškodljivo raspolaganje svinjskim gnojem, posebice na utjecaj dodavanja zeolita u prahu iz Nižny Hrabvca, Slovakia, Montanit 300 iz Slovenije i sintetičkog zeolita pripravljenih hidrotermalnom izmjenom u električnoj centrali, u tekuću frakciju svinjskog gnoja, s osvrtom na mikrobiološke aspekte. Petrijeve ploče prikazuju psihrofilne, mezofilne, koliformne i fekalne koliformne bakterije koje su utvrđene nakon različitih perioda kontakta gnoja s zeolitom (24h, 48h, 14 i 28 dana). Dodavanje zeolita rezultiralo je smanjenjembroja promatrane grupe mikroorganizama u supernatantu. Smanjenje, prikazano u postocima, znatno se razlikuje, posebice psihrofilnih mikroorganizama (5-89%). Najveće smanjenje primjećeno je kod fekalnih koliformnih bakterija poslije dodaanja sintetičkog zeolita (95.7%). Najbolja srednja vrijednost smanjenja, za sve grupe promatranih mikroorganizama postignuta je s Montanitom 300. Utjecaj zeolita može se ocijeniti pozitivnim također u relaciji znatnog smanjenja kemijskog zagađenja u tekućoj frakciji svinjskog gnoja.

Ključne riječi: zeolit u prahu, svinjski gnoj, ploče za brojanje bakterija

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