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Conference paper

STABILISATION OF THE SOLID FRACTION OF PIG SLURRY AMENDED WITH NATURAL ZEOLITE

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Summary

Investigations were carried out to observe the influence of 1 and 2% addition of natural zeolite (clinoptilolite) to the solid fraction of pig slurry on decomposition processes during storage for 3 months at temperatures 18-25°C with mixing after 3 and 6 weeks. The presence of zeolite influenced the dynamics of temperatures in the core of substrates as well as the chemical parameters (pH, dry matter, residue on ignition/ash, total nitrogen and total phosphorus). The highest temperature was recorded in the control in the 4th week of the experiment (37.1°C). Values of pH in water extracts corresponded to the course of temperatures in the core of the substrates. In the first stage of the experiment, statistically significant difference was recorded in the content of dry matter and total nitrogen between substrates with zeolite and the controls. The influence of zeolite was also observed in the values of total phosphorus, particularly in the substrate 3 in which the Pt values doubled in comparison with the control after 6 and 12 weeks of storage. The values of individual parameters and the course of temperatures in the core of substrates indicated different influence of 1% and 2% addition of zeolite on decomposition processes during the storage.

Key words: zeolite (clinoptilolite), solid fraction, pig slurry, aerobic microbial decomposition

Introduction

Due to limited capacity of land, slurry produced by intensive pig-fattening farms cannot be used solely for manuring. This problem may be resolved by

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treating this slurry by activated sludge system in biological wastewater treatment plants. In the first stage of the treatment the solid fraction (SF) is separated from the liquid. The pig manure solids contain large proportion of difficult-to-degrade organic substances, bacteria, viruses and parasitic stages so they should be subjected to biothermic treatment before application to agricultural soil (6.14). This requirement is not always met which can result in the loss of valuable nutrients and environmental contamination. Some natural materials can be added to this material to affect the decomposition processes, improve the availability of nutrients and affect positively the structure of soil (2).

The aim of our study was to investigate the effect of natural zeolite clinoptilolite on decomposition processes in the solid fraction of pig slurry stored for 3 months without addition of some bulking agents.

Material and methods

Experiments were carried out with pig slurry solids obtained by mechanical separation of pig slurry on vibrating sieves before treatment with activated sludge. Approx. 50 kg portions were collected from a conveyer belt, mixed manually with zeolite (1% and 2% by weight) and filled to plastic bags to a height about 60-70 cm (substrates 2 and 3). Unamended solid fraction was used as a control (substrate 1). Probes for measurement of temperature were introduced into the centre of the substrates and the bags were stored opened at room temperature (18°- 23°C) for 12 weeks. After 3 and 6 weeks of storage samples were taken from the core of the substrates, the material was then thoroughly mixed and placed back to the bags. Samples from the initial solid fraction and from substrates 1-3 after 12 weeks of storage were taken too.

A natural zeolite (40-56% clinoptilolite) mined at Nižny Hrabovec, Slovakia (main fractions: 76.9% 0.125-0.250 mm, 10.8% 0.25-0.5 mm; CEC 0.77 mol.l1; pre-dried at 105°C) was used in the study.

The samples obtained were examined for pH in water extracts (5 g+45 ml H_2O, filtrate diluted 1:2), dry matter (DM) content (105°C), residue on ignition (550°C), total nitrogen (Nt) and total phosphorus (Pt). All determinations were carried out in duplicate.

Temperature in the core of the substrate was recorded in l h intervals using Commeter System probes (Rožnov p. Radh. s.r.o., CR).

Samples for Nt and Pt determinations were digested using a HACH-Digesdahl apparatus. Nt was distilled with NaOH (40%) and Pt was determined using the vanadomolybdate method.

Results and discussion

Changes in individual chemical parameters during the storage of SF are illustrated in Tab. 1 - 2 and Fig. 3 - 4. The core temperatures for substrates 1-3 are shown in Fig. 1 a, b.

Table 1. - THE PH VALUES IN WATER EXTRACTS OF SUBSTRATES 1-3

Storage	pH		
	S1 Control	S2 Zeolite 1%	S3 Zeolite 2%
0	8.43		
3 weeks	7.00	7.86	7.26
6 weeks	7.35	6.41	6.51
12 weeks	7.40	7.14	7.37

Table 2. - RESULTS OF EXAMINATION OF THE SOLID FRACTION OF PIG SLURRY DURING ITS STORAGE

Storage	Dry matter content (105°C) %			Ash content (550°C) %		
	S1 Control	S2 Zeolite 1%	S3 Zeolite 2%	S1 Control	S2 Zeolite 1%	S3 Zeolite 2%
0	21.50			11.41		
3 weeks	23.30	28.91	28.61	8.81	11.67	17.88
6 weeks	22.63	26.32	26.87	9.34	15.85	20.60
12 weeks	17.18	17.0	18.91			

During the storage of animal manure and pig slurry solids portion of organic substances contained in these materials decomposes and the products obtained are less odourous and safer also from the hygiene point of view (3.7). Some of the substances volatilize and the weight of the stored substrates decreases. The decomposition rates of individual stages of this process depend on the conditions of storage (temperature, aeration, humidity, pH, content of nutrients, type and structure of the material, and others). Specific microorganisms play dominant role in these stages.

Zeolitic structure contains interconnected canals and cavities that are sufficiently big to adsorb some ions and water but too small to allow viruses or bacteria to penetrated into them (5). Zeolites show high affinity to ammonia ions and may improve uptake of nitrogen by plants by decreasing risk of ammonium toxicity and preventing excessive nitrificatio and leaching of nitrates when applied to soil together with excrements.

After 3 weeks of storage, the value of pH in the water extract of substrate 1 (control) was considerably lower than the pH values in extracts of substrates amended with zeolite. However, in the subsequent period, the opposite trend was observed, especially after 6 weeks of storage. This indicates a definite role of zeolite in decomposition processes under the conditions used. The initial decrease in pH in the stored excrements has been ascribed to formation of acidic compounds and volatilization of ammonia (4). On the basis of the structure of zeolites and their high affinity to NH_4^+ (5) volatilization of ammonia may be decreased.

The initial increase in dry matter and ash may be caused by release of some of the liquid retained in the substrates during the first 48 hours of storage. After that DM and the content of ash were higher in the substrates amended with zeolite (2 and 3) for most of the experimental period except for substrate 2 after 12 weeks of storage. This could also imply decreased volatilization of compounds from substrates 2 and 3.

Figure 2. - TOTAL NITROGEN (%DM)

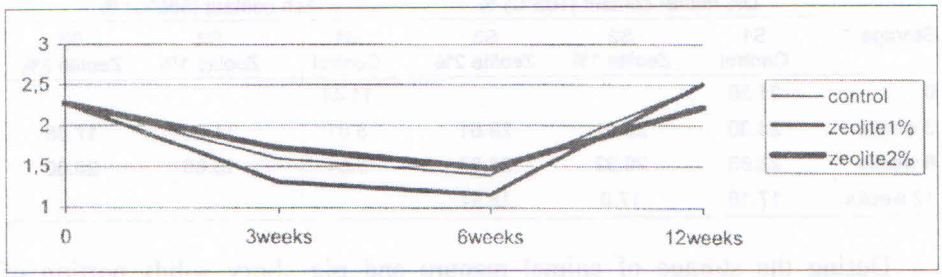
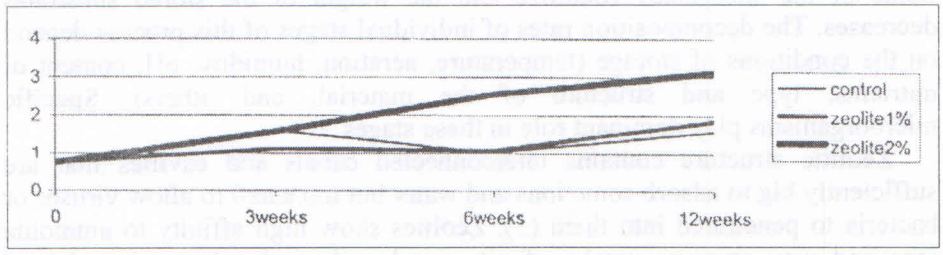


Figure 3. - TOTAL PHOSPHORUS (%DM)



After 3 and 6 weeks of storage, Nt was the highest in the substrate 3 and the lowest in the substrate 2. After 12 weeks of storage the substrate 3 showed

the lowest value of total N. However, the ratios Nt/DM and Nt/ash indicated higher mineralization of N in the substrates with zeolite.

Figure 4.a - THE COURSE OF TEMPERATURES IN THE SUBSTRATE CORE

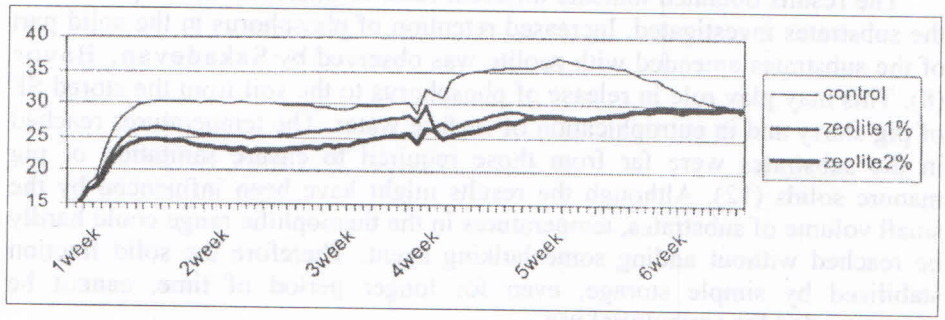
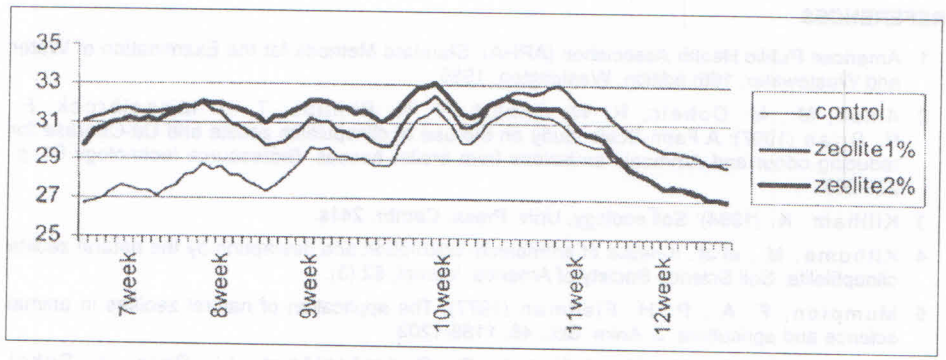


Figure 4.b - THE COURSE OF TEMPERATURES IN THE SUBSTRATE CORE



Considerable increase in Pt was observed in the substrate 3 during the experiment. The final concentration of Pt in the substrate 3 was twice as high as that in the control and substrate 2. This coincided with the ash content. When compared with the DM content it is evident that phosphorus forms accumulated in DM in the substrate amended with 2% zeolite but not as much in the substrate amended with 1% zeolite. This deserves additional investigation.

Temperatures recorded in the core of substrates 1-3 differed considerably. The highest temperature (37.1°C) was recorded in the control approximately after 4 weeks of storage. Another increase to 31.7-31.8°C was observed after 9 weeks of storage. Starting from the 6th week of storage, temperature was higher in the substrates with zeolite (max. temperatures in the substrates 3 and

2 reached 32.5°C and 33.1°C after 9 and 10 weeks of storage, resp.). In this period as well as during the 6th week of storage the temperatures in the substrate 3 were higher (max. 31.8°C) than those in the substrate 2 but lower than in the control.

The results obtained indicate different rates of microbial decomposition in the substrates investigated. Increased retention of phosphorus in the solid part of the substrates amended with zeolite was observed by Sakadevan, Bavor (8). This may play role in release of phosphorus to the soil from the stored SF of pig slurry and in eutrophication of surface water. The temperatures reached in the substrates were far from those required to ensure sanitation of pig manure solids (12). Although the results might have been influenced by the small volume of substrates, temperatures in the themophilic range could hardly be reached without adding some bulking agent. Therefore the solid fraction stabilized by simple storage, even for longer period of time, cannot be recommended for agricultural use.

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STABILIZACIJA KRUTE FRAKCIJE SVINJSKOG GNOJA POBOLJŠANOG PRIRODNIM ZEOLITOM

Sažetak

Istraživanje koje smo proveli o utjecaju dodavanja prirodnog zeolita (clinoptilolita) krutoj frakciji svinjskog gnoja pri procesima raspadanja kroz tri mjeseca pohrane na temperaturi 18-25°C. Prisustvo zeolita utječe na temperaturne promjene u središtu promatranog supstrata kao i na promatrane kemijske parametre (pH u vodenom ekstraktu, suha tvar, ostaci paljenja, ukupni dušik i ukupni fosfor). Najviša temperatura u središtu supstrata (37.1°C) zabilježena je pri kontroli u četvrtom tjednu pokusa. Vrijednosti pH u vodenom ekstraktu podudarale su se s promjenama temperature u središtu supstrata. U prvom stadiju pokusa statistički znakovita razlika zabilježena je u količini suhe stvari i ukupnog dušika u supstratu s zeolitom i kontrolnom supstratu. Utjecaj zeolita je također promatran kroz vrijednosti ukupnog fosfora, posebice u supstratu 3, u kojem se Pt vrijednost udvostručila u usporedbi s kontrolnim, nakon 6 i 12 tjedna pohrane. Vrijednosti individualnih parametara i promjene temperature u središtu supstrata ukazuju na različit utjecaj 1% i 2% dodatka zeolita na procese raspadanja tijekom pohrane.

Ključne riječi: zeolit (clinoptilolit), kruta frakcija, svinjski gnoj, aerobno raspadanje

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