COMPARISON OF AEROBIC AND ANAEROBIC WAYS OF TREATMENT OF PIG SLURRY SOLIDS

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SUMMARY

Temperature development was observed on a laboratory scale in the solid fraction of pig slurry amended with 1 and 2% powder zeolite during storage under anaerobic and aerobic conditions. The highest temperatures reached in the controls were 31.5^{o} C and 36.9^{o}C (anaerobic and aerobic, resp.). In zeolite-amended substrates the temperatures were 29.8^{o} C (anaerobic) and 30.0^{o} C (aerobic). The plate counts of faecal coliforms decreased more in zeolite-amended substrates compared to the control. None of the substrates were considered hygienically safe after the storage.

Keywords: pig slurry, zeolite, aerobic and anaerobic storage, microbial plate counts

INTRODUCTION

Excrements of animals from systems with bedding produce little risk as their biothermic processing can be ensured easily and the final product is hygienically safe and suitable for application to agricultural soil. However, treatment and disposal of slurry presents frequently serious problems intensified by large volumes of this form of animal excrements and their potential environmental consequences. Many pathogenic micro-organisms can accumulate in the slurry and remain vital for different periods depending on many factors. One of the important factors is the treatment of slurry. The frequently used aerobic biological treatment of slurry with activated sludge starts with separation of slurry to the liquid and solid fractions within the primary treatment (Dubinský *et al.,* 2000).

The solid fraction of pigs slurry obtained by separation on vibrating sieves is frequently treated only by simple storing in field dung pits without adding any bulk materials or turning. Composition of pig slurry solids with regard to dry mater content and C/N ratio does not support thermophilic processes and because of that higher temperatures needed for sanitation of this substrate cannot be reached. Decomposition processes in stored, non-aerated pig slurry solids are mostly anaerobic which results in longer time needed for decomposition of complex organic substances to make them suitable for manuring and potential risk of survival of some pathogenic micro-organisms. Many bacteria and helminth eggs can survive under anaerobic conditions for relatively long time Novák *et al.,* 1998, Juriš *et al.,* 2000).

MATERIAL AND METHODS

The solid fraction of pig slurry (21.5% DM) was amended with powder zeolite at a ratio of 1% and 2% by weight (substrates 2 and 3). The substrates were poured loosely to plastic bags, 50 kg substrate per bag, height of the substrate approx. 65 cm (1% zeolite – substrates 2 and 5; 2% zeolite – substrates 3 and 6). Unamended pig slurry solids were used as a control (substrates 1 and 4). All bags were stored in enclosed room and openings were made at the bottom for draining the liquid. Bags 1–3 were closed at the top and were not mixed during the storage to simulate anaerobic conditions. Bags 4–5 remained opened and their content was mixed in specified intervals to introduce some air. Samples were taken and analysed after 6 and 12 weeks of storage.

Chemical examination included determination of DM, ash, N_t and P_t. Microbiological examination consisted of determination of plate counts of psychrophilic, mesophilic, coliform and faecal coliform bacteria.

RESULTS AND DISCUSSION

The development of temperature in the core of substrates is shown in Fig.1 and Fig. 2.

During the first 6 weeks of storage, the highest temperature was recorded in the control substrates 1 and 4 (31.5 and 36.9°C) while in those with zeolites they did not exceed 29.8°C and 30.0°C (anaerobic and aerobic, resp.). During the second half of the experiment, the highest temperature (33.1°C) was recorded in the aerated substrate with 2% zeolite and in anaerobic substrate with 1% zeolite (29.7°C). External temperature varied in the range 18–23°C.

Our experiment with pig slurry storage under laboratory conditions showed that thermophilic range of temperatures necessary for sanitation of this material was not reached. A positive influence of zeolite was observed only in the later period of storage (after 6 weeks). The content of moisture at the beginning of the experiment was in the range 76.5–78.5% which, together with insufficient aeration, can be considered the main reason for not reaching the thermophilic phase (Tiquia *et al*., 1998).

The results obtained showed that the release of individual forms of nitrogen, particularly of ammonia nitrogen, into water extract was slower and more uniform in the presence of zeolite. Concentrations of $N\text{-}NO_3$ indicated that more favourable conditions for nitrification developed in the substrate with 1% zeolite. Gradual release of nutrients into water extracts from the substrates with zeolite was indicated also by values of electrolytic conductivity. After 3 weeks of storage we observed an increase in P-fixation capacity in the substrate with 2% zeolite, more pronounced in the aerated substrates (Fig. 3 and 4), which is in agreement with the observations of Sakadevan and Bavor (1998). In dependence on respective conditions of storage (anaerobic, aeration) we observed differences in decomposition processes, reflected in pH, dry mater content and phosphorus, in favour the aerated substrates similar as those observed by Day and Shaw (2000).

Considerable quantity of liquid retained in the substrate is released in the first stage of storage of pig slurry solids. This liquid may penetrate into soil and eventually into ground water if capture of dung water is not ensured. Our study showed that addition of zeolite decreased considerably the volume of dung water released during the first 48 h of storage. Also the concentration of CHSK, N_t, P_t, $N\text{-}NH_3$, $N\text{-}NO_3$ and EC in released dung water was lower. The influence of zeolite in this direction was dose dependent (Tab. 1).

Plate counts of psychrophilic, mesophilic and coliform bacteria corresponded more or less to the course of temperature in the respective substrates. (Fig. 5 and 6). Differences between

substrates with zeolite and the control were insignificant throughout the experiment. However, with regard to faecal coliform bacteria, which are considered indicators of sanitation, we observed their decreased survival in the substrates with zeolite compared to control substrates in the last stage of storage. Their lowest plate counts were found after 3 and 6 weeks of storage in the substrate with zeolite which was aerated by turning.

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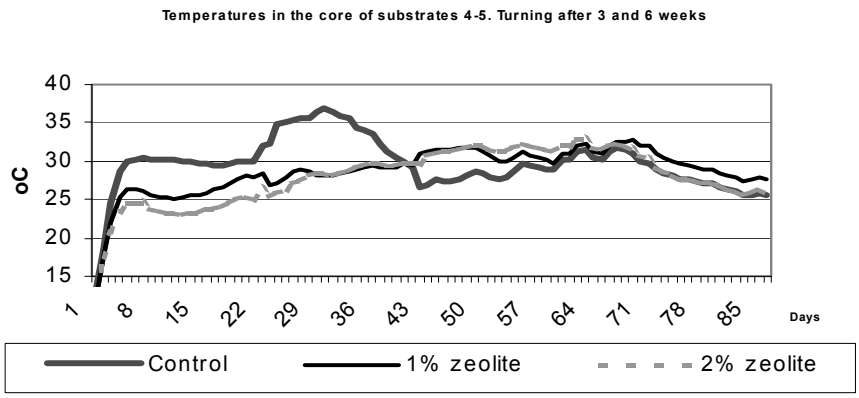

Figure 1. Temperatures in the core of substrates 1–3. anaerobic condition

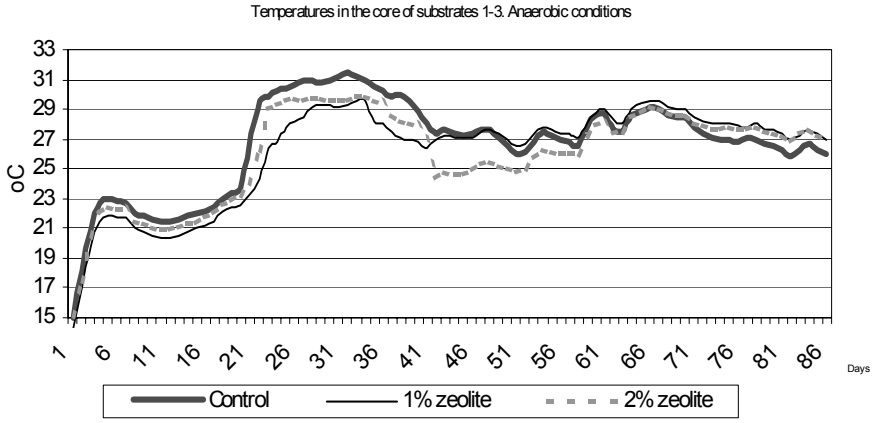

Figure 2. Temperatures in the core of substrates. Turning after 3 and 6 weeks aerobic conditions

Table 1. Concentration of nutrients in the liquid released from stored substrates and their decrease in comparison with the control in %

	Control substrates (1, 4)	1% zeolite – substrates (2, 5)	2% zeolite – substrates (3, 6)
N_t [g]	22,504	15,983 (28,98%)	13,538 (39,84%)
N-NH_3 [g]	16,612	12,074 (27,32%)	10,57 (36,37%)
N-NO_3 [g]	4,637	3,151 (32,0%)	2,59 (44,11%)
P_t [g]	0,898	0,707 (21,2%)	0,594 (33,85%)
COD[g]	169,361	122,942 (27,4%)	106,785 (36,95%)

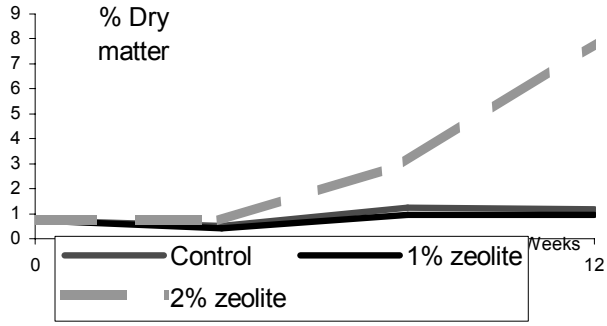

Figure 3. P_t – anaerobic conditions

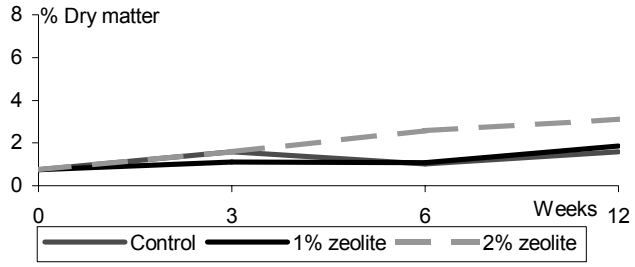

Figure 4. P_t – aerobic conditions

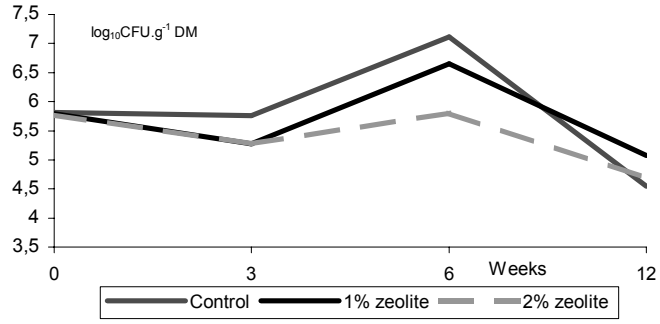

Figure 5. Coliform bacteria – anaerobic conditions

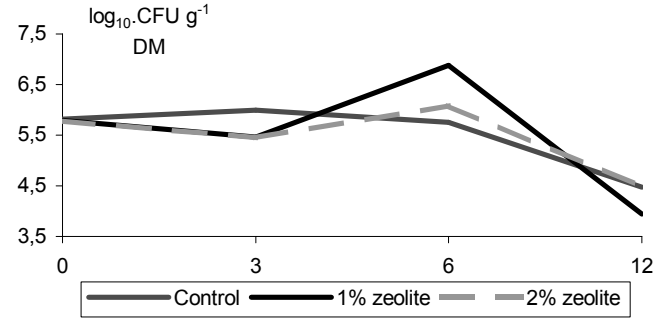

Figure 6. Coliform bacteria – aerobic conditions