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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EFFECT OF DIFFERENT DOSES OF NATURAL ZEOLITE ON DECOMPOSITION PROCESSES IN STORED PIG SLURRY SOLIDS

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ABSTRACT

The study was carried out on pig slurry solids obtained in mechanical separation stage of slurry treatment with activated sludge. Two kg portions of pig slurry solids were amended with 1, 2, 3 and 4% by weight of natural powder zeolite clinoptilolite and stored for 10 weeks in thermally insulated plastic bags in dark without access of air except for mixing and sampling after 1, 2, 3, 4, 5, 6, 7, 8 and 10 weeks of storage. Unamended control was handled in the same way.

Despite thermal insulation of substrates the temperature in the core of substrates remained below 33°C, most likely due to the high moisture content and insufficient aeration. Zeolite amendment affected dry matter content and residue on ignition. The latter indicated that processes producing volatile compounds were supported by zeolite. This was in agreement with pH values of water extracts that were the highest (6.43-6.82) in the control and lowest (5,77-5,80) in the substrates with 4% and 3% of zeolite for most of the experiment. The level of extractable ammonia was according to expectation the lowest in the substrates with zeolite and the highest in the control where its considerable fluctuations were observed.

Key words: zeolite, pig slurry solids, decomposition, pH, ammonia, ash, dry matter

INTRODUCTION

The solid fraction (SF) of pig slurry obtained by mechanical separation in the first stage of pig slurry treatment by activated sludge is a substrate with relatively high content of nutrients and abundant microbial population. It can be a source of spreading of infections and parasitoses and also of environmental pollution (Venglovský et al., 1999). It should be mixed with sufficient amount of bulking materials and composted before it is applied to cropland. If this is not fulfilled, the processes of decomposition may not ensure sufficient sanitation of this material and some nutrients may be lost and contaminate soil and water.

Zeolites have been tested as amendments to excrements and soil because of their unique three-dimensional structure that allows them to absorb water and various ions and release them gradually to the environment (Sasáková et al., 2000).

The aim of our study was to investigate the chemical aspects of decomposition processes in the solid fraction of pig slurry amended with 1-4% natural powder zeolite (clinoptilolite) under the conditions that may occur in practice.

MATERIAL AND METHODS

Experiments were carried out on 2kg portions of SF amended with 1%, 2%, 3% and 4% by weight of powder natural zeolite clinoptilolite (SF-1, SF-2, SF-3, SF-4) mined in Nižný Hrabovec, Slovakia (main fractions: 0.125-0250 mm - 76.9%; 0.25-0.5 mm - 10.8%; CEC 0.77 mol/l). The substrates were stored for 10 weeks in thermally insulated plastic bags without access of air except during mixing before sampling after 1, 2, 3, 4, 5,

6, 7, 8 and 10 weeks of storage. Unamended control (SF-C) was handled in the same way.

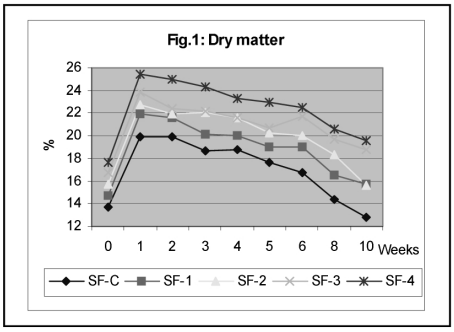
Temperature in the core of substrates was continuously recorded (Commeter System, Rožnov pod Radhoštěm, CR). Chemical examination included determination of dry matter (DM, drying at 105°C to constant weight), residue on ignition (or ash, 550°C, 4 h) pH (10g SF + 90 ml dist. H_2O, 3 min. mixing , filtering) and extractable ammonia (N-NH_4^+, 100g SF + 500 ml H_2O, 3 min mixing, filtering, distillation).

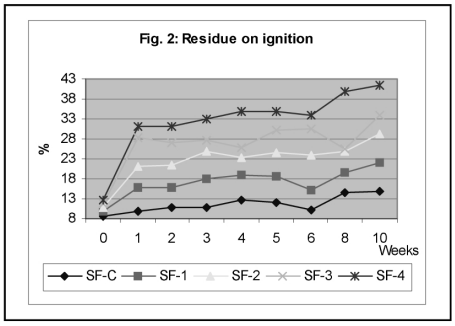
All determinations were carried out at least in duplicate and the results presented are average values. Statistical analysis was carried out by the paired Student's t-test.

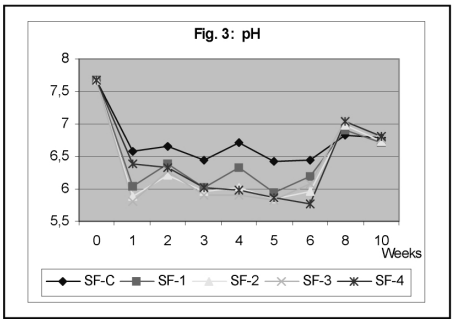
RESULTS AND DISCUSSION

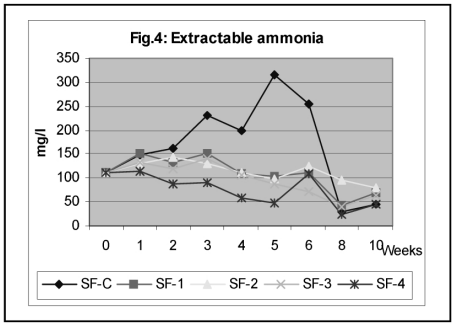
Temperature in the stored substrate is one of the most important indicators of decomposition processes. The most important factors affecting its level are aeration, water content, pH and satisfying of nutritive demands of micro-organisms. It determines the hygienic safety of the product (Strauch, 1987). In our experiment the highest temperature (32.3°C) was reached in SF-C after 53 days of storage while in substrates with zeolite (SF-1 to SF-4) the maximum temperatures ranged from 30.3 to 32.1°C. Temperature peaks were observed in the second half of 2-week intervals so we evaluated also five 2-weeks intervals. In this evaluation the highest mean temperature (25.72°C) was recorded in SF-4 throughout the experimental period and was followed by SF-C, SF-1, SF-3 and SF-2. The temperatures recorded were not sufficient to ensure sanitation of the respective substrates.

Results of chemical examination are shown in Figs. 1-4.









The content of dry matter (DM) increased during the first week due to release of some retained liquid and then decreased gradually towards the end of the experiment. Fig. 1 shows that the decrease was affected by the added zeolite which adsorbs water and is able to release all of it at temperatures higher than those used for determination of DM (105°C). This was not advantageous in our case due to high initial water content.

Residuum on ignition or ash (550°C) is the inorganic portion consisting of various inorganic minerals, such as Ca, Mg, Na, Fe and Mn, together with other trace metals. Their cations form carbonates, bicarbonates, sulphates, phosphates, nitrites and others (Day et al., 1996). They should not be affected by the composting. During composting netto losses of organic matter occur and the proportion of ash increases. Our results show that the decomposition processes reflected in ash content were affected by zeolite and were dose dependent. Evidently, the processes leading to formation of volatile compounds were supported by zeolite and these compounds were released during mixing. This effect was observed consistently in all our experiments with this material (Vargová , 1999).

The pH values were in the range suitable for composting (De Bertoldi et al., 1983). Starting from week 1 until week 7, pH in all experimental substrates was lower than in the control. This suggests anaerobic processes and accumulation of organic acids (Inbar et al., 1993). After their utilization as substrates for aerobic micro-organisms, pH increases again.

The level of ammonia present in water extracts (Fig.4) indicated an important role of zeolite during decomposition of organic matter. The differences compared to the control were significant for SF-3 ($P<0.05$) and SF-4 ($P<0.01$). Ammonia is adsorbed to large internal surface of zeolite particles and slowly released to the environment. This may prevent environmental pollution (soil, water, air) due to ammonia and eventually also nitrates related to improper storage, handling and land application of excrements.

REFERENCES

Day, M., Krzymien, M., Shaw, K., Zeremba, L., Wilson, W. R., Botden, C., Thomas, B., 1996: An investigation of the chemical and physical changes occurring during commercial composting. *Compost Science & Utilization*, 6:44-66.

De Bertoldi, M., Vallini, G., Pera, A., 1983: The biology of composting. *Waste manage. Res.*, 1:157-176.

Inbar, Y., Hadar, Y., Chen, Y., 1993: Rrecycling of cattle manure: The composting process and characterization of maturity. *J. Environ. Qual*, 22:857-863 .

Sasáková, N., Pačajová, Z., Venglovský, J., 2000: The influence of absorption properties of natural sorbents on pig slurry (In Slovak), *Slov. vet. čas*, 5:282-286.

Strauch, D. (ed.) 1987: Animal production and environmental health. World animal science,

B6, Elsevier Sci. Publ. B.V., 324p.

Vargová, M., 1999:The possibilities of use of natural zeolite clinoptilolite in the process of treatment of pig slurry (In Slovak), Dissertation thesis, UVL Košice, 123 p.

Venglovský, J., Pačajová, Z., Sasáková, N., Vučemilo, M., Tofant, A., 1999: Adsorption properties of natural zeolite and bentonite in pig slurry from the mirobiological point of view. *Vet. Med. - Czech*, 44, 11:339-344

Acknowledgement: The study was supported by Grant VEGA 1/1017/20.