AMENDMENT OF URBAN SEWAGE SLUDGE WITH NATURAL ZEOLITE AND QUICK LIME WITH REGARD TO CHEMICAL AND MICROBIOLOGICAL QUALITY OF THE TREATED MATERIAL

Naďa Sasáková, Oľga Ondrasovicová, Miloslav Ondrasovic, Milada Vargová, Jana Kottferová, Kornélia Culenová, Ingrid Papajová*

University of Veterinary Medicine, Komenského 73, 041 81 Kosice, the Slovak Republic
**Parasitological Institute of the Slovak Academy of Sciences, Hlinkova 3, 040 01 Kosice, the Slovak Republic*

Key words: waste-water treatment plant, municipal pre-treated sludge, quick lime, zeolitu, helminth eggs, bacteria,

Introduction

In the recent decades, the increase in human population brought about increased quantity of wastewaters and increased demands on the quality of wastewater treatment products, the effluent and sewage sludge. This is related to environmental protection and protection of humans, animals and plants from undesirable infections. The recent increase in the costs of artificial fertilisers renders materials such as sewage sludge, previously regarded as waste, a valuable commodity. Recycling of sewage sludge by application to soil is beneficial in many ways but poses some risk that must be eliminated by its proper treatment and monitoring (Begon *et al*., 1999; Juris *et al*., 2000; Skalická *et al*., 2000).

The aim of our study was to investigate the risk arising from sewage sludges of municipal sewage with regard to the recipient of the effluent and application of wastes to agricultural land with or without additional treatment with quick lime and zeolite.

Material and methods

Sewage sludge was obtained from a municipal waste water treatment plant (WWTP) treating waste-waters produced by about 250 000 inhabitants. The sludge is subjected to anaerobic and aerobic treatment before its dewatering and disposal. Treated sludge (15 kg samples) was collected and stabilised under laboratory conditions with quick lime (CaO, Carmeuse, Slovakia), powdered zeolite (42-56% clinoptilolite, Nižný Hrabovec, Slovakia, main fraction: 76.92% - 0.125-0.250 mm) and zeolite with lime (3% by weight each) and stored for 42 days.

Bacteriological examination consisted of determination of plate counts of mesophilic, coliform and faecal coliform bacteria (STN-ISO 9308-2) on solid cultivation media (Endo agar, Imuna, Slovakia) and faecal streptococci in the municipal sludge (STN-EN ISO 7899-2) on Slanetz-Bartley agar (Biomark, India).

Chemical examinations included determination of pH, dry matter (DM, 105°C), ammonia nitrogen ($N\text{-}NH_4^+$) and nitrate nitrogen ($N\text{-}NO_3^-$) in water extracts. Distillation method was used for determination of ammonia nitrogen and ion selective method for nitrate nitrogen. Results of additional chemical parameters were reported elsewhere (Venglovský *et al*., 2005).

Results and discussion

If diseases are to be spread by raw and processed wastes, the material must become infected with the causative organisms, which must survive treatment or storage, remain capable of causing disease and survive in the material until a human or animal host is encountered. The type of pathogens most commonly found in sewage and sewage sludge depends on the state of health of the population, as well as the presence of hospitals, meat processing plants and abbatoirs in the area (Bruce and Davis, 1983). Sewage sludge may contain a large variety of bacterial and viral pathogens including *Salmonella, Shigella, Yersinia,* and enteroviruses (Straub *et al*., 1993) as well as eggs of parasites such as *Ascaris lumbricoides, Cryptosporidium* and *Giardia* (Reddy *et al*., 1981). Temperatures above 55°C, maintained for sufficient period of time, devitalise practically all pathogens and parasites except for the most resistant ones (Novák, 1994; Day and Shaw, 2000; Dubinský, Juris, Moncol *et al*., 2000). Treatment of sewage sludge by lime was investigated by a number of authors with regard to viability of pathogens and helminth eggs (Eriksen *et al*., 1996, Plachý *et al.,* 1996). Their inactivation was observed by all the mentioned authors and was associated also with increased pH.

Liming and treatment of municipal sludge with zeolite affected most of the parameters determined including the chemical ones, particularly pH (Fig.1).

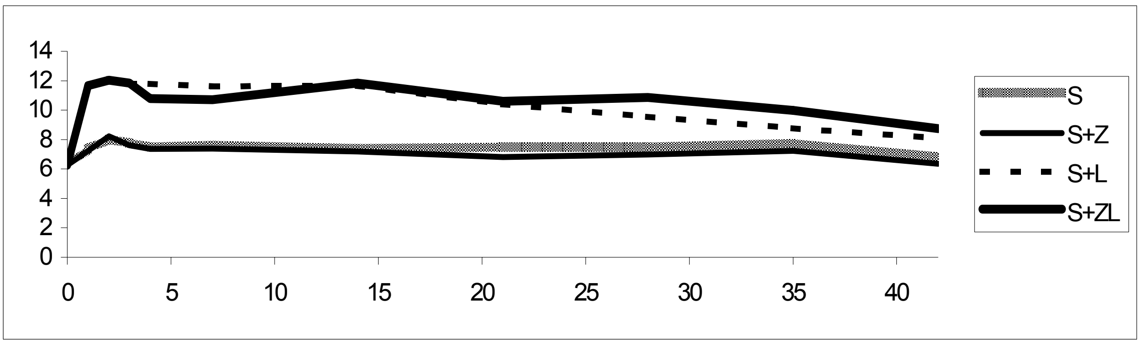

Fig.1 pH levels during 42-day storage (S – sludge; S+Z – sludge with zeolite; S+L – sludge with lime; S+ZL - sludge with zeolite and lime)

DM content increased during the storage. The differences were significant (P<0.01) between S and S+Z and between S+Z and S+V. At the end of the experiment, DM was the highest in S+Z substrate.

The results of ammonia nitrogen showed that addition of lime and lime and zeolite caused considerable loss of ammonia during storage particularly in the initial stage (probably due to increased pH) , which resulted in lower levels in the following stages. Ammonia was lost also from the control while the release from S+Z was gradual.

Nitrate nitrogen levels also indicated excessive release of nitrates to water extract immediately after amendment with lime which may pose risk to ground and surface water if the sludges are limed very shortly befor application to soil. Our results were in agreement with those presented by Wong *et al*. (2001)

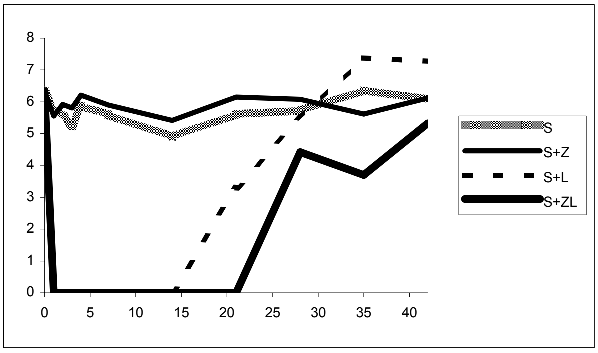

Fig. 2 Plate counts of total coliform bacteria

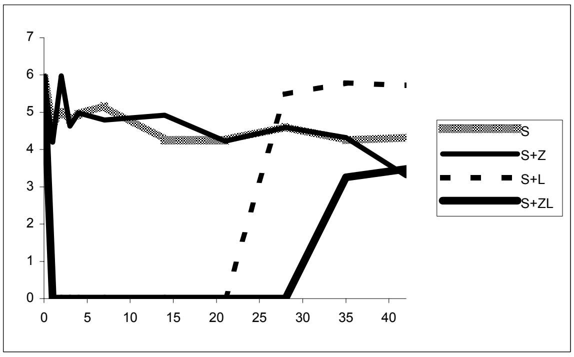

Fig. 3 Plate counts of faecal coliform bacteria

Plate counts of total coliforms (Fig. 2), faecal coliforms (Fig. 3) and faecal streptococci in the amended substrates differed from those in the control.

Plate counts of faecal coliforms showed similar behaviour but thir absence persisted until day 22 and 27 for S+L and S+ZL, resp. Faecal streptococci decreased by about two orders in S+ZL and started to increase after 25 days of storage.

The results obtained showed that addition of lime and zeolite increased hygiene safety of the treated sludge only for limited time. The timing of application of the treated sludge appears important also with regard to environmental aspects, particularly potential pollution of ground and surface water with nitrates.

References

1. *Begon, M., Harper, J. L., Townsend, C. R. (1999): Ecology: individuals, population and community. Publ. House of Palacky Univ. Press, Olomouc: 1-950*
2. *Bruce, A. M., Davis, R. D. (1983): Utilization of sewage sludge in agriculture. Maximising benefits and minimising risks. Proceedings of the International Symposium "Biological Reclamation and Land Utilisation of Urban Wastes. Naples: 121-142*
3. *Day, M., Shaw, K. (2000): Biological, chemical and physical processes of composting. In Stofella, P. J., Kahn, B. A. "Compost utilisation in horticultural cropping systems". Lewis Publishers, Boca Raton, USA: 17-50*
4. *Dubinský, P., Juris, P., moncol, D. J. et al. (2000): Environmental protection against the spread of pathogenic agents of diseases through the wastes of animal production in the Slovak republic. Harlequin, Ltd., Kosice*
5. *Eriksen, L., Andreasen, P., Ilsoe, B. (1996): Inactivation of Ascaris suum eggs during storage in lime treated sewage sludge. Water Res., 30: 1026-1029*
6. *JURIS, P.; RATAJ, D.; ONDRASOVIC, M.; SOKOL, J.; NOVÁK, P.: Hygienic and ecological requirements on recycling of organic wastes from agriculture (In Slovak). Publ. house M. Vaska, Presov, 2000a, ISBN 80-7165-257-1.*
7. *NOVÁK, P.: Dynamics of indicate microorganizms in composing of sludges (In Slovak). Zb.: Ekologia a veterinárna medicína, Kosice, 1994, 69-73*
8. *Plachý, P.; JURIS, P.; PLACHÁ, I.; VENGLOVSKÝ, J.: The use of hydrated lime for disinfection of model pathogens Salmonella typhimurium and Ascaris suum in sewage sludges (In Slovak). Vet. Med.- Czech, 41, 8, 1996, 255—259*
9. *reddy, k. r., khaleel, r., overcash, m. r. (1981): Behavior and transport of microbial pathogens and indicator organisms in soil trated with organic wastes. Journal of Environmental Quality, 10: 255*
10. *straub, t. m., pepper, i. l., gerba, ch. p. (1993): Hazards from pathogenic microorganisms in land-disposed sewage sludge. Reviews of Environmental Contamimation and Toxicology, 132: 55-91*
11. *SKALICKÁ, M.; Makoová, Z.; KORÉNEKOVÁ, B.: The influence of aflatoxin B1 on activity of alkaline, phosphatase and body weight of broiler chicks. Trace elements and electrolytes, 17, 3, 2000, 142-146*
12. *STN-EN ISO 7899-2. Determination of intestinal enterococci (In Slovak)*
13. *STN-ISO 9308-2 Determination of coliform and thermotolerant coliform bacteria. (In Slovak)*
14. *STN 83 0531 Microbiological analysis of surface water (In Slovak).*
15. *Venglovský, J., Sasáková, N., Vargová, M., Pacajová, Z., Plachá, I., Petrovský, M., Harichová, D. (2005): Evolution of temperature and chemical parameters during composting of the pig slurry solid fraction amended with natural zeolite. Bioresource Technology, 96: 181-189*
16. *WONG, J.W.C.; LAI, K.M.; SU, D.C.; FANG, M.; ZHOU, L.X.: Effect of applying Hong Kong biosolids and lime on nutrient availability and plant growth in an acidic loamy soil. Environmental Technology, 22, 12, 2001, 1487-1495.*