ELIMINATION OF *ASCARIS SUUM* EGGS DURING COMPOSTING OF ORGANIC WASTE IN THE KNEER CONTAINER TECHNOLOGY

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SUMMARY

Inactivation of *Ascaris suum* eggs is very important aspect of hygienization during composting process. The elimination of *A. suum* eggs was evaluated during composted waste from municipal green areas mixed with sewage sludge using the Kneer container technology. Carriers containing eggs were introduced into the material in a container and then into a windrow. The results of the study indicated a high efficiency of composting in uppers layers of biomass. The theoretical time of their survival ranges from 16 to 20 days. Inactivation of eggs in the bottom layer proceeded very slowly. Daily decrease in number of alive eggs ranges from 0.11% to 0.94%.

Keywords: *Ascaris suum*, sewage sludge, composting

INTRODUCTION

Composting is one of commonly used methods of organic waste utilization [7]. Besides the traditional way of composting in piles, the in-vessel systems, where there is a considerably higher possibility of the efficient process handling arouses a growing interest. Their application will permit us to reduce in gas emission, shorten particular stages of the process, require less space and it ensures a higher level of environmental biosafety [2,6,9]. In Poland, one of numerous applied technologies is the container Kneer system technology, which is used for municipal waste utilization. Due to frequent addition of sewage sludge to composted materials, there is a high risk of biomass contamination with pathogenic microorganisms and enteric parasite eggs. The inactivation of eggs of the genus *Ascaris*, frequently present in sewage sludge, is an essential aspect of hygienization during the composting process [1,3,4,5], as helminth eggs are characterized by a high resistance to unfavourable environmental conditions, including high temperatures [8,10,11]. The aim of the study was to estimate the effectiveness of *Ascaris suum* eggs elimination during the composting process using the container technology of Kneer type.

MATERIAL AND METHODS

The research was conducted in a composting plant of waste from municipal green areas and sewage sludge working in the container technology of the system Kneer. Properly fragmented and mixed material was placed in containers, where a stage of intensive composting proceeded for approximately 14 days. Then the biomass was removed from the containers and formed in a windrow. In order to provide a proper aeration, the windrow was turned mechanically every two weeks. The stage of the biomass maturation lasted about 4–6 weeks.

The hygienization level of waste subjected to composting was tested on the basis of the inactivation of the enteric parasite *Ascaris suum* eggs inactivation. Eggs were isolated from prepared uteruses of sexually mature females, which were squeezed with a glass rod into a solution of saline on a Petri dish. Next, 1 ml of their suspension was introduced into perlon bags of 28µm pore diameter. Prepared carriers were placed in the composted material in a container at the top, medium and bottom layer of the biomass. During the stage of intensive composting the carriers were removed several times from each layer and subject to analyses. After forming the windrow, part of the carriers was transferred into it from the container, and additional carriers were introduced, containing the eggs of the helminth *Ascaris suum*. Every several days the carriers were removed, cut out and placed in sterile Petri dishes. The bags were poured with water and incubated for 30 days at a temperature of 28ºC. The dishes were opened in order to provide oxygen and filled up with water. After the incubation, 300 eggs were observed under the microscope, and the percentage of invasive eggs, containing live larvae, was calculated. The control was the eggs incubated directly after taking from the fragments of *Ascaris suum* uteruses. The results obtained were subjected to statistical analysis using the program Statistica. Regression lines were drawn and were a basis for the calculation of the theoretic time needed for the inactivation of *Ascaris suum* eggs.

RESULTS AND DISCUSSION

The results of analyses showing the elimination of *Ascaris suum* eggs were presented in Table 1 and in Figures 1 and 2.

A considerably similar course of the hygienization process was observed in the investigations conducted in the two containers. In the carriers in container I, *Ascaris suum* eggs died fastest in the top layer of the biomass. After 13 days, microbiological analyses showed the presence of 19% of invasive eggs here, and after 5 successive days no more eggs able to develop were found (Fig.1). In the medium part the inactivation proceeded in a similar way. The calculated time of the full elimination of parasite eggs amounted to 20 days (Tab.1). In the bottom layer, however, egg inactivation proceeded very slowly. After 4 days, the percentage of viable eggs decreased slightly to 95% and it remained at this level until the 29^{th} day, when the analyses of the content of the carriers, transferred earlier from a container to the windrow, were made for the last time (Fig.1).

In container II, after 18 days of the process no viable eggs were present in the carriers from the top and medium layers (Fig.1). Yet in the bottom layer, the theoretical time of eggs survival was very long and amounted to 101 days. Their daily decrease calculated on the basis of regression line equations was slight – 0.94% (Tab.1).

In new carriers additionally introduced into the windrow the elimination of *Ascaris suum* eggs in the upper and central part preceded similarly. It has been indicated that after 5 days from placing the carriers in the windrow *Ascaris suum* eggs did not remain maintain the ability to further development (Fig.2). Yet in the bottom layer the number reduction rate was very slow and amounted to 0.46% /day. Calculated statistically, the time needed for their full inactivation was 205 days (Tab.1).

The results obtained confirm a high hygienization efficiency of composting process in the upper layers of biomass. The inactivation did not occur during the stage of intensive composting in containers, which was connected with too low temperature generated during the process (Fig.3). After forming the windrow, however, mixing the material and its better aeration resulted in temperature growth. At the same time, no viable *A. suum* eggs were recorded (Fig.4).

Numerous authors' report that in thermophilic conditions occurs the full elimination of enteric parasite eggs [8]. Gantzer [3] claims that a temperature above 45ºC is sufficient for obtaining a hygienic product.

Attention should be given to the bottom layer of the composted biomass, where both in the containers and in the windrow the full inactivation of the eggs was not achieved. The phenomena was connected with the lack of the thermophilic stage in this layer of the composted material. Strauch [12] reported that composting ensures hygienization of the material on condition that all biomass is exposed to a sufficiently high temperature (55ºC for 14 days). Also Gaspard [4] indicated that *Ascaris* eggs maintain their ability to growth after 30 days of composting, if an even temperature distribution over all the biomass is not ensured.

Using the compost where enteric parasite eggs were not totally destroyed in agriculture may result in soil contamination. Studies by Strauch [13] prove that *A. suum* eggs that get do soil will not lose their viability even for 14 years. Therefore, particular emphasis should be put on the full elimination of *Ascaris* eggs in all parts of composted material, by means of the proper handling and control of the process of sewage sludge utilization.

Table 1. The dynamics of *Ascaris suum* eggs elimination in the composted material

Location carriers	Layers of biomass	Regression equations	r^2 (%)	Survival of eggs (days)
container I	top	y = –5.78x + 99.73	98.01	17
	medium	y = –5.09x + 106.54	88.36	20
	bottom	y = –0.11x + 97.13	32.49	883
container II	top	y = –5.22x + 84.86	84.64	16
	medium	y = –5.89x + 101.62	92.16	17
	bottom	y = –0.94x + 94.89	88.36	101
windrow	top	–	–	nd (after 5 days)
	medium	–	–	nd (after 5 days)
	bottom	y = –0.46x + 94.39	73.96	205

nd – no occurrence detected of viable eggs

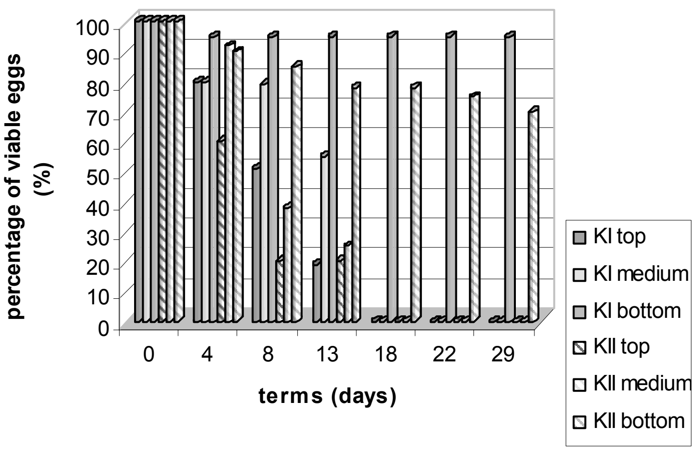

Figure 1. Inactivation of *Ascaris suum* eggs during composting process of biomass in the container I (K I) and container II (K II)

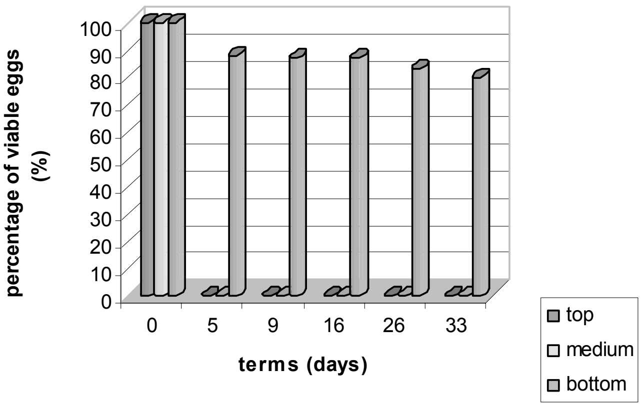

Figure 2. Inactivation of *Ascaris suum* eggs during composting process of biomass in the windrow

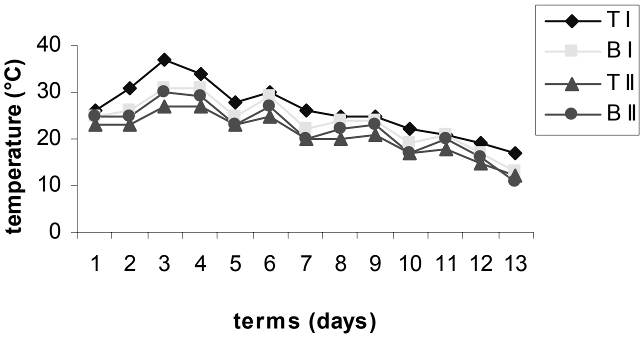

Figure 3. Temperature distribution in the composted biomass in the container I and container II, in the top (T) and bottom (B) layer

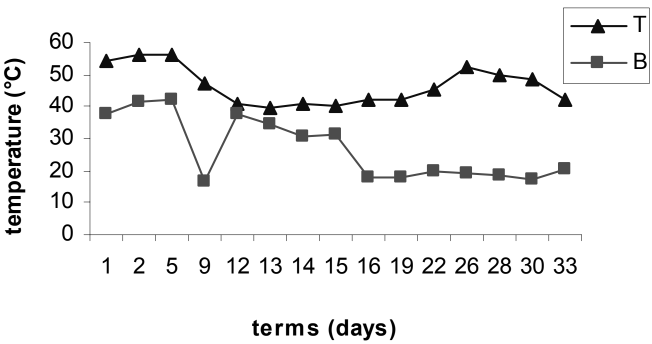

Figure 4. Temperature distribution in the composted biomass in the windrow, in the top (T) and bottom (B) layer

CONCLUSIONS

1. The research showed a high effectiveness of the composting process in the inactivation of *Ascaris suum* eggs using the container technology of the type Kneer in the top and medium layer of the biomass.
2. The bottom layer of the composted material makes the hazard area, due to the slow rate of eggs elimination.
3. The focus should be on improving the aeration conditions, thereby obtaining a properly high temperature in all parts of the composted material.
4. A simple and effective method for research used in the experiments allows having a direct control over the hygienization process of the composted material.

REFERENCES

1. Barbier D., Perrine D., Duhamel C., Doublet R., Georges P.: Parasitic hazard with sewage sludge applied to land. Appl.Environ.Microbiol.1990, 56,1420–22.
2. Cekmecelioglu D., Demirci A., Graves R., Davitt N. Applicability of optimized in-vessel food waste composting for windrow systems. Biosystems Engineering. 2005, 91 (4), 479–486.
3. Gantzer C., Gaspard P., Galvez L., Huyard A., Dumouthier N., Schwartzbrod J. Monitoring of bacteria and parasitological contamination during various treatment of sludge. Wat. Res. 2001, 35(16),3763–3770.
4. Gaspard P.G., Wiart J., Schwartzbrod J. Urban sludge reuse in agriculture: waste treatment and parasitological risk. Bioresource Technol. 1995, 52,37–40.
5. Johnson P.W., Dixon R., Ross A.D.: An in-vitro test for assessing the viability of *Ascaris suum* eggs exposed to various sewage treatment processes. International J. Parasitol. 1998, 28,627–633.
6. Mathur S.P. Composting Process. In: Martin A.M., Bioconversion of waste Materials to Industrial Products. 1991, 147–183.
7. Paluszak Z., Bauza-Kaszewska J., Górski L. Effect of composting system on the inactivation of Escherichia coli (EHEC) in sewage sludge. Polish Journal of Natural Sciences. 2003, 15 (3), 653–659.
8. Plym-Forshell L. Survival of *Salmonellas* and *Ascaris suum* eggs in a thermophilic biogas plant. Acta Vet. Scand. 1995, 36,79–85.
9. Schaub S.M., Leonard J.J. Composting: An alternative waste management option for food processing industries. Trends in Food Science & Technology. 1996, 7, 263–268.
10. Shamma M., Al-Adawi M.A. The morphological changes of *Ascaris lumbricoides* ova in sewage sludge water treated by gamma irradiation. Radiation Physics and Chemistry. 2002, 65,277–279.
11. Strauch D., Carrington E.G. Hygienic aspect related to treatment and use of organic sludge and sanitary aspects of spreading of slurries and manures. In: Treatment and use of sewage sludge and liquid agricultural wastes. Review of COST 68/681 programme. 1992, 1972–90. (Hall J.E., l'Hermite P., Newman P.J., Eds) 112–143.
12. Strauch D. Survival of pathogenic micro-organisms and parasites in excreta, manure and sewage sludge. Rev. Sci. Tech. Off. Int. Epiz. 1991, 10, 813–846.
13. Strauch D. Przeżywalność drobnoustrojów chorobotwórczych i pasożytów w wydalinach, nawozie i szlamie ściekowym. Medycyna Weterynaryjna. 1993, cz.II, 49(3), 117–121.