THE INFLUENCE OF THE CLIMATIC CONDITIONS ON THE SANITARY STATE OF WINDROWS

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Abstract

Staphylococci and *Salmonella* bacteria have the influence on the quality of the compost. The samples of the compost were taken before and after the period of low outside temperature (till -20 °C) to obtain different numbers of Staphylococci and *Salmonella* bacteria. Comparing to the data at the end of 2005, the number of *Salmonella* sp. at the beginning of 2006 decreased till zero, but the number of *Staphylococcus aureus* at the beginning of 2006 increased. The results showed that low outside temperature does not impede the functioning of the *Staphylococcus aureus* bacteria.
Key words: Germination tests, organic waste, quantification, temperature.

Introduction

For the use of compost in gardens and other places where people are in touch with soil, the compost must satisfy some strict requirements. One of them is the absence of *Staphylococci* bacteria and *Salmonella* bacteria (Zariņa et al., 2005b). *Staphylococci* can cause many forms of infection – for example, deep-seated infections, such as osteomyelitis and endocarditis, also can cause soft tissue infections and toxic shock syndrome. The problem with *Staphylococci* is that these bacteria are able to survive for a long time in the environment (Mezapuke et al., 2005). *Salmonella* on the other hand are the cause of two diseases called salmonellosis. The influence of the low temperature of environment on these bacteria's survival in windrows is shown in this study. The objective of the present study is to evaluate the sanitary state of compost windrows, to observe the influence of the low surrounding temperature on the *Staphylococci* bacteria and *Salmonella* sp., and to estimate the obtained compost using seed germination tests and total number of bacteria.

Materials and Methods

Inspected windrows in experimental composting field were 1-2 m in height, 2 m in width, and 12 m in length. In the beginning (during the first two months) the composting process in the windrows was realized under anaerobic conditions (Viesturs et al., 2004), and then it was continued under aerobic conditions (Zariņa et al., 2005a). The composting material was prepared as follows: domestic organic waste with sawdust was mixed and humidified. The windrows were mixed with special mixing machinery two times a week during first month and one time a week after that.

The samples were taken at the end of 2005 and at the beginning of 2006. The outside temperature during this period fluctuated from 0 °C to -20 °C. Samples 1, 2 and 3 were for finished compost from different places but from the same compost pile. Samples 4 and 5 were for finished compost from other different compost windrows. Finished compost was obtained by composting sawdust and domestic organic waste. Sample 6 was for unfinished compost (unfinished compost was in windrow for two months); sample 7 was for finished compost, which was obtained from sewage sludge composting. Samples 1/M and 2/M were two average samples which were taken from different previous samples.

The quantification of the total number of microorganisms, *Staphylococcus aureus* and *Salmonella* sp. in the compost was performed. Three repetitions were done for each quantification. The plate count method was used for estimation of the total number of microorganisms per 1 g of dry compost. The medium for quantification of the total number of bacteria was Bacto nutrient agar (DIFCO LABORATORIES, USA); for *Salmonella* and *Staphylococcus aureus* – RidaCount® Tests media (R-Biopharm AG, Germany) was used. For the processing of the obtained data the method of the descriptive statistics was used. The mean numbers of bacteria are shown in Table 2 and Table 3.

The quality of finished composts (finished compost was in windrow for four months) was determined using the seed germination tests (using cress salad) (Dubova et al., 2004). During the tests, three repetitions were performed using ten cress salad seeds in each repetition. Plates with seeds were evaluated after five days from tests' beginning. Data in Table 1 is obtained from the comparison between the roots of seeds germinated with a trace of compost and the roots of seeds germinated without of trace of compost.

Results and Discussions

The quality of finished compost was determined by seed germination tests and microbiological analyses. Table 1 shows the seed germination tests' results – root's length in various samples. Mean relative standard error showed that the accuracy of tests was satisfactory in most tests.

Seeds germination tests (see Table 1) showed that

Table 1

Compost quality (seed germination tests with cress salad) in November 2005

Sample's No.	Germination, %	Root's length (average)		Mean relative standard error
		mm	% of control*	%
1	100	61.3	94	5
2	100	56.6	86	4
3	100	54.9	84	6
4	90	53.0	81	10
5	100	58.3	89	4
6	100	67.8	104	5
7	93	50.0	76	5

** - control sample is a sample without a trace of compost*

samples 4 and 7 contained toxic compounds – not all seeds germinated, but all of them had the same conditions for the germination. It was also reflected on the root's length – samples 4 and 7 had the smallest root length from all samples.

Performed quantification of the total number of bacteria, *Staphylococcus aureus* and *Salmonella* sp. is shown in Table 2. Results of the compost microbiological analysis are compared and it shows that activity of bacteria is dropping – total number of bacteria decreased. Number of *Salmonella* sp. also decreased, but *Staphylococcus aureus* behaved variously – only in two samples it decreased, in others – increased.

Although the mean relative standard error for data in Table 2 is rather high this is explicable by the small quantity of experiments and diversity of composts.

Table 2

Survival of pathogenic agents in compost (2005)

Sample's No.		1		2		3		4
		Nov.	Dec.	Nov.	Dec.	Nov.	Dec.	Nov.
Total number of bacteria	number of bacteria, cells g^{-1} dry compost	$9.47 \cdot 10^9$	$0.12 \cdot 10^9$	$7.27 \cdot 10^9$	$0.15 \cdot 10^9$	$9.22 \cdot 10^9$	$0.05 \cdot 10^9$	$10.7 \cdot 10^9$
Mean relative standard error	%	9	11	10	2	11	13	3
Salmonella sp.	number of bacteria, cells g^{-1} dry compost	0	0	16	6	0	0	33
Mean relative standard error	%	-	-	12	6	-	-	9
Staphylococcus aureus	number of bacteria, cells g^{-1} dry compost	0	8	198	103	0	6	22
Mean relative standard error	%	-	13	7	14	-	13	13

Table 2 – continuation

Sample's No.		4	5		6		7	
		Dec.	Nov.	Dec.	Nov.	Dec.	Nov.	Dec.
Total number of bacteria	number of bacteria, cells g^{-1} dry compost	$0.07 \cdot 10^9$	$8.29 \cdot 10^9$	$0.08 \cdot 10^9$	$4.83 \cdot 10^9$	$0.16 \cdot 10^9$	$1.81 \cdot 10^9$	$0.09 \cdot 10^9$
Mean relative standard error	%	12	11	13	9	10	6	12
Salmonella sp.	number of bacteria, cells g^{-1} dry compost	0	0	0	28	0	52	0
Mean relative standard error	%	-	-	-	11	-	10	-
Staphylococcus aureus	number of bacteria, cells g^{-1} dry compost	15	0	6	28	49	26	87
Mean relative standard error	%	12	-	13	5	11	12	14

Another analysis of the compost samples was made in February 2006 (see Table 3). It showed that compared to the results in Table 2, the number of *Staphylococcus aureus* did not decrease but just opposite – increased and continued to progress. So *Staphylococcus aureus* underwent low temperatures and unlike *Salmonella* sp. it was not an obstacle for their capability to function.

Microbiological analyses described the quality of finished compost. Total number of bacteria and zero number of *Salmonella* sp. (see Table 3) satisfied the requirements of high quality compost, but existence of *Staphylococcus aureus* showed that the compost was not sanitary clean, so it cannot be used in gardens and fields – this compost may be used for the remediation of old dumpsites.

Conclusions

- The sample of sewage sludge compost and one of the samples of the compost obtained from organic waste contained toxic compounds.
- The number of *Salmonella* sp. under the influence of low outside temperature decreased till zero.
- The obtained compost is not of high quality and is applicable only for waste dump recultivation.
- Low temperature does not impede the functioning of the *Staphylococcus aureus*.

Table 3

Survival of pathogenic agents in compost (February 2006)

Variant	1/M	2/M
	Number of bacteria (cells g^{-1} dry compost)	
Total number of bacteria	$2.84 \cdot 10^9$	$2.82 \cdot 10^9$
Salmonella sp.	0	0
Staphylococcus aureus	$2.68 \cdot 10^2$	$1.62 \cdot 10^2$

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