Comparing composts formed by different technological processing

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Abstract. The presented article compares quality of composts which were formed by different technological processes. The subject to comparison was a compost which was created in a closed fermenter where ideal conditions for decomposition and organic substances conversion were ensured, with compost which was produced in an open box of community composting. The created composts were analysed to determine whether it is more important for the final compost to comply with the composting conditions or better sorting of raw materials needed for compost production. The results of the carried out experiments showed that quality of the resulting compost cannot be determined unequivocally.

1. Introduction

In accordance with legislation of waste management in EU, it is necessary to comply with so-called waste hierarchy which prefers use of waste to its disposal [1]. The biodegradable component forms a significant part of mixed municipal waste. Legislation established obligation for municipalities to ensure introduce and operate a system of separate collection of biowaste. The most wide-spread method of processing such waste is composting. Using this biowaste processing method is connected to suitable choice of composting technology.

2. Description of experiments

Within the experiments researching the quality of composts, the composts were compared from the point of view of two different technological processes. In the first case, composting was carried out in a so-called industrial way, in a closed system in an aerobic fermenter which had ideal conditions for decomposition and conversion of organic substances and vegetable products. In the second case, the compost was processed via community composting in a box in a community garden.

The created composts were analysed to determine whether it is more important for the final compost to comply with the composting conditions or better sorting of raw materials needed for compost production.

One of the experiments was a growing test when we examined growth of white mustard (Sinapis alba) and lettuce (Lactuca sativa L.). The plants were grown in cultivation containers in the mixture of compost and soil. After the growth period, the plants were harvested and analysed.

Another experiment was a germination test. This is a biological method of evaluating phytotoxicity of sample leachate using germination index of garden cress (Lepidium sativum) in the area of compost
water leaching [2]. The test serves for evaluation of intensity of organic substances decomposition and the final compost maturity.

Also, results from laboratory analysis of both composts were compared. Heavy metals were determined as well as content of nutrients and elements. The results obtained from all analyses were assessed in accordance with valid Czech norms and Czech legislative requirements.

3. Growth test of mustard and lettuce
Two types of compost and arable soil were used for the growth test. The components were mixed in various rates into ten cultivation containers (pots). The composts were mixed with soil in the proportion 1:1 and 1/3:2:3. The test also included a control sample of the soil alone, without any compost. The varieties of white mustard and lettuce were used for the growth test; these were planted into the prepared substrates.

The test took place for six weeks. Germination and growth of plants was documented (see figure 1 – The plant growth in the third week of the experiment). In the sixth week, the growth trend remained constant. The grown plants were after the six-week period harvested, the underground aboveground parts were separated (roots). The plants were then dried at room temperature and weighed. The obtained values are recorded in table 1.

| Sample name | Mixture rate | Plant          | Above-ground [g] | Roots [g] |
|-------------|-------------|----------------|------------------|-----------|
| A1          | Industrial compost from the closed fermenter | 1 : 1 | White mustard | 0.181 | 0.024 |
| A2          |             | Lettuce        | 0.076 | 0.069 |
| B1          | 1/3 : 2/3  | White mustard | 0.117 | 0.019 |
| B2          |             | Lettuce        | 0.031 | 0.015 |
| C1          | Community compost from the community garden | 1 : 1 | White mustard | 0.157 | 0.043 |
| C2          |             | Lettuce        | 0.228 | 0.055 |
| D1          | 1/3 : 2/3  | White mustard | 0.475 | 0.059 |
| D2          |             | Lettuce        | 0.243 | 0.940 |
| E1          | Soil        | White mustard | 0.065 | 0.005 |
| E2          |             | Lettuce        | 0.226 | 0.139 |

Figure 1. Plant growth in the third week of the growth test.

The largest amount of harvested dried vegetable mass was weighed from the mixture of community compost and soil in the rate of 1/3 : 2/3. On the other hand, the smallest amount of dried vegetable
mass was weighed in the above-ground part from the mixture of industrial compost and soil in the rate of 1/3:2/3 and in the underground part form the control sample in soil alone.

4. Germination test

The germination test of phytotoxicity allows qualitative evaluation of compost decomposition intensity. The phytotoxicity value directly reflects the content of toxic intermediate products formed during aerobic decomposition of organic substances [2]. In the Czech Republic, the cress test is carried out according to the manual of Pliva et al. [3]. The method is based on calculating germination index (IK) of garden cress in the area of water compost leachate. The absence of phytotoxins (IK is about 100 %) indicates mature compost [4]. The values of germination index in our experiment are shown in table 2.

Table 2. The values of germination index.

| Sample designation                        | IK (germination index) |
|-------------------------------------------|------------------------|
| Control                                   | 100.00 %               |
| Industrial compost from a closed fermenter| 119.27 %               |
| Community compost from the community garden | 97.77 %               |

The germination index shows that the industrial compost with IK of 119.27 % can be described as compost with growth stimulation properties, the community compost with IK of 97.77 % as well-matured compost.

Compost maturation also determines suitability of using the compost [3]. According to the presented sources, industrial compost is mature compost with growth stimulation properties and may be used as substrate for horticulture and floriculture. Community compost is well-matured compost and can be applied before sowing and planting.

5. Interpretation of results of chemical analysis of composts

The obtained composts were analysed in laboratories. Table 3 presents results of the analyses from the point of view of hazardous elements content, Table 4 presents results of agrochemical analyses from the point of view of basic nutrients and values of quality signs. The obtained values were compared to the limits of relevant norms – Decree of the Ministry of Agriculture No. 474/2000 Coll., on establishing requirements fertilisers, as amended and supplemented [5] and ČSN (Czech national standard) 46 5735 Industrial composts [6].

Table 3. Results of chemical analyses regarding content of hazardous elements.

| Parameter | Content unit dry matter | Measured content in Industrial compost | Measured content in Community compost | Limits according to the Decree No. 474/2000 Coll. | Limits according to the ČSN 46 5735 |
|-----------|------------------------|----------------------------------------|---------------------------------------|-----------------------------------------------|---------------------------------|
| As        | mg/kg                  | 11.5                                   | 18.3                                  | 20                                            | 50                             |
| Be        | mg/kg                  | 0.784                                  | 1.09                                  | —                                             | —                              |
| Cd        | mg/kg                  | 0.535                                  | 0.432                                 | 2                                             | 13                             |
| Co        | mg/kg                  | 5.0                                    | 9.81                                  | —                                             | —                              |
| Cr        | mg/kg                  | 93.4                                   | 86.5                                  | 100                                           | 1000                           |
| Cu        | mg/kg                  | 43.6                                   | 33.4                                  | 150                                           | 1200                           |
| Hg        | mg/kg                  | 0.612                                  | 0.632                                 | 1.0                                           | 10                             |
| Mo        | mg/kg                  | 3.64                                   | 1.57                                  | 20                                            | 25                             |
| Ni        | mg/kg                  | 44.9                                   | 43.8                                  | 50                                            | 200                            |
| Pb        | mg/kg                  | 39.8                                   | 59.3                                  | 100                                           | 500                            |
### Table 4. Results of agrochemical analyses of composts regarding content of basic nutrients and values of quality signs.

| Observed parameter                  | Units of measurement | Measured content | Standards value for composts according to ČSN 46 5735 |
|-------------------------------------|----------------------|------------------|-----------------------------------------------------|
|                                     |                      | Industrial compost | Community compost |                                                                 |
|                                     | %                    |                  | min. 35 - max. 60                                     | from 6.0 to 8.5                                      |
| Dry matter                          | %                    | 49.4             | 69.1                                                | min. 25                                             |
| pH - H₂O                            |                      | 7.36             | 7.63                                                |                                                     |
| Combustible substances              | % dry matter         | 39.4             | 11.8                                                | min. 25                                             |
| Cox total                           | % dry matter         | 19.7             | 6.63                                                | min. 12.5                                           |
| N total                             | % dry matter         | 1.64             | 0.638                                               | min. 0.6                                           |
| Rate C : N                          | % dry matter         | 12.0 : 1         | 10.4 : 1                                            | max. 30 : 1                                         |
| Non-degradable impurities           | %                    | 3.83             | 7.17                                                | max. 2                                              |
| Total content P                     | % dry matter         | 0.467            | 0.193                                               |                                                     |
| Total content K                     | % dry matter         | 2.03             | 0.537                                               |                                                     |
| Total content Ca                    | % dry matter         | 2.46             | 1.115                                               |                                                     |
| Total content Mg                    | % dry matter         | 0.422            | 0.295                                               |                                                     |
| Total content Na                    | % dry matter         | 0.063            | 0.026                                               |                                                     |
| Total content S                     | % dry matter         | 0.126            | 0.052                                               |                                                     |

### 6. Evaluation of results

The results of the carried out experiments showed that quality of the resulting compost cannot be determined unequivocally. In the germination test, it was proved that the analysed industrial compost is mature compost with growth stimulation properties and is suitable for use in horticulture and floriculture. The observed community compost was evaluated as mature compost suitable for application before sowing and during planting.

Laboratory analyses of individual composts clearly show that industrial compost is convenient thanks to its content of hazardous elements and it has contents of acceptable nutrients, organic substances and values of other signs not only for growing plants, but also for its commercial use. Although the community compost is convenient considering the content of hazardous elements, but it
is not convenient due to its content of organic substances, oxidable carbon, non-degradable impurities and dry matter.

The carried out experiments show better results in case of industrial compost, therefore it can be stated that complying with the composting conditions is the most important aspect, but the growth experiment showed that community compost had the best results.

7. Conclusion
Composting is natural aerobic decomposition of organic substance. Decomposition takes place with help of microorganisms which require optimum conditions to assist the whole process and make it as fast as possible. The main limiting factors include temperature, moisture content, airing, participle size, but also pH and carbon to nitrogen ratio. The product of the optimum process is high-quality fertilizer with a number of indispensable properties. The aim of the carried out experiments was to evaluate technological processes of composting from the point of view of quality of produced compost. Although the quality of analysed composts cannot be determined unequivocally, composting is a very important way of using biowaste as raw material for composting during which valuable substances can be returned back to soil.

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References
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