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COMPOST OVERSIZE FRACTION COMPOSITION

Bohdan Stejskal, Kateřina Jordánková
Mendel Uniersity in Brno

Summary

This article is focused on the problematics of compost oversize fraction composition. The main aim was to determine the ratio of woodchips in oversize fraction of sieved compost for its further energy utilization. Ten compost oversize fraction samples of the weight of 100 kg (each sample) were collected at Central Compost Plant Brno in the period from 10.11.2014 to 20.3.2015. The samples were manually sorted to four fractions: 1) soil, 2) wood, 3) minerals, 4) other parts. The fraction analysis revealed that more than 70% of oversize compost fraction consist of soil while the ratio of woodchips is less than 14% only. The ratio of minerals and other parts is less than 10% or 5% respectively.

Key words: compost, woodchip, oversize fraction, waste to energy

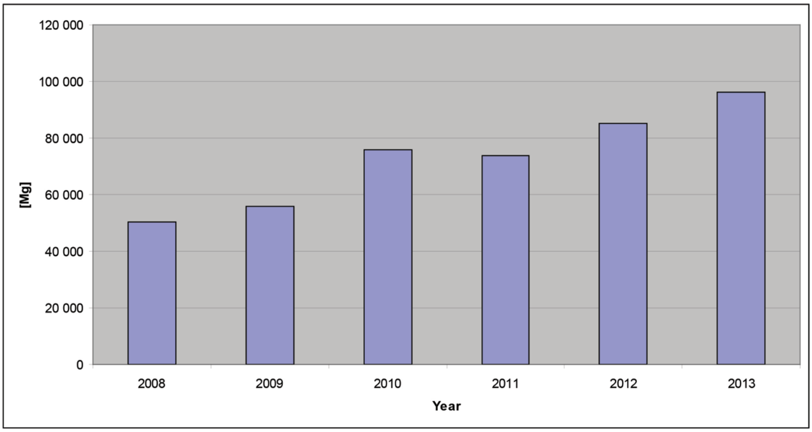
INTRODUCTION

Organic waste is one of the major components of municipal solid waste. Organic waste placed in landfills leads to generation of leachate and methane gas forcing operators to continue long-term aftercare. In Europe, the Landfill Directive (99/31/EC) declares that countries should reduce the amount of organic material in landfilled waste. That is the reason why the new Waste Management Plan of the Czech Republic (Government Regulation No. 352/2014 Coll., valid from January 1, 2015) set a target to reduce the landfilled amount of organic fraction of municipal solid waste (OFMSW) in 2020 to 35% (at most) compared to total amount of produced OFMSW in 1995. Moreover, by the amendment to the Waste Act No. 229/2014 Coll. municipalities were imposed to create a system of separate collection and treatment of OFMSW at least for OFMSW of plant origin.

While mechanical biological pre-treatment and incineration are options for meeting this requirement, biological treatment such as composting or methane fermentation, both of which have a long history as traditional methods for treating various types of organic waste, can be used for recovering resources and energy production. (Zhang and Matsuto 2011)

Biowaste composting is one of the main technologies of the sustainable waste management. Composting relies mostly on the ability of microorganisms to biodegrade and stabilize the organic waste, to destroy pathogens and produce an esthetically acceptable soil conditioner (Insam and de Bertoldi 2007, Metcalf 2003). Composting is a sustainable method of recycling carbon with minimum greenhouse gas production (Amlinger *et al*. 2008). The production of stabilized compost is regarded as a tool for temporary preservation of the greenhouse gas carbon dioxide in the soil environment. (Váňa 2002[a])

The amount of separately collected and composted OFMSW in the Czech Republic is still increasing (see Fig. 1) and it is evident that – in accordance with the targets set out in Waste Management Plan – the amount of composted biowaste is going to increase even more. Similar trend is expectable in all countries of developed waste management.



Data source: Czech Statistical Office 2015

Figure 1. Amount of composted biodegradable municipal solid waste in the Czech Republic

Even with source separation, biowaste still contains some contaminants which might disturb the treatment process and/or impact on the quality of the compost. Contaminants can be found in the separated biowaste fraction due to the fact that a separate collection of biowaste is not always well understood or carried out in a correct way. Furthermore, the collection system itself (for example with plastic bags) can result in impurities in the biowaste. Biowaste is a highly heterogeneous mixture of different organic materials depending on several local factors like sorting criteria specified by the municipality, collection system including the types of collection bags, the efficiency of the citizen in sorting properly, socioeconomic factors, etc. (la Cour Jansen *et al*. 2004; Castagna *et al*. 2013; Puig-Ventosa *et al*. 2013).

Depending on the subsequent biological treatment, biowaste has to be mechanically treated. An optimal mechanical treatment for biowaste enables a clear separation between the wanted organic components and the unwanted contaminants in combination with optimization of the physical properties of the waste components. The simplest option to pretreat biowaste is to use a shredder and a magnet. This technique is only suitable for clean biowaste because plastic or glass cannot be removed. For example, if the biowaste contains glass and plastic particles, a combination of screening at approx. 60 mm and additional hand sorting of the screen overflow is applied practice to remove the contaminants. However, this is unpleasant work and the efficiency is limited. (Jank *et al*. 2015)

Practical experience has repeatedly shown that screen / sifting device is nearly indispensable equipment of each composting. Sifting device adjusts the compost with a higher proportion of non-degradable particles. It is suitable to equip compost plants with these devices with corresponding sieving performance allowing to sort the finished compost into two (or more) fractions intended for shipment or further processing in the compost process. Sieves with different mesh sizes (15, 20, 40 mm) are used based on the requirement of the final product. Most sifting devices are equipped with a cleaning brush, which permits cleaning the screen during operation, thereby preventing clogging mesh under unfavorable conditions for screening. Separators are mainly used in composting of organic waste collected from separately collected OFMSW. The reason for that is the quantity of PVC and other impurities which must be separated after compost sieving. This means that the oversize material is sorted to the metallic scrap, light impurities (plastics etc.), minerals and clean oversize biodegradable waste. (Plíva *et al*. 2012) Compost screening removes up to 98% unsuitable impurities if the screen holes are larger than 60mm. (Čermák and Kebísek 2008)

The amount of oversize compost fraction from compost sieving depends on the input materials feedstock and on the used sieve. Amounts of oversize fraction usually varies between 10-30% (see Table 1), but in the event of unfavorable conditions, the amount of oversize fractions constitute up to 40-50% of the stabilized material. (Váňa 2002, Horáčková 2015, Polášková 2015)

Table 1. Ratio of oversize compost fraction

Facility	Ratio of oversize compost fraction[%]
Compost Plant Rapotín	15-20 / 40-50
Compost Plant Zábřeh	10
Compost Plant Otrokovice	20
Compost Plant Slavkov u Brna	15
Central Compost Plant Brno	20-30
Compost Plant Blansko	10
Compost Plant Bavory	10
Compost Plant Zabrze	30

Data sources: (Váňa 2002[b], Horáčková 2015, Polášková 2015)

Obtained oversize fraction is usually returned to the composting process as a source of microflora while sorted non-degradable impurities are usually landfilled. Excess oversize fraction is usually used for technical processing of landfills or landfill reclamation. (Slejška and Grygara 2003, Horáčková 2015, Polášková 2015) Such a method, however, does not use the real recycling of organic matter, i.e. its return on agricultural land.

Some compost plants produce (except of composts) even woodchip for energy utilization in facilities „waste to energy“ (Kranert at al. 2010). Practice experience shows that the sale of woodchips (for energy utilization) keeps the compost plants processing in black numbers. It is therefore the possibility of energy utilization of woodchips from oversize compost fraction. Unfortunately, literature sources do not provide even the estimation of the amount of wooden chips in the oversize compost fraction. That is why the research has been done.

The aim of the research was to determine the ratio of woodchips in the compost oversize fraction.

METHODOLOGY AND MATERIALS

The research has been done at Central compost plant in Brno, plc (hereinafter CKB, a.s.). which has been owned and operated by SITA CZ, plc company since 2009. The plant is certified according to ISO 9001, ISO 14001 and OHSAS 18001. The process of composting is carried out in concrete troughs. CKB, a.s. is capable of processing up to 70,000 Mg of biowaste annually. Certified composts of CKB, a.s. include: “Black Dragon” (compost that was prepared from biowaste and co-composted sludge from wastewater treatment plants), “Green Dragon” (green compost, prepared just from greenery waste) and “Grey Dragon” (substrate, a mixture of compost and soil). Besides the mentioned certified composts, CKB, a.s. also produces woodchips and scrap created by pallets crushing.

The total area of the compost plant is 21,200 square meters and only biodegradable waste is composted there. Pure wood without any impurities (from branches and unglued pallets) is used as a source of woodchips which are crushed to the size of 5 cm. The compost process is operated with bottom aeration. Composted materials are moistened as necessary by the basis of actual moisture measured by a compost hygrometer. The total time of the compost process is 6 months and then the compost is sieved on a drum sorter Doppstadt SM 518 with mesh sizes 24/40 mm. The compost oversize fraction is deposited in an open-air area.

Ten oversize compost fraction samples were collected by the Czech Standard ČSN 46 5735 „Industrial Composts“ in the period from November 10, 2014 to March 20, 2015. Weight of each sample was 100 kg. Particular samples were taken to a university laboratory. The samples were weighted again and subsequently manually sorted to four fractions: 1) soil, 2) wood, 3) minerals, 4) other parts. Other parts contained mostly plastics, metals, glass, textiles and other undesirable impurities. Each fraction was weighted and so the weight ratio (and the percentage ratio) of mentioned fractions were determined. The information on particular samples composition is presented in Table 2. The normal distribution of measured values was tested by Anderson-Darling normality test.

Table 2. Composition of oversize compost samples

Sample no.	Over-size compost fractions				Total [kg]
	Soil [kg]	Wood [kg]	Minerals [kg]	Others [kg]	
1	64.7	9.7	19.7	6.1	100.2
2	81.4	10.7	6.9	1.1	100.1
3	73.6	14.2	6.2	6.1	100.1
4	68.3	18.2	11.3	2.3	100.1
5	71.3	14.3	12.1	2.4	100.1
6	65.8	19.2	6.8	8.2	100.0
7	81.0	9.1	7.5	2.5	100.1
8	68.3	15.1	12.2	4.4	100.0
9	77.9	10.5	6.3	5.3	100.0
10	72.3	14.9	7.1	5.6	99.9

RESULTS AND COMMENTS

Unfortunately, it is impossible to compare measured values with other authors‘ results because of missing literature data sources although there are lots of articles about possibilities of non-biodegradable impurities removing.

The values of oversize compost samples fractions are presented in Table 2.

Due to the sample weight, the percentage ratios of sorted fractions are almost the same as the amount ratios and they are presented in Table 3.

Table 3. Percentage composition ratios of oversize compost samples

Sample no.	Oversize compost fractions			
	Soil [%]	Wood [%]	Minerals [%]	Others [%]
1	64.5	9.7	19.7	6.1
2	81.3	10.7	6.9	1.1
3	73.5	14.2	6.2	6.1
4	68.2	18.2	11.3	2.3
5	71.2	14.3	12.1	2.4
6	65.8	19.2	6.8	8.2
7	80.9	9.1	7.5	2.5
8	68.3	15.1	12.2	4.4
9	77.9	10.5	6.3	5.3
10	72.4	14.9	7.1	5.6

Soil contained in the oversize compost fraction samples varied from 64.5% to 81.3% with a mean value of 72.4%. It is evident that soil is the most abundant fraction of oversize compost. Regardless of the method of further processing, treatment or utilization, almost three quarters of the oversize compost fraction is constituted by soil.

Wood fraction in the oversize compost fraction samples varied from 9.1% to 19.2% with a mean value of 13.6%. Wood fraction is the second most abundant fraction of oversize compost fraction but its amount is more than five-times less than the amount of soil.

Minerals content in the oversize compost fraction samples varied from 6.2% to 19.7% with a mean value of 9.6% and their content is almost the same as the woodchips content in the oversize compost fraction.

Content of other parts in the oversize compost fraction samples from 1.1% to 8.2% with a mean value of 4.4% and thus represent the smallest part of oversize compost fraction.

The average percentage ratio of oversize compost fraction parts is shown in Fig. 2.

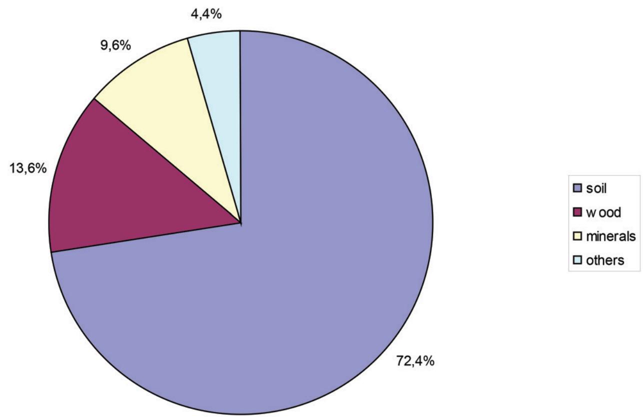


Figure 2. Average percentage ratio of oversize compost fraction parts

CONCLUSION

Woodchips produced at compost plants can be the key product of compost plants economic processing. Except of separately produced and kept woodchips that are not treated at composting process there are additional woodchips as a part of oversize compost fraction, obtained during final compost sieving.

The fraction analysis revealed that more than 70% of oversize compost fraction consist of soil while the ratio of woodchips is less than 14% only. The ratio of minerals and other parts is less than 10% or 5% respectively.

Such oversize compost fraction is easy to use as an inoculum at a new compost pile or as a substrate for landfill reclamation. Of course, it is impossible to use all the volume of produced oversize compost fraction as an inoculum throughout the compost plant processing; the volume has to be reduced. Oversize compost fraction utilization for landfill reclamation should be the last possibility of its treatment and moreover such utilization is less cost effective compared to energy utilization for the compost plants.

Future research should focus on two ways of possible oversize compost fraction energy utilization:

1. To explore the way of direct energy utilization of oversize compost fraction by its co-combustion in existing energy facilities, and
2. To explore the ways of practical and economically acceptable method of woodchips separation from the oversize compost fraction.

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Ing. Bohdan Stejskal, Ph.D.
bohdan.stejskal@mendelu.cz
Ing. Kateřina Jordánková
xjordank@node.mendelu.cz
Mendel University in Brno
Faculty of Agronomy
Department of Applied and Landscape Ecology
Zemedelska 1/1665
613 00 Brno
The Czech Republic

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