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Variability in physical contamination assessment of source segregated biodegradable municipal waste derived composts

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ABSTRACT

Physical contaminants (glass, metal, plastic and 'other') and stones were isolated and categorised from three finished commercial composts derived from source segregated biodegradable municipal waste (BMW). A subset of the identified physical contaminant fragments were subsequently reintroduced into the cleaned compost samples and sent to three commercial laboratories for testing in an inter-laboratory trial using the current PAS100:2011 method (AfOR MT PC&S). The trial showed that the 'other' category caused difficulty for all three laboratories with under reporting, particularly of the most common 'other' contaminants (paper and cardboard) and, over-reporting of non-man-made fragments. One laboratory underreported metal contaminant fragments (spiked as silver foil) in three samples. Glass, plastic and stones were variably underreported due to miss-classification or over reported due to contamination with compost (organic) fragments. The results are discussed in the context of global physical contaminant test methods and compost quality assurance schemes.

1. Introduction

Compost product quality is important for ensuring continued confidence in organic waste recycling industries. From the perspective of the general public and consumers, physical contamination is arguably the single most important quality criterion for organic waste derived products (Aspray, 2016). Only last year for instance, physical contaminants (elsewhere known as foreign matter, impurities or inerts) in compost products going to land were highlighted in a UK prime time television programme, followed up by wider media attention. Despite its obvious importance, reported data on physical contaminants such as glass, metal and plastic in source segregated biodegradable municipal waste (BMW) derived compost is limited. Most studies instead focus on stability and maturity quality indicators (Aspray et al., 2015; Cesaro et al., 2015; Oviedo-Ocaña et al., 2015). In fact, only one article in the literature reports physical contamination in source segregated BMW derived composts (Dimambro et al., (2007). These authors comparing ten source segregated BMW derived composts alongside two mixed municipal solid waste (MSW) derived composts. The authors found that source segregated BMW composts had lower amounts of physical contaminants than MSW derived composts. Elsewhere further data on physical contamination in MSW derived composts can be found (Brinton, 2005; Montejo et al., 2015; Sharifi and Renella, 2015). Therefore, additional data needs to be gathered on source segregated BMW derived compost to address this shortfall.

Tests for determining the abundance of physical contaminants in source segregated BMW compost products tend to follow the same basic procedure. In short, dry or wet sieving, manual isolation of physical contaminant fragments and, quantification on a weight basis. However, industry tests for individual countries show a number of key differences. In the USA, for example, man-made 'inerts' such as glass, metal, plastic and synthetic textiles >4 mm are assessed on a weight basis (TMECC, 2001). By comparison in Germany, 'foreign matter' (glass, metal, plastic, rubber and composite materials) >2 mm, and stones >5 mm are assessed (BGK, 2003). The translated version of the German Compost Quality Assurance Organisation (Bundesgütegemeinschaft Kompost (BGK)) weight based test also states that paper, stones, lava and clay granulate should not be considered foreign matter.

The focus of this study is the UK test AfOR MT PC&S which is used to assess physical contamination of composts certified under

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the UK voluntary PAS100 certification scheme (B.S.I. PAS100:2011). The AfOR MT PC&S test is more complicated by comparison with both the TMECC and BGK weight tests in combining directly compost particle size distribution (PSD) and physical contaminant analysis in one. In addition, physical contaminants (>2 mm) must be classified as either glass, metal, plastic or 'other' with % w/w limits applied to both individual 'plastic' and 'total' (the sum of glass, metal plastic and other) categories. Unlike the BGK test, paper and cardboard are specifically identified as physical contaminants falling in the 'other' category. Finally, stones (>4 mm) are reported alongside physical contaminants and may include; aggregate, concrete, pebbles, pottery, rubble, tile and 'any other consolidated mineral particles'.

A recent, albeit unpublished, UK study has found data inconsistencies between commercial laboratories following AfOR MT PC&S prompting the need to re-assess the test protocol. In addition, a key UK agriculture quality assurance scheme has recently successfully driven for lower physical contaminant limits (QMS, 2016) giving rise to further need to re-evaluate the robustness of the method. Specifically, compost going to Quality Meats Scotland (QMS) agricultural assurance scheme land producing Scotch beef and lamb must not exceed half the PAS100:2011 permitted level of physical contamination (i.e. a reduction of the limits by 50%). As QMS represents 90 and 80% of Scotland's breeding cattle population and breed sheep stock respectively, the significance for compost going to the Scottish agricultural land banks is clear. Therefore, the aims of this research were to (1) identify aspects of the test protocol leading to apparent variability between laboratories and, (2) evaluate the robustness of the test for lower market specific limits. An inter-laboratory trial was chosen to assess these aims with testing carried out by commercial laboratories and supported by in-house analysis. The outcomes of the work provide useful information for wider physical contamination tests and compost quality assurance schemes. The research also adds to the currently scarce literature in characterising physical contaminants in source segregated BMW derived composts.

2. Materials and methods

2.1. Composts

Composts were collected from UK commercial sites during Winter 2014/2015 representing the three key product grades, as well as, different processes and feedstocks (Table 1). Twenty spot, or incremental, samples (>1.2 kg) were taken of finished compost products from batch piles after scraping away at least 50 mm of surface material as per the Renewable Energy Assurance Ltd (REAL) compost certification scheme (CCS) sampling guidelines (which are based on BS EN 12579:2013). Physical contaminant fragments were removed from (1.2 kg fresh weight) compost samples by hand (without drying to help maintain sample integrity) and classified into glass (>2 mm), plastic (>2 mm), metal (>2 mm), 'other' (>2 mm) and stones (>4 mm). The fragments were weighed before and after drying, and after removal of loosely bound organic material (by gentle shaking in closed Petri dishes). Moisture content of compost aliquots was determined gravimetrically by drying overnight at 105 °C. The clean compost samples were weighed (~1 kg fresh weight), bagged and stored at 4 °C until spiking (Section 2.2).

2.2. Inter-laboratory trial

Cleaned compost samples were spiked at two loading rates of physical contaminants according to the type of contaminants present originally in specific compost grades (Table 2). The high loading rate was chosen as the current PAS100:2011 limits for total (sum of glass, metal, plastic and other) contaminants. The low loading rate was chosen as 50% of the current PAS100:2011 limit for total contaminants; now a market specific limit for compost

Table 1
Original physical contaminants in 20 spot samples from finished compost piles with significant differences between sites indicated by superscript lettering.

Site	Product grade	Feedstock	Composting process type	Physical contaminants (% g/g DM)					
				Glass (>2 mm)	Metal (>2 mm)	Plastic (>2 mm)	Other (>2 mm)	Total (>2 mm)	Stone (>4 mm)
1	0–10 mm	GFW	In-vessel	0.14 (0.08)	<0.00	0.03 (0.02)[a]	0.04 (0.03)[a]	0.21 (0.09)	2.16 (0.99)[a]
2	0–25 mm	GW	Open windrow	0.03 (0.05)	<0.00	0.10 (0.09)[b]	0.23 (0.22)[b]	0.37 (0.26)	12.32 (4.10)[b]
3	0–40 mm	GW	Open windrow	0.08 (0.17)	0.06 (0.26)	0.06 (0.07)[ab]	0.22 (0.26)[b]	0.41 (0.45)	12.33 (6.56)[b]
PAS limits						0.12		0.25	8 or 10[*]

GFW – green and food waste; GW – green waste; PAS – publicly available specification (for composted materials).
Standard error in parenthesis.
[*] Limit for mulches.
[a,b] Columns with different letters are significantly different (one-way ANOVA, $p < 0.05$).

Table 2
Spiking of physical contaminants both on a % weight (and fragment number in parenthesis) basis. The % weight shows the narrow range achieved for spiked compost samples provided to the commercial laboratories using real physical contaminant fragments.

ID	Product grade	Contaminant loading	Physical contaminants % g/g DM and fragment number					
			Glass (>2 mm)	Metal (>2 mm)	Plastic (>2 mm)	Other (>2 mm)	Total (>2 mm)	Stone (>4 mm)
1	0–10 mm	Low	0.07–0.11 (6[*])	n/a	0.01–0.03 (6)	0.00–0.03 (3)	0.11–0.14	0.86–1.89 (32)
		High	0.23–0.28 (14)	n/a	0.01–0.02 (6)	0.00–0.01 (3)	0.26–0.29	0.72–1.34 (32)
2	0–25 mm	Low	0.04–0.06 (2)	n/a	0.04–0.06 (6)	0.01–0.03 (2)	0.11–0.12	4.46–6.10 (27)
		High	0.30–0.32 (8)	n/a	0.01–0.06 (6)	0.01–0.03 (2)	0.34–0.40	4.52–6.59 (27)
3	0–40 mm	Low	n/a	0.00–0.02 (3)	0.08–0.10 (6)	n/a	0.08–0.12	5.01–9.41 (28)
		High	0.09–0.21 (2)	n/a	0.08–0.12 (6)	n/a	0.17–0.34	4.62–7.06 (28)

n/a – not applicable.
[*] With the exception of two samples which each had seven fragments.

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