



Short Communication

Input materials and processing conditions control compost dissolved organic carbon quality



Angela L. Straathof*, Rob N.J. Comans

Wageningen University and Research Centre, Department of Soil Quality, P.O. Box 47, 6700 AA Wageningen, The Netherlands

HIGHLIGHTS

- The DOC quality of 11 composts was characterized using fractionation.
- Hydrophobic DOC proportions ranged up to 33% between samples.
- Hydrophilic DOC decreased as composting temperature and time increased.
- Qualifying DOC improves user's ability to select a compost based on needs.

ARTICLE INFO

Article history:

Received 22 October 2014
 Received in revised form 11 December 2014
 Accepted 15 December 2014
 Available online 22 December 2014

Keywords:

Dissolved organic carbon
 Organic matter
 Fractionation
 Composting
 Municipal solid waste

ABSTRACT

Dissolved organic carbon (DOC) has been proposed as an indicator of compost maturity and stability. Further fractionation of compost DOC may be useful for determining how particular composting conditions will influence DOC quality. Eleven composts ranging in input materials and processing techniques were analyzed; concentrations of DOC ranged from 428 mg kg⁻¹ to 7300 mg kg⁻¹. Compost DOC was qualified by fractionation into pools of humic acids (HA), fulvic acids (FA), hydrophobic neutrals (HoN), and hydrophilic (Hi) compounds. The range in proportion of DOC pools was highly variable, even for composts with similar total DOC concentrations. Longer composting time and higher temperatures consistently corresponded with a depletion of hydrophilics, suggesting a preferential turnover of these compounds during the thermophilic composting phase. Qualification of DOC pools through fractionation may be an informative tool in predicting the effects of a processing technique on compost quality and, ultimately, soil functional processes.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

Composts are produced using many different processing techniques and with a broad range of input materials, resulting in physical and chemical heterogeneity between compost types (Lannan et al., 2012). This heterogeneity makes it difficult to predict how a soil's biogeochemical properties are influenced by compost application. Dissolved organic carbon (DOC) concentration is associated with many indicators of both compost and soil quality, including maturity and microbial activity, respectively. Therefore, DOC has been proposed as an indicator of compost maturity and stability (Bernal et al., 1998; Zmora-Nahum et al., 2005). Between compost types, however, DOC quality may range broadly and

independently of total DOC, depending on input materials (Wei et al., 2014) and duration of composting (Said-Pullicino et al., 2007).

Qualification of DOC is often performed by isolating and quantifying the pools of hydrophobic and/or hydrophilic DOC in a solution extracted from solid-phase materials (Aiken et al., 1985), such as compost. Hydrophobic compounds include humic acids, fulvic acids and hydrophobic neutrals. These compounds tend to be more aromatic and higher in molecular weight than hydrophilic compounds (Aiken et al., 1985). These various pools of DOC also function distinctly from one another; the size and hydrophobicity of compost humic acids facilitate their ability to complex contaminants such as trace metals, polycyclic aromatic hydrocarbons, and pesticides (Semple, 2001). Meanwhile, hydrophilics extracted from compost have been found to influence rates of microbial activity in soils (Straathof et al., 2014) which may subsequently impact nutrient availability and turnover. As compost's application purposes range from remediation to nutrient supplementation to pathogenic disease suppression (Termorshuizen et al., 2006), the

* Corresponding author at: Wageningen University and Research Centre, Droevendaalsesteeg 4, P.O. Box 47, 6700 AA Wageningen, The Netherlands. Tel.: +31 317 48 44 38.

E-mail addresses: angela.straathof@wur.nl (A.L. Straathof), rob.comans@wur.nl (R.N.J. Comans).

characterization of the respective pools that influence these processes may be valuable information for end users.

The objective of this experiment was to investigate the range in quality of dissolved organic carbon from a variety of composts. It was hypothesized that composts sourced from different organic input materials and composted under different processing conditions would have different DOC quality profiles independent of total DOC concentration. Furthermore, it was hypothesized that increasing the length of maturation time and/or increasing proportions of woody input material would result in higher concentrations of hydrophobic compounds relative to hydrophilic compounds. This will provide insight into how input materials and processing conditions of a particular compost influence the DOC quality of the final product.

2. Methods

2.1. Compost collection and characterization

Eleven compost types were collected from different composting facilities in The Netherlands between March 2012 and June 2013. Each compost was collected on-site from the commercial composting facilities (Table 1) except MW6, which was received from the supplier in commercial packaging. Composts collected on-site were shoveled from a minimum depth of 30 cm below the surface of the compost heap, from multiple points in the heap, and homogenized manually into one sample. All composts were collected at the stage of readiness for commercial distribution (*i.e.* a final product). The input materials and/or processing conditions (Table 1) were different for each compost, to better obtain a broad range in properties. Composts were transported to the laboratory and refrigerated (4 °C) for a maximum of one week before pretreatment and analysis.

Prior to chemical analysis (Table 2), composts were air dried at 40 °C and ground (<1 mm) for homogeneity of each sample. For pH, total soluble N and PO₄-P, samples were equilibrated for 1 h in a 1:10 ratio of dry material to 0.01 M CaCl₂, and filtered to 0.45 µm. Nitrogen and P were measured on a San⁺⁺ 6 channel

segmented flow analyzer (SFA) (Skalar, The Netherlands). Calcium carbonate content on each compost was determined using the Scheibler method (ISO10693) and total elemental C and N measurements were performed on a LECO Truspec CHN analyzer (LECO Corporation, St. Joseph, MI, USA) (Table 2). Organic matter (OM) content was determined by loss on ignition from 105 to 550 °C (Table 2).

Extraction of DOC was performed on dry-weight-equivalent fresh compost material in ultra-pure water (1:10). Due to heterogeneity of the fresh compost materials, four suspensions of 10 g compost were equilibrated, filtered, and subsequently pooled. Equilibration for 1 h via end-to-end shaking preceded 0.45 µm filtration of the solution. A subsample of the pooled solution was taken for measuring total DOC concentration on a TOC-5050A analyzer (Shimadzu Corporation, Kyoto, Japan). The remainder of the total DOC sample was fractionated.

2.2. Fractionation of DOC

After extraction, the total DOC sample was fractionated using the operational definitions set by the International Humic Substances Society (IHSS) and described by Aiken *et al.* (1985). Hydrophobic humic acid (HA), fulvic acid (FA) and neutral (HoN) compounds were physically separated from hydrophilic (Hi) compounds through pH changes to the solution and equilibration with a resin. In this experiment, the batch fractionation procedure (Van Zomeren and Comans, 2007) was used; first, the total DOC sample was acidified to pH 1 with 6 M HCl and allowed to stand overnight. This precipitated humic acids out of solution. The acidified solution was then centrifuged (15 min, 3000g), separating the HA from the supernatant containing FA + HoN + Hi. Next, the HA pellet was resuspended in 0.1 M KOH (pH 12) and the HA DOC concentration was determined on a TOC-5050A analyzer (Shimadzu Corporation, Kyoto, Japan). The supernatant (FA + HoN + Hi) was then added in a 1:10 resin to solution ratio to the resin DAX-8 (Sigma-Aldrich). DAX-8 is a non-ionic, macroporous resin. The resin was prepared for use by extracting organic impurities in a 24 h Soxhlet extraction with acetonitrile and then methanol, as described by Van

Table 1
Composts included in this study, source material ingredients of the compost, and processing procedure.

Compost code	Composting facilities	Source material	Peak temperature (T) ^a (°C)	Time at peak T (d)	Additional
MW-1	Van Iersel Compost, Biezenmortel, Netherlands	55% shredded wood, 25% grass litter, 20% leaf litter	80	52	Sieved to 10 mm. 10 d in windrow (turned 5×), 42 d on tablebed (turned 4×)
MW-2	Van Iersel Compost, Biezenmortel, Netherlands	55% shredded wood, 25% grass litter, 20% leaf litter	80	52	Sieved to 15 mm. 10 d in windrow (turned 5×), 42 d on tablebed (turned 4×)
FL	Van Iersel Compost, Biezenmortel, Netherlands	Forest (leaf) litter	70	28	Sieved to 30 mm. Windrow, turned 6×
SG	Van Iersel Compost, Biezenmortel, Netherlands	75% soil sieved from woody municipal waste + 25% grass litter	75	14	Sieved to 20 mm. Windrow, turned 7×
MW-3	Van Iersel Compost, Biezenmortel, Netherlands	65% shredded wood, 17.5% grass litter, 17.5% leaf litter	80	52	Sieved to 15 mm. 10 d in windrow (turned 5×), 42 d on tablebed (turned 4×)
FG-1	Van Iersel Compost, Biezenmortel, Netherlands	70% shredded wood, +30% clay, grass litter & compost as inoculum	70	84	Windrow, turned 15×
FG-2	Orgaworld, Lelystad, Netherlands	Grass clippings + fungal-inoculated mulched wood	>65	21	Turned 7–10×. Inoculated with <i>Trichoderma</i> spp.
MW-IW	Orgaworld, Zeeasterweg, Netherlands	80% municipal organic waste + 20% industrial organic waste	50–65	1	Turned 2×
MW-4	Orgaworld, Lelystad, Netherlands	Municipal organic waste ^b	50–65	1	Turned 2×
MW-5	Orgaworld, Drachten, Netherlands	Municipal organic waste	65–70	10	Turned 3×
MW-6	Comgoed, Dirksland, Netherlands	Municipal organic waste	55–60; >50	3; 14	Turned 4–5×. 3 d at peak T then 14 d slightly below peak T.

^a Internal maximum temperature of compost heap.

^b Municipal organic waste is a mixture of vegetable, fruit and garden waste collected from curb-side municipal programs.

Download English Version:

<https://daneshyari.com/en/article/680197>

Download Persian Version:

<https://daneshyari.com/article/680197>

[Daneshyari.com](https://daneshyari.com)