Chemical Characterization of Three Compost of (Sugarbeet) Vinasse with other Agroindustrial Residues

DÍAZ, M.J.*, MADEJÓN, E.**, LÓPEZ, R.*, RON VAZ, M.D.* and CABRERA, F.*

Increasing amounts of liquid and solid wastes are produced by the food and agricultural industries in Andalusia. However, the recycling of these residues is not always billed and their elimination, is, at times, an environmental problem. Beet vinasse, a high density liquid waste from the sugar industry, contains high levels of OM (35%), N (3%) and K (3%), which make the vinasse a potential fertilizer. However, the direct application of concentrated vinasse on agricultural land may lead to economical and environmental problems because of high salinity (EC 250–300 dS m⁻¹), low P content (P₂O₅ 0.012%) and its liquid dense character (1.3g cm⁻³). The co-composting of vinasse with other agricultural residues could be used to overcome these disadvantages by producing a compost easily handled with higher P content and lower salinity.

Three composts were obtained from mixtures of vinasse (V) (2.5% N, 0.06% P₂O₅, 3.6% K₂O, 27% OM) with each of the three following agroindustrial residues: grape marc (1.4% N, 0.63% P₂O₅, 0.9% K₂O, 71.6% OM) (compost OC), olive pressed cake (1.03% N, 0.06% P₂O₅, 0.9% K₂O, 71.6% OM) (compost CO), and cotton gin trash (1.45% N, 0.35% P₂O₅, 2.53% K₂O, 67.8% OM) (compost GC). Sugarbeet factory lime (F) containing 50% CaCO₃ was added to the mixtures to increase pH. This was carried out to overcome the vinasse acidity (pH 4.7). The mixtures containing olive pressed cake and cotton gin trash were complemented with leonardite (L) (0.3% N, 0.04% P₂O₅, 0.16% K₂O, 48.7% OM), a low maturity lignite containing 25% (w/w) of humic acids. The proportion of V, GM, OC, CC, F and L for each mixture was as follows: Pile 1: GM (82%) 1 V (17%) 1 F (1%); Pile 2: OC (76%) 1 v (17%) 1 F (1%) 1 L (6%); Pile 3: CC (47%) 1 V (49%) 1 F (1%) 1 L (3%), where GM, OC, CC, F and L are expressed on a dry matter basis.

Co-composting was carried out in static piles, under cover, with forced aeration and in controlled conditions during three months. During the process, the piles were watered regularly to maintain moisture contents to 50% for pile 1, 40% for pile 2 and 40% for pile 3. After this stage, the composts were left to mature during the winter.
the following four months. Samples were taken periodically at two depths (0–30 and 40–100 cm) in three zones of the pile. The following parameters were determined throughout the whole process: moisture content, pH_{H_2O} (1:5 w:v), OM, EC_{H_2O} (1:5 w:v), total-N, NH_4-N, NO_3-N, P_2O_5, K_2O, CEC, Na, Ca, Mg, Fe, Cu, Mn and Zn. The main chemical characteristics of the mixtures before and after composting are shown in Table I. After composting, the lipidic fraction composition of the composts was also determined to study the presence of anthropogenic compounds.

The maturity of the composts was completed after 90 days where the C/N and CEC reached a constant value. The evolution of these parameters, among others, have been used as an index to control the maturity of the final products (Harada et al., 1981). For composts GC and CC, the C/N and CEC values after 210 days of composting were within the values of mature composts (Mathur et al., 1993). This was not the case for compost OC which showed a high C/N ratio and a low CEC value. However, these two parameters did not show any change from day 90 onwards and therefore this compost could be considered mature (Harada et al., 1981).

Table I. Main chemical characteristics of the mixtures before and after composting.

<table>
<thead>
<tr>
<th>Pile 1 (compost GC)</th>
<th>Pile 2 (compost OC)</th>
<th>Pile 3 (compost CC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moist (%)</td>
<td>pH</td>
<td>OM (%)</td>
</tr>
<tr>
<td>0 days</td>
<td>52</td>
<td>7.1</td>
</tr>
<tr>
<td>210 days</td>
<td>35</td>
<td>8.3</td>
</tr>
<tr>
<td>0 days</td>
<td>41</td>
<td>6.8</td>
</tr>
<tr>
<td>210 days</td>
<td>32</td>
<td>8.5</td>
</tr>
<tr>
<td>0 days</td>
<td>42</td>
<td>7.3</td>
</tr>
<tr>
<td>210 days</td>
<td>24</td>
<td>8.1</td>
</tr>
</tbody>
</table>

*Ash-free material basis

The three composts were under the maximum water content (40%) permitted by EEC regulation. The pH values were stabilized above 8, being these values slightly higher than those reported as optimum for compost stabilization (Nogales and Gallardo-Lara, 1984). However, similar pH values have been reported for composts derived from similar agroindustrial residues (García-Izquierdo et al., 1987).

For the three composts, the OM, total-N, NH_4-N, NO_3-N and K_2O contents were well above the minimum nutritional specifications described by Zucconi and De Bertoldi (1987). Similar results for other agroindustrial composted products have been reported elsewhere (Baca-García et al., 1987). For pile 3, the largest pile, the ammonium accumulation at the end of the process was probably due to a lack of oxygen since the aeration system used was not powerful enough to provide higher oxygen concentration. Furthermore, the ammonium concentration in pile 3 was higher in the samples taken in the deepest zones (data not shown).
The three composts showed a high EC value because of the high salinity of the vinasse. However, these composts could be added to soils at low rates to avoid detrimental effects for plant growth.

Sodium, Ca, Mg and micronutrients contents for the three composts (data not shown) were within the range of similar products (Chen et al., 1988). Lixiviation of the macro and micronutrients throughout the composting process was too small to be considered important.

Analysis of the lipidic fraction for the three composts revealed the absence of anthropogenic compounds which could have been derived from pesticides added to the crops, and therefore they may have been present in the agroindustrial residues used for composting.

From the chemical characterization of these composts, it could be concluded that the co-composting of vinasse with grape marc (compost GC, pile 1) and with cotton gin trash (compost CC, pile 3) resulted in final products with a high value from an agricultural standpoint (rich in OM and mineral nutrients, low C/N ratio and high CEC values). However the compost OC, mixture of vinasse with olive pressed cake, showed a high C/N ratio and a low CEC value to be considered a suitable organic fertilizer. The addition of these composts as organic fertilizers has been tested in field experiments. Soils fertilized with composts GC and CC gave a better quality crop and higher yields than those treated with mineral fertilizers alone (Madejón et al., 1994).

References


CHEMICAL CHARACTERIZATION