Co-Composting Process of (Sugarbeet) Vinasse and Grape Marc

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

Beet vinasse, a high density liquid waste from the sugar industry, and grape marc, a primary by-product of wine production, could be recycled as fertilizers due to their high OM and nutrient contents. The direct incorporation of grape marc into agricultural land, a common practice, has become a serious problem because degradation products inhibiting root growth are released (Inbar *et al.*, 1991). Furthermore, the direct application of vinasse has also several shortcomings because of its high salinity ($EC\ 250\text{--}300\ dS\ m^{-1}$), low P content ($P_2O_5\ 0.012\ \%$) and liquid dense character ($1.3\ g\ cm^{-3}$). An alternative to overcome these disadvantages is the co-composting of vinasse with grape marc.

A compost was obtained from a mixture of vinasse, V (2.5% N, 0.06% P_2O_5 , 3.6% K_2O , 27% OM) with grape marc, GM (1.4% N, 0.63% P_2O_5 , 1.16% K_2O , 71.6% OM). Sugarbeet factory lime (F) containing 50% $CaCO_3$ was added to the mixture to overcome the vinasse acidity (pH 4.7). The proportion of each component in the mixture was 17% of V, 82% of GM and 1% of F, where GM and F are expressed on a dry matter basis.

The co-composting process was carried out in a static pile, under cover, with forced aeration following the Rutgers method with a total mass of ca. 15 metric tons. The pile (3m length x 5 m width x 1.5 m height) was centered over three perforated pipes installed in grooves in the concrete floor. The air required for the process was provided by a blower at a rate of $0.87\ kg\ O_2\ h^{-1}$.

During the co-composting process, samples were taken periodically at two depths (0–30 and 40–100 cm) in three zones of the pile. Temperature was measured in four zones at the same depths. 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, $NH_4\text{--}N$, $NO_3\text{--}N$ and CEC. Macro and micronutrients were measured after 1, 80 and 190 days of composting. Elemental analysis (C, N, and H) of the mixture was carried out before and after composting.

The temperature profiles at two depths in the compost pile are shown in Figure 1. The temperature rose rapidly reaching an averaged value of $53^\circ C$ at day 8. The thermophilic phase was completed after 54 days of composting. Similar temperature profiles have been described elsewhere (Pérez García and Iglesias Jiménez,

* Instituto de Recursos Naturales y Agrobiología de Sevilla (CSIC). Apdo. 1052, 41080 Sevilla, Spain.

** EBRO AGRICOLAS S.A. Apdo. 9, 41300 S. José de la Rinconada, Sevilla, Spain.

1984), where the thermophilic phases were too long due to the large size of the piles. The moisture content was maintained during the thermophilic period at around 50%, this being considered the optimum. After 54 days, the mesophilic stage started lasting one month. The compost was then left to mature for the following four months. No water was added throughout the mesophilic and maturing stages. The final moisture content of the compost was 30% being under the maximum water content (40%) permitted by EEC regulation.

The pH increased from 7.1 to a maximum of 9.5 after 25 days of composting. Afterwards, the pH decreased to 8.3, remaining approximately constant during the maturity period. This pH value has been considered as standard for compost stabilization (Poincelot, 1974). The losses of organic matter and nitrogen were calculated by a mass balance following Haug (1980). The OM decreased by ca. 24%. The OM content of the final product was 50%. The N loss accounted for 0.22 moles $\text{NH}_3 \text{ kg}^{-1}$ compost, which represents 15% of the total-N, this loss being similar to that reported by De Bertoldi *et al.* (1982).

The $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ evolutions in the deep samples through the composting process are shown in Figure 2. A high $\text{NO}_3\text{-N}$ content of the mixture at the beginning of composting was observed. This could be attributed to an initial N mineralization of the substrates during their storage because of their high moisture contents in addition to the aeration produced in the conveyance. The $\text{NO}_3\text{-N}$ content decreased from 1066 to 311 $\text{mg NO}_3\text{-N kg}^{-1}$ in the thermophilic period and then, increased up to 697 $\text{mg NO}_3\text{-N kg}^{-1}$ in the mesophilic stage. The $\text{NH}_4\text{-N}$ content increased rapidly from 25 to 958 $\text{mg NH}_4\text{-N kg}^{-1}$ after 10 days of composting. Afterwards, $\text{NH}_4\text{-N}$ content tends to decrease reaching the original values after 180 days of composting.

The evolutions of C/N and CEC are given in Table I. Generally, composts having a $\text{C/N} < 20$ are considered mature. However, a $\text{C/N} < 20$ cannot be used as an indicator of maturity when a N-rich waste, is added to the compost mixture (Mathur *et al.*, 1993). Nevertheless, the evolution of C/N and CEC, among others, have been used as an index to control the maturity of the final products (Harada *et al.*, 1981). The CEC values increased steadily to reach a constant value of ca. 142 $\text{cmol}_c \text{ kg}^{-1}$ in 4 months. Furthermore, a highly significant linear relationship between CEC and C/N was found: $\ln(\text{CEC}) = 12.18 - 2.93 \ln(\text{C/N})$, $r^2 = 0.90$ ($P < 0.001$). Similar findings have been reported by Inbar *et al.* (1991) during grape marc composting. This relationship indicated that the CEC values could be used for estimating the degree of maturity of this compost.

The N (2.1%), P_2O_5 (0.70%) and K_2O (1.3%) contents of the compost were well above the minimum nutritional specifications described by Zucconi and De Bertoldi (1987). Sodium, Ca, Mg and micronutrient contents for the compost (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.

Figure 1 Temperature profile at two depths

Figure 2 Evolution of $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ during composting

The compost showed a high EC value (11.5 dS m^{-1}) because of the high salinity of the vinasse. Nevertheless, this compost could be added to soils at low rates to avoid detrimental effect of its salinity on plant growth.

The co-composting process of beet vinasse and grape marc followed the classic pattern described in the literature. The compost maturity was achieved in four months. The final product, despite of its high salinity, has a high agriculture value because of its OM, N and K contents.

Tabla 1 Evolution of the maturity parameters

	C/N	C.E.C.* cmolec kg ⁻¹
Day		
1	15.4	66
32	14.6	74
52	13.1	83
79	12.5	124
120	11.5	142
190	11.9	146

*Ash-free material basis

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