WASTE ORGANIC MATTER QUALITY VERSUS SOIL AMENDMENT EFFECTS

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ABSTRACT

To predict organic wastes (OW) amending capacity and its behaviour in soils it is necessary to study the organic fraction quality (OFQ), this information can not be obtained from the total organic fraction content (OFC), usually expressed as total C or volatile solids. Actually, to express OW stability or compost maturity several parameters are in use. In working documents on land reuse for biowaste and sewage sludge, prepared by European Commission, different quality products are establish according their chemical content (heavy metals and organic compounds) and hygienisation conditions (removal of pathogen organisms), but these does not consider any specific parameter related to OFQ other than the Respiration Activity or Dynamic Respiration Index which express their biodegrability capacity.

The aim of this paper is to discuss the results of several parameters obtained by simple and economic laboratory methods in order to determine OFQ and also to predict the long term evolution in soils when composted organic wastes are applied. Studied samples belong to several Spanish composting plants, which treated residues from different origin and using various composting system. OFQ of more than 500 compost samples has been analysed, a good relationship between different parameters and composting conditions is observed when results are compared. In addition, from values of several OFQ parameters possible OW behaviour in soil could be predicted.

INTRODUCTION

To protect environment and public health from wastes management systems and to take profit from different waste components, lately different sort of rules have been established. In south European countries, soil recycling after composting had been one of the most encouraged technologies to maintain or to restore soils organic mater depletion. In Catalunya (northeast region of Spain), waste regulation (Llei 6/93) settled basis for municipal solid waste (MSW) separate collection (SC). Composting organic waste (OW) has progressively been recognised as one of the best alternatives to waste management.

The most valuable components for successful use of OW in plant grown are organic fraction and fertiliser contents; further low pollutants content is expected. The organic fraction content (OFC) is usually expressed as total C or as volatile solids; nevertheless, several parameters are in use to express OW stability or compost maturity, as Coperband et al. (2003) summarise. There are widely recognised OW abilities for amending, conditioning, or improving soils, those effects are due to the organic fraction persistence into soils. In order to predict OW soil behaviour it is necessary to establish parameters for OFQ characterisation.

Several reviews on composition of different composted OW from different geographical regions had been published but these usually contain a short number of samples. In this study more than 500 compost samples integrated in a compost database (Huerta et al., 2003) has been considered, several data had been published previously (Soliva et al., 1992; Soliva et al., 1993b; Soliva et al., 2003).

The aim of this study was to compare analytical results after application some simple and economic chemical laboratory methods. Comparisons between organic fraction content (OFC) and representative parameters which express organic fraction quality (OFQ) are done, furthermore its relationship with other parameters currently employed for OW agronomic characterisation (pH, EC, nutrient content) are also provided.

MATERIALS AND METHODS

a. Compost samples. More than 500 samples were colleted according to the procedure described by Soliva et al. (1985) from composting plants of different origin. Main samples belong to compost from municipal solid waste (MSW); raw material was selected by mechanical separation (MS) or separate collection (SC): MS was practised before 1997 (MSW-1, n=282); SC was done in municipalities from Catalunya after 1997 (MSW-SC, n=158), but not in those from the other Spanish communities (MSW-2, n=42). The smallest group belongs to sewage sludge compost (SS, n=32).

b. Analytical methods. Compost samples were analysed according to the analytical procedures described by Saña et al. (1989). (i) Organic fraction characterisation was done applying following procedures: Total volatile solids (VS) was determined by loss on ignition heating for 3 hr in a muffle furnace at 560 °C and organic nitrogen (org-N) by specific ion electrode after Kjeldahl digestion. Resistant organic mater (ROM) and non hydrolysable nitrogen (Nh-N) were determined in the residue obtained after two successive sulphuric acid hydrolysis [one in cool for 3 hours with 72% H_2SO_4 followed by a second hydrolysis conducted boiling to reflux for 5 hours in a H_2SO_4 water dilution (≈ 0.07N H_2SO_4)]. Stabilisation degree (SD) was calculated as SD = ROM x100/VS; and resistant nitrogen (r-N) calculated as r-N = Nh-Nx100/org-N. Results are expressed in percentage. (ii) Physicochemical characteristics and other agronomical parameters were obtained applying the following procedures: EC (dS m^{-1}) and pH measured in distilled water extract 1:5 (w/v). Water extractable inorganic nitrogen forms (NH_4^+-N and NO_3—N, expressed in mg kg^{-1}) were measured in the same extract using specific ion electrodes. Total nutrient (%) was determined by AA, after dry ash (ignition at 470º C) dissolution in 3N HNO_3. Moisture content (H) was calculated after drying at 105 °C to constant weight and expressed en %.

All determinations were conducted with dry samples, except for H, pH, EC, and water extractable inorganic nitrogen (NH_4^+-N and NO_3—N) which was determined in wet ones. Analyses were done on duplicate samples, being the differences between replications always less than 5%.

RESULTS AND DISCUSSION

***Table 1**. Multiple comparisons the mean values of several representative parameters (organic fraction composition and agronomical characteristics) for composted waste from different origin.*

	VS	orgN	C/N	ROM	SD	N-hN	rN	P	K	pH	EC	H	NH_4-N	NO_3-N
MSW-1	ab	c	a	d	d	c	c	d	c	c	b	a	a	a
MSW-2	ab	b	b	c	c	b	b	c	bc	b	a	bc	b	a
MSW SC	b	a	c	b	b	a	a	b	a	a	c	c	c	a
SS	ab	a	c	a	a	a	a	a	b	ab	d	b	a	a

Within a column, same letters are not significant different using Tuckey's Multiple Comparison Test

Chemical results have been studied applying statistical analysis by SAS statistic software. Comparing mean values of studied parameters (table 1) significant differences can be observed, except for volatile solids (VS) and water extractable nitrate (NO^{-}_{3}-N). Even there are not differences for VS between groups; differences appear when organic fraction is analysed by parameters indicative of its quality. Furthermore, in figure 1 some box plot of representative parameters are presented.

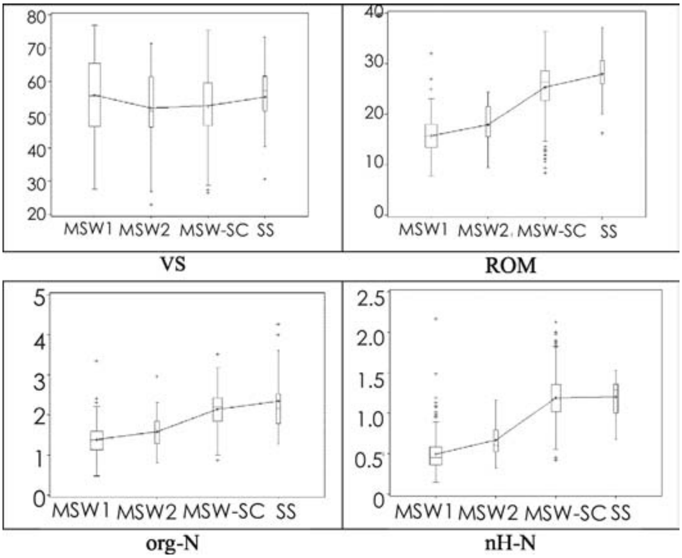

***Figure 1**. Comparison of some representative parameters of OFQ for compost from different origin.*

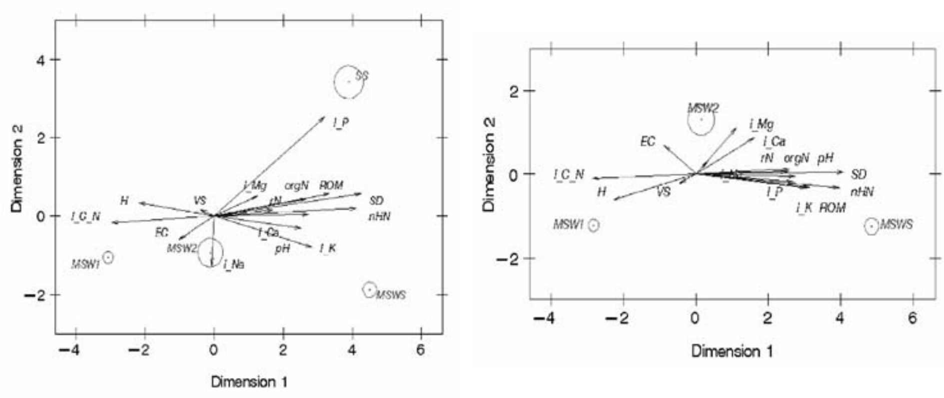

***Figure 2**. Multidimensional scaling between several representative parameters (organic fraction composition and agronomical characteristics) and composts from different origin: (a) for all sample groups and (b) only MSW groups.*

From those results some important assertion can be done: (i) Differences in organic N (org-N), resistant organic matter (ROM), stability degree (SD), non hydrolysable N (Nh-N) and resistant N (r-N) can be attributed to operating conditions in composting plants, in this case the better conditions has been done for MSW-C; while differences in P, K and EC are due to raw material characteristics. (ii) N losses during composting process frequently have been measured (Soliva, et al., 1993a). N conservation or N losses could be detected comparing org-N and Nh-N values; conservation is done in MSW-C and losses in SS which have higher N feedstock. (iii) To predict N release in soil when OW would be reused for agricultural purposes r-N values could be used. MSW-SC and SS groups would present slow release with regard to other groups. (iv) Finally, in general, compost with high ROM values have also more stable organic fraction, this fact is corroborated by higher SD, Nh-N and r-N values. For those reasons, these parameters are useful to establish organic fraction quality.

In Figure 2, a multidimensional scaling analyses is represented, from them previously indicated asserts can also be read. Moreover, relationship between nutrient content and compost origin is well reflected: P highest content is associated to SS compost, while K to MSW-SC ones.

CONCLUSIONS

According to the above data analysis it can be concluded that composition of composted OW varies widely according with: the input raw material characteristics, the operational plant capacity (seasonal variations inputs or continuous overload) and the plant objectives and workers interest.

Furthermore, results indicate the useful information which could be obtained from following parameters: ROM, SD, org-N, Nh-N and r-N. Those parameters can be used to characterise organic fraction quality from OW and its soil behaviour. Parameters can be obtained by simple and economical chemical laboratory methods.

Acknowledgements. Results presented were supported in part by ESAB contract projects from: Servei de Medi Ambient de la Diputació de Barcelona and Instituto Geológico Minero de España (IGME).

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