AN EVALUATION OF COMMERCIAL ADDITIVES IN OPTIMISATION OF THE COMPOSTING PROCESS

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ABSTRACT

The effects of five additives, available on the market, aimed at optimising the composting process and reducing odour emissions, was tested on a mixture of FORSU + wooden residues. An experimental plant was purpose-built consisting of 6 aerated static reactors (volume = 1 m^3 each) and software for controlling the amount of air supplied in function of the temperature. Efficiency was evaluated by observing the mass balance, assessing the static respiration index and measuring odour concentrations in accordance with the criteria of dynamic olfactometry. No significant differences were measured on process yield and the static respiration index between the additive treated and the untreated mixtures. Two of the five products reduced odour production on the first sampling, just after process start-up. All the same, even though the average values were completely different, no significant statistical difference was revealed.

INTRODUCTION

In the ambit of the three year experimental project "Sostanza organica nei terreni" (Organic material in soils" financed by the Region of Emilia-Romagna in accordance with the law LR 28/98 and co-financed by members of the "Italian Consortium of Compost Makers- CIC" from Emilia-Romagna, CRPA has undertaken a series of tests, included in the activity "Evaluation of technical methods in composting", aimed at evaluating the efficiency of some commercial preparations, available on the market, in reducing the emission of unpleasant odours and/or speeding-up the composting process (Bidlingmaier et al., 1997). So far five additives, produced by four Italian companies, have been subjected to testing.

MATERIALS AND METHODS

An experimental plant was purpose-built to test the efficiency of the proposed additives in optimising the composting process, consisting of 6 open air container-reactors with an individual volume of circa 1 m^3, each equipped with a centrifugal ventilation device with inverter and systems for measuring the capacity of air delivered and mass temperature. All the revealed parameters were controlled, run and memorised by a programmable processing unit (PLC) which also automatically controlled, via a specially created program, the capacity of air delivered in function of the mass temperature. The system allows the comparison of 2 treatments, (the control mixture and the treated mixture), each repeated three times and sited at the AIMAG SpA composting plant of Fossoli di Carpi (MO), member of the CIC. So far five additives have been tested, each of them added to a mixture of chopped and mixed organic waste which includes:

- sorted organic waste collected at the source through differentiated waste collection (FORSU);
- wooden residues from minced plant trimmings leftover from maintenance work: the quantity added was between 30 and 56% of total FORSU weight and varied with individual humidity levels.

The doses and methods for using the individual products were obtained direct from each company (Table 1); the additions were carried out manually on reactor loading.

***Table 1**. Dosages and methods for using the products and the period and length of each test composting cycle.*

Additive	Dosage	Modality	Test period	Length of cycle (days)	Spraying with water
A1	1 kg/5 m^3	Undiluted	April '02	40	190 l/reactor
A2	200 g/m^3	Dilution in warm water	July '02	34	190 l/reactor
A3	2,5 kg/m^3.	Undiluted	October '02	39	No
A4	60 g/ m^3	Dilution in warm water	February '03	34	90 l/reactor
A5	200 g/m^3	Dilution in warm water	April '03	38	130l/reactor

Evaluation of the efficiency of the preparations was assessed by identifying the following parameters:

- the initial and final chemical-physical characterisation of the mixture and mass balance;
- continuous measurement of mass temperature and air delivered during the process;
- identification of the specific hourly consumption of oxygen (SRI: static respiration index) [DIVAPRA, 1998]; at time 0, at the second odour sampling and at the end of the cycle (emptying of reactors);
- olfactometry assessment at three pre-established times in conformance with the regulations given in European Standard EN 13725 [CEN 2003]: at process start-up (from 4-10 days after loading), after another 10 and 20 days from the first measurement.

The total length of the composting cycle varied from 34 to 40 days. All the collected data was statistically processed using T- test with 5% significance.

RESULTS AND DISCUSSION

All the tests were carried out on starting mixtures with optimal chemical-physical characteristics for composting and with more than acceptable variability between the different tests (Table 2), as confirmed by the variation coefficient values (on average below 20-25%).

***Table 2**. Average chemical-physical composition of the mixture at start-up of treatment.*

Parameters		UNTREATED			TREATED		
		MEDIA	Dev. St.	CV (%)	MEDIA	Dev. St.	CV (%)
pH		**6.15**	1.02	16.55	**6.09**	1.27	20.90
TS	**(%)**	**39.22**	7.30	18.61	**38.83**	7.08	18.22
VS	**(% TS)**	**70.57**	7.43	10.52	**70.48**	6.70	9.50
TKN	**(% TS)**	**1.78**	0.37	20.72	**1.86**	0.47	25.30
N-NH4	**(% TS)**	**0.13**	0.06	49.72	**0.15**	0.08	52.25
	(% TKN)	**7.58**	3.47	45.75	**7.92**	3.03	38.30
TOC	**(% TS)**	**38.02**	4.05	10.64	**38.37**	4.66	12.14
C/N		**21.85**	3.54	16.19	**21.54**	5.02	23.28

In general terms, in all the tests variation of the chemical-physical composition of the mixture was coherent with good progress of bio-oxidative degradation of the organic matter present and there was no clear difference between the control mixture and the treated mixture. The balance of the overall mass, in all the tests, led to completely analogous results between the two treatments for all the parameters considered (Figure 1).

The management software kept the temperature values inside each reactor within the optimal range for the process (50-60°C).

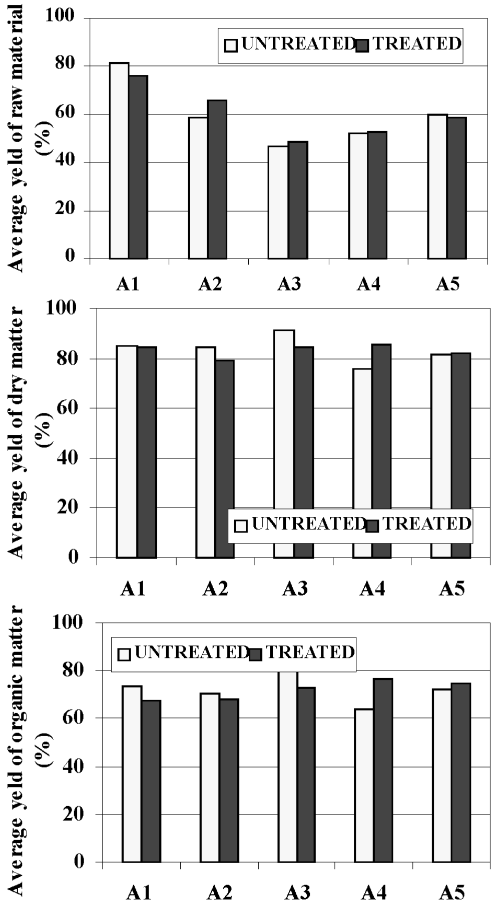

Figure 1. *Average yield at the end of the cycle of raw material, dry matter and organic matter (value % respect to initial weight).*

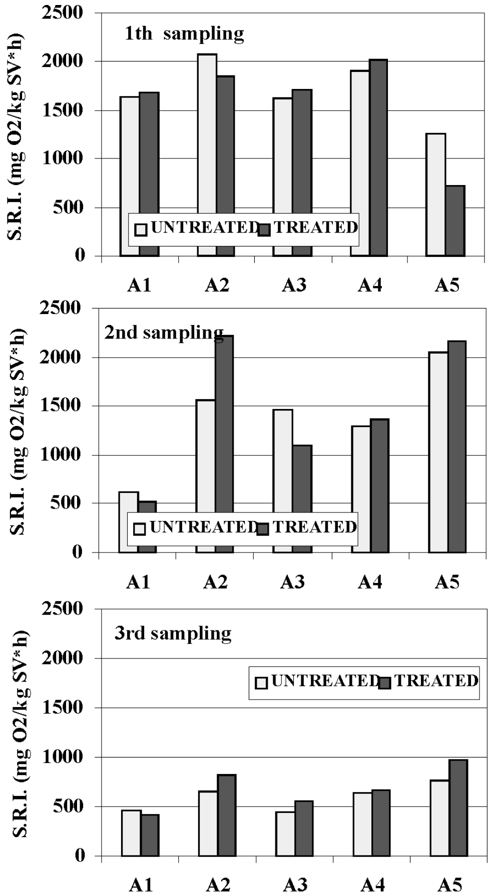

Figure 2. Static respiration index (S.R.I.): average values of three repeats for each test.

The values of the static respiration index (Figure 2) measured on the fresh mixtures, at reactor loading, are within the range of 1600-2250 mg O_2/kg SV*h and the control and treated mixtures are very similar confirming a good degrees of homogeneity in the mixtures; with the single exception of test 5 where the mixture initially shows low fermentability. At the end of the treatment cycle, the SRI values lie in the range of 410-987 mg O_2/kg SV*h.

As far as the effect of the addition of additives is concerned, the only significant result is the difference shown by additive A2; at both second third and last sampling the treated mixture has higher SRI values. In all the remaining cases the slight difference revealed between the average values of the two treatments is never significantly different. The mixture treated with product A5, initially poorly reactive, later managed to recover fermentability and reached higher SRI values at the 2nd sampling; at the end of the process SRI values fell noticeably, even though settling at values slightly superior to the remaining values at cycle end. Regarding the concentrations in units of odour (ou/m^3) in the exhaust air, in the ambit of each test, notwithstanding the regularity shown in process evolution, we see an elevated variability between the repeats which

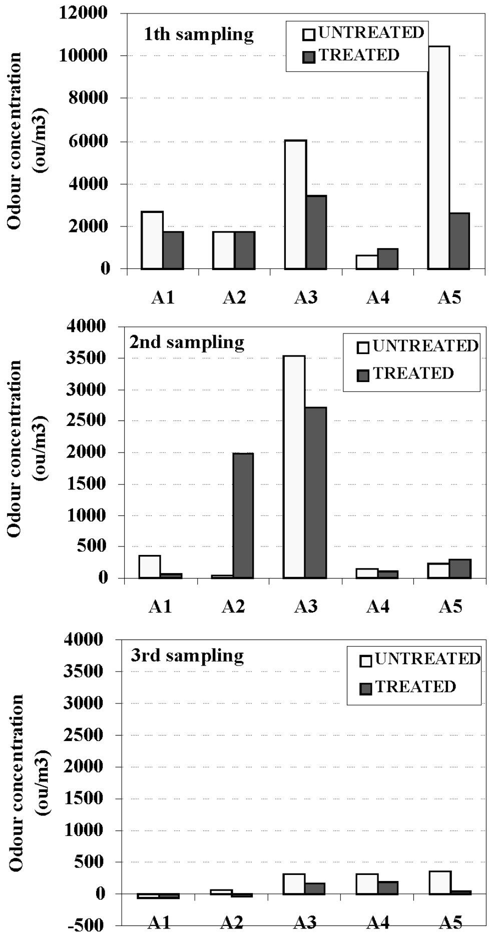

Figure 3. *Odour concentrations: average values for three repeats for each test.*

is illustrated by the high variation coefficient readings. At the second and final sampling (figure 3), in tests 1 and 2, the values are negative: the composting mass seems to have carried out its biofiltering function by reducing the odour load of the environmental background. At the moment of major olfactory impact (1st sampling), the mixtures treated with additives 3 and 5 (A3 and A5) have lower average concentrations than their corresponding control mixtures; the difference is more marked with product A5 which thus seems to have produced a noticeable reduction in odour emissions in the most critical phase of the process. Yet, in neither of these two cases, difference between the average was statistically significant.

CONCLUSIONS

In general, additives caused a more regular mass composting, but process optimisation did not, all the same, lead to lower SRI values [Fabbri, 2001]. The five additives produced different levels of efficiency in containing odorous emissions; additives A3 and A5 produced lower concentrations of odours with respect to the control mixtures, especially at first sampling; the differences are not however statistically significant.

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