THE INFLUENCE OF C/N RATIO, MOISTURE AND pH ON THE AEROBIC MICROBIAL ACTIVITY OF RICE STRAW AND SEWAGE SLUDGE BLENDS

L. Roca-Pérez, J. Arévalo, R. Boluda
Departamento de Biología Vegetal, Facultad de Farmacia, Universidad de Valencia, Av. Vicent Andrés Estellés s/n, 46100 Burjassot (Valencia), Spain.
luis.roca@uv.es, boluda@uv.es

ABSTRACT

Composting is an alternative for recycling agricultural residues and sewage sludge, and the end product can be used as fertilizer for land application. In order to study the composting process with sludge from water sewage treatment plants and rice straw, environmental factors should be controlled. The aim of our study was to investigate the optimum C/N ratio, moisture and pH to maximize microbial activity. The incubation of sewage sludge and rice straw mixtures were conducted using an experiment design with three different C/N ratios (17, 24 and 41), moistures (40, 60 and 70 %) and pH (5.65, 6.65 and 8.75). The microbial activity was measured as manometric measurement of oxygen consumption. The enhancement of microbial activity is induced by low C/N ratio, high moisture content, and pH basic. Our results suggest that the initial blend with these raw materials must be about 17 C/N ratio, while moisture content must be between 60 % and the pH 8.75 in the composting process.
Keywords: *Composting, environmental factors, rice straw, sewage sludge, microbial activity.*

INTRODUCTION

The amount of sludge generated from water sewage treatment plants in Valencia Community is 59,500 dry tons per year and this quantity is expected to increase as a result of the new wastewater treatment plants required under the EU Wastewater Directive (91/271/EEC). Moreover, The Albufera Natural Park (ANP) in Valencia yields 100 million kg per year of rice residue, which when burned has the effect of provoking various respiratory diseases. Composting is one alternative for recycling these residues. Its process has been defined as the biological decomposition and stabilization of organic substrates, under conditions that allow development of thermophilic temperatures as a result of biologically produced heat, to produce a final product that is stable, free of pathogens and plant seeds, and can be beneficially applied to land (Haug, 1993).

Carbon and nitrogen are the two most important elements in composting. Carbon contained in substrates is source of energy and contributes to the biomass of microbial populations. Nitrogen, a constituent of proteins and genetic matter, is critical for microbial growth (Barker, 1997). Thus, negative relationship was found between C/N ratio and microbial activity on a composting systems treating pulp and paper biosolids (Larsen and McCartney, 2000). Other factor such as moisture content has been shown a significant impact on composting performance, thus very low moisture content values in the composting blend caused biological unstable compost (Bertoldi et al., 1983), while high moisture may produce anaerobic conditions from water logging (Tiquia et al., 1996). On the other hand, pH is chemical factor that influence on decomposition of organic matter on the composting process (Nakasaki et al., 1993).

The aim of this work was to study the influence of C/N ratio, moisture and pH on microbial activity of rice straw and sewage sludge blends use in composting.

MATERIALS AND METHODS

Rice straw and sewage sludge were collected from ANP and the sewage treatment plants (EMARSA) in Valencia (Spain), characteristics of these materials were reported by Iranzo et al. (2004). The respiration activities of microorganism were determined on initial mixtures with different C/N ratio (17, 24 and 41), moistures (40, 60 and 70 %) and pH (5.65, 6.65 and 8.75). For three different C/N mixtures, moisture and pH were adjusted to ca 60 % and ca 8.60 respectively. In the case of moisture settings C/N ratio and pH were adjusted to 24 and 8.60 respectively. For pH raw materials mixtures C/N ratio and moisture were adjusted to ca 24 and ca 60 % respectively. Adjustment of pH was accomplished by uniformity adding 4 ml of 1 and 2 N acetic acid solution to the composting mixture for obtaining 6.65 and 5.65 values of pH respectively, the pH of initial mixture of raw materials was 8.75.

Determination of oxygen uptake for microorganism on these composting mixtures (rice straw and sewage sludge) was performed by manometric measurement of oxygen consumption during the simultaneous absorption of CO_2 in caustic soda solution (1 N) OxiTop-C (WTW, Weilheim, RFA) (Platen and Wirtz, 1999). The initial mixtures (ca. 25g) were placed in vessel (1 L) and incubated at 20 ºC for 24 hour, except pH settings which were incubated at 35 ºC. Two replicates were performed per mixture. Moisture content was determined by oven-drying at 105 ºC for 24 h, and pH was measured on a 1:5 water soluble extract (w:v).

RESULTS AND DISICUSION

The results are showed in Table 1. The oxygen consumption rates obtained in all mixtures performed, except C/N 17, showed values that are under what considered active: 1.0-1.5 mg g^{-1} h^{-1} (Epstein, 1997). This fact could be due to short time of incubation, since mixtures were at the begging of the composting process, and the incubation temperature used for us.

Table 1. *Microbial activity of initial mixtures of rice straw and sewage sludge at different initial: C/N ratios, moisture and pH.*

Parameter		mg O_2 g^{-1} d. w. h^{-1}
C/N	17	1.08 (0.01)
	24	0.66 (0.02)
	41	0.39 (0.02)
Moisture (%)	40	0.21 (0.06)
	60	0.50 (0.08)
	70	0.67 (0.01)
pH	5.65	0.22 (0.08)
	6.65	0.60 (0.00)
	8.75	0.75 (0.02)

Among all C/N ratios setting evaluated, treatment with the lowest C/N ratio (17) exhibit higher microbial activity than lager C/N ratios (24 and 41), similar results were obtained using pulp and paper biosolids with C/N ratios of 107, 55, 29 and 18 (Larsen and McCarney, 2000). This result is related with N is a key parameter for microbial growth (Barker, 1997).

Regarding moisture contents, results showed that 60 and 70 % values presented close microbial activity (0.50 and 0.67 mg O_2 g^{-1} d. w. h^{-1} respectively). Nevertheless, oxygen con-

sumption on 40 % mixture was lower than previous treatments. Our study suggests that initial moisture content in rice straw and sewage sludge blends should be higher than 40 %, and the optimum is about 60-70 %, nevertheless in order to prevent anaerobic conditions and lixiviate formation in piles it is better 60 % moisture content. This result confirms previous works with other biosolids blends (Tiquia et al., 1998; Liang et al., 2003), which indicated that 50% moisture contents was the lower limit for a rapid increased in microbial activity. In the case of mixtures with straw, Barrington et al. (2003) found that higher values of moisture led to higher temperatures.

The pH optimum ranges, in the composting process using a liquid medium, to degraded proteins and glucose are 7-8 and 6-9 respectively (Nakasaki et al., 1993). Our results showed that the pH of initial mixture of raw materials (8.75) was the highest microbial activity, nevertheless mixture adjusted to pH of 5.65 showed the lowest oxygen consumption. Similar result was found by Nakasaki et al. (1993), thus they found that microbial activity was inhibited at the low pH.

CONCLUSION

Oxygen consumption measured in rice straw and sewage sludge blends at different C/N ratios, moistures and pH setting show that variations on these parameters have a great influence on microbial activity. The maximum activity was obtained with a 17 C/N ratio, 60% of moisture and basic pH (8.75), initial value of mixture. Further work is required to validate these results in full-scale composting operations.

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