Humification of Pig Slurry in Presence of Sawdust

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Abstract One of the main economical activities of small farms in South Brazil is the swine production which produces a relatively high amount of pig slurry. The discard of this effluent as "*in natura*" in the environment may contaminate the soil and impair the crops. Therefore, the aim of this study was to monitor the humification of swine slurry conducted in windrows, employing two different pH conditions. The composting of pig slurry was conducted with a 50% (m/m) mixture of sawdust and wood shaving in two pH conditions. The liquid pig slurry was weekly added at different rates and the total added amount of dry matter was approximately 82 kg in 3 months. In the weekly collected samples, the contents of C and N were determined and the humic substances (HS) were quantified. The C content of compost did not vary with time, while the decrease of C/N ratio indicated the humification of the slurry mixture. These results were corroborated by the increase of C_{HS} and that of C_{HA}/C_{FA} ratio within 3 months. The acidic medium enhanced the formation of humic acid (HA) over fulvic acid (FA).

Keywords Humic substances • Chemical composition • Nitrogen

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Introduction

Swine production in Brazil is an important source of income in small farms, especially those located in the south of the country. The south is responsible for 48% of the Brazilian pig herd, corresponding to approximately 39.4 million animals (IBGE 2010). The resulting slurry is usually used as an organic nutrient source in cultivated areas and pastures. However, in many properties, the amount of produced manure exceeds the carrying capacity of soils, and after repeated slurry applications, the crop productivity and quality may be impaired. One possible sustainable fate for the produced pig swine slurry, that may also be economically attractive, is its use in composting systems for further agronomic use. In this case, some strategies have to be adopted to minimize the emissions of N-gases and therefore mitigate the greenhouse effect and improve the compost fertilizing quality (Chen et al. 2010). Therefore, the aim of this study was to monitor the humification of swine slurry conducted in windrows, employing two different pH conditions.

Materials and Methods

The composting was conducted in two windrows (4 m × 1 m × 1 m) made of wood and internally coated by a polyethylene sheet. The substratum consisted of a 50% (m/m) mixture of sawdust and wood shaving (233 kg + 233 kg). The liquid pig slurry was weekly added at a rate that varied from 1.47 L kg^{-1} substratum at the beginning of the experiment (December, 2011) to 0.21 L kg^{-1} substratum at the 3rd month (March, 2012). The total amount of added slurry dry matter was approximately 82 kg (3,836 L of liquid slurry) in this period, corresponding to a total amount of 46.2 kg of added N-NH_4. After each slurry addition, the composting material was strongly revolved twice a week. In treatment 1, the swine slurry was applied in its natural condition (pH = 7), and in treatment 2, the slurry was acidified to pH 6 with an 85% phosphoric acid solution prior to its addition. Two samples of the composted material (50 g) were collected weekly at 10 cm below compost surface and at 10 cm above the windrow bottom. The composed sample was air-dried and the contents of C and N were determined by dry combustion (FlashEA 1112 Thermo Finnigan). The humic substances (HS) were extracted in triplicate from the composed sample according to Dick et al. (1998) and quantified by determining the absorbance at 580 nm after reaction with a dichromate acid solution at 60°C during 4 h.

Results and Discussion

The C content along the 3 months composting period oscillated around 41 to 45% and did not differ between the treatments. In contrast, N content increased from 0.01% at $t = 1$ day after composting start (dac) to 2.5 at $t = 64$ dac. Consequently, C/N ratio decreased with time (Fig. 1) indicating the humification of the slurry mixture.

The content of C_{HCL}, that consist of organic matter of relatively low molecular weight and may represent the first step of humification process, varied from 2.5 at 1 dac to 5 g kg^{-1} compost at the 56 dac in treatment 1, and tended to stabilized around this value (Fig. 2). The content of C_{HS} increased gradually from 20 g kg^{-1} compost at the 1 dac to 40 g kg^{-1} compost at the 64th dac. After that, it decreased to 30 g kg^{-1} compost at the 91 dac. Among the two analyzed HS, the content of C_{FA} in treatment 1 did not vary relevantly along the monitoring of the composting, and the observed values were between 12 and 15 g kg^{-1} compost. In contrast, C_{HA} increased gradually and reached 25 g kg^{-1} compost at the 64 dac (Fig. 2). Therefore, this humic fraction was the main responsible for the observed C_{HS} increase along composting time.

In treatment 2, C_{HCL} values also varied around 5 g kg^{-1} compost during the monitored period (Fig. 3) and did not differ from the values obtained in treatment 1. In contrast, C_{HS} increased at a slower rate with composting time and reached its maximum value at the 91 dac (36 g kg^{-1} compost). Similar to the behavior observed with treatment 1, the increase of the humic substances was caused by the increase of C_{HA} that reached 28 g kg^{-1} compost at the 91 dac. Conversely, C_{FA} decreased from 15 g kg^{-1} compost at 1 dac to 7 g kg^{-1} compost at 91 dac.

The C_{HA}/C_{FA} ratio increased with composting time (Fig. 4) corroborating the humification process of slurry + wood shaving mixture and confirming the indication of the C/N ratio results.

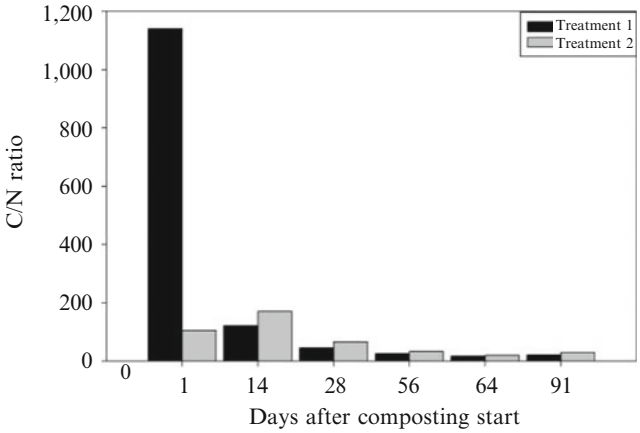

Fig. 1 Compost C/N ratio during composting time

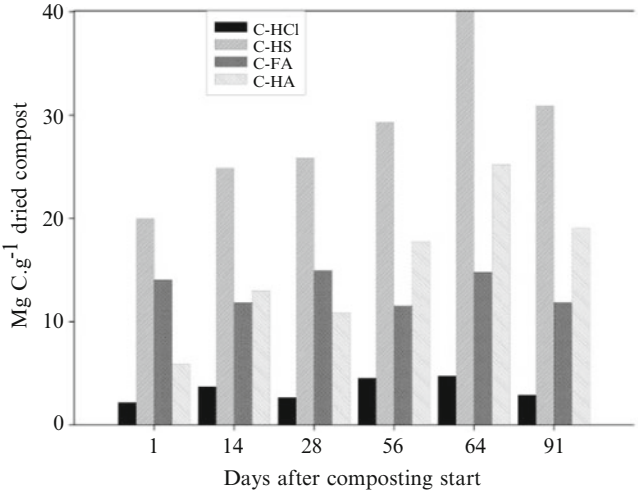

Fig. 2 Content of C_{HCL}, C_{HS}, C_{HA} and of C_{FA} of the compost in *treatment 1* ($n = 2$)

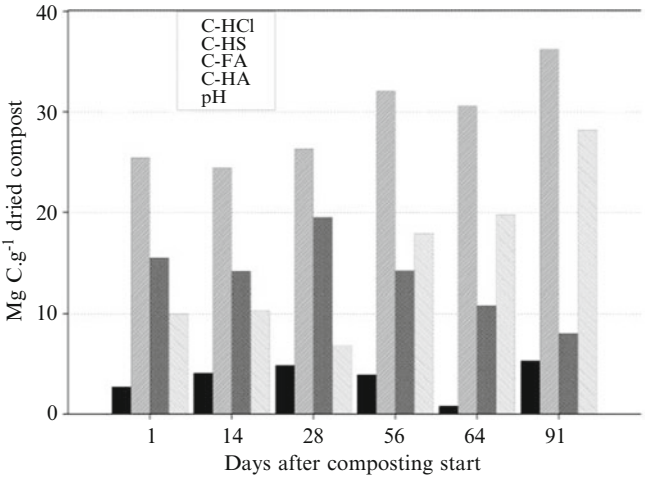

Fig. 3 Content of C_{HCL}, C_{HS}, C_{HA}, and of C_{FA} of the compost in *treatment 2* ($n = 2$)

Conclusions

In both composting conditions, the humification process occurred with the relative enrichment of humic acid fraction, indicating the stabilization of the compost within 91 days. Composting of pig slurry in its natural pH condition with sawdust attained its maximum at the 64th composting day. The previous acidification of

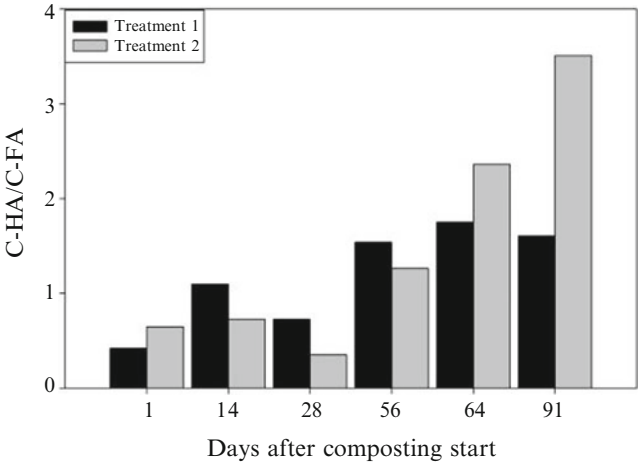

Fig. 4 C_{HA}/C_{FA} ratio during decomposting process in *treatments 1* and *2*

slurry slowed down the humification rate but promoted a higher C_{HA}/C_{FA} ratio at the 91 day. The acid pH, besides decreasing the emission of N-gases, enhances the formation of HA over FA.

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