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A N I N T E R N A T I O N A L J O U R N A L

Evaluation of Poultry Litter Traditional Composting Process

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ABSTRACT

The objective of this work was to study the poultry litter composting and evaluate the physico-chemical and microbiological transformations as a time-function. At the end of composting, an increase of humification matter, a decrease of microbial diversity and the elimination of pathogens were observed. Results showed that poultry litter was liable of composting, without any nutritional complementation or inoculation and the process occurred similarly to other kind of organic residues.

Key words: Poultry litter, composting, organic residues, thermophilic phase

INTRODUCTION

Agroindustrial residues frequently represent a volume bigger than the products themselves. Poultry litter stands among the industrial residues, and is composed by faeces, feather, remains of the feed and a support matrix which can vary according to the country and region, such as sawdust, shavings, peanut shell, rice husk and others materials. According to Associação Brasileira de Exportadores e Produtores de Frango de Corte (2009), in 2008 Brazil was the largest exporter of broiler, generating around 11 billion Kg of poultry litter (Aires, 2009).
Poultry litter was largely used on pasture fertilization and animal feeding until 2001, when its use was forbidden by the Normative Instruction n. 15 from the Ministério da Agricultura, Pecuária e Abastecimento (Brazil, 2001). Therefore, other alternatives for use and arrangement of this material are necessary. According to Kozen (2003), poultry litter offers great potential as fertilizer for the vegetation fertilization, Gobbi et al., (2000) used it in the culture of *Zea mays* as a supplement of macro-nutrients. There are several other residues which can be used as fertlizers to improve the fertility of the soil; for example sewage sludge is used to increase the amount of nutrients in the soil (Faveretto et al., 2007; Fonseca et al., 1997). However, it is necessary to ensure that no pathogens are released in the environment through the application of such residues. One of the methods to ensure this protection and improve the quality of the fertilizer is composting, which improves the quality and availability of the nutrients in the soil and eliminates pathogenic organisms. The compost can be characterized as stabilized and pleasant odor

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organic matter, free of pathogens. It is considered an excellent organic fertilizer due to the presence of minerals and húmus. The organic matter, added to soil as organic fertilizer, improves the physico-chemical and biological soil properties (Kiehl, 2002).

The important chemical properties in the organic fertilizers and soil conditioners are organic matter content, moisture, pH, cation exchange capacity (CEC) and soluble salts (Matos, 2006). To assure the compost sanitary security, it is necessary that the thermophilic phase lasts for a reasonable period so that most of the pathogenic microorganisms do not survive (Brazil, 2009).

The objective of this study was to compost poultry litter, *"in natura"* without any thermal or chemical pré-treatment, nutritional correction or inoculation.

MATERIALS AND METHODS

Poultry litter

The litter was collected from a poultry grange located in the city of Mandirituba/PR. Third brood poultry litter was gathered from several spots of the hangar.

Construction of bioreactors for composting evaluation

In order to simulate the composting stack, expanded polystyrene bioreactors were made, maintaining the temperature during the thermophilic phase of the process. The aeration was done through forced air injection from the bottom of the bioreactor (Fig. 1).

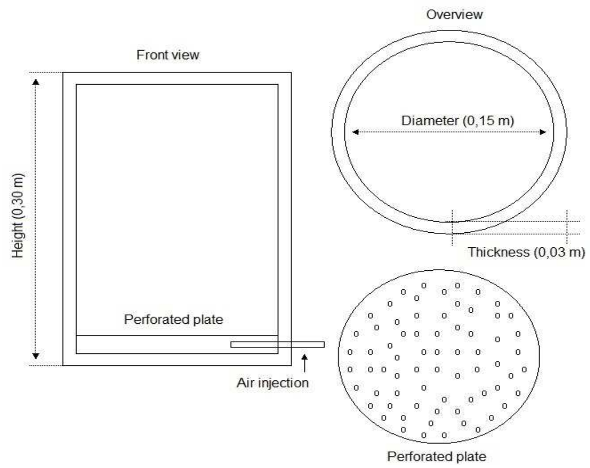

Figure 1 - Schematic drawing of the bioreactor used in the study.

Physico-chemical characterization and composting monitoring

The analysis made for material characterization and composting monitoring were total volatile solids (TVS), ashes, cation exchange capacity (CEC), pH, moisture, water activity (A_W) and temperature measurements. These analysis were made following the procedures described in Normative Instruction n. 28 from the Ministério da Agricultura, Pecuária e Abastecimento (Brazil, 2007) and in the Standard methods for the examination of water and wastewater (APHA, 2000).

Microbiological analysis

Microbiological analysis was made according to Conama rules n. 375 of August, 2006 Microbiological diversity was estimated before and after the composting through microorganisms differentiation by the colonies form and by Gram staining.

Composting

Composting tests were made in triplicate, considering each bioreactor as a replica of the experiment. Before the beginning of composting, material moisture was adjusted to 57% and air flux was adjusted to 60 ml/min. Samples were weekly taken for physico-chemical analysis. The total time for the composting was 90 days, as described by Kiehl (1998). The statistical analysis was done through the comparisons of averages by Turkey test with 0.5% of significance.

RESULTS AND DISCUSSION

According to Kiehl (1998), temperature can be an evidence of composting initiation, as it is the first parameter that changes in the system. Figure 2 showed that the thermophilic phase was reached as soon as the process began, reaching 50ºC of maximum temperature, which lasted less than five days. According to Stentiford et al., (1992), the ideal temperature during the thermophilic phase must be between 45 and 50ºC, keeping for at least three days at 55ºC in order to sanitize the material. Studying poultry litter carcass composting by the windrow method, Paiva (2008) achieved a sanitizing period of seven days with temperatures above 55 ºC. Although the thermophilic phase didn't last according to the recomendations, pathogenic organisms were not observed at the end of composting, in accordance with Conama rules n. 375 of August, 2006.

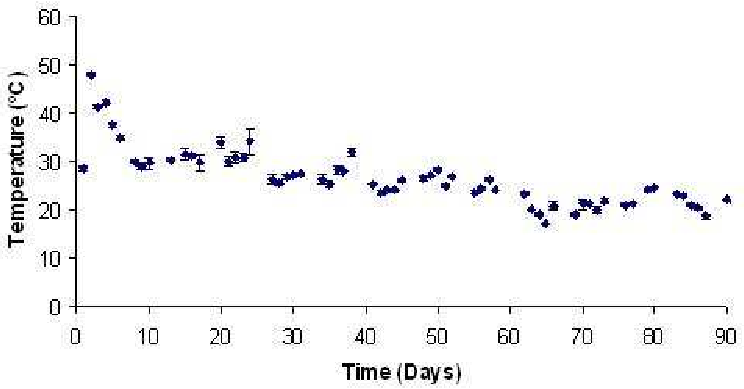

Figure 2 - Temperature variation in the composting medium as a time function.

Initially, with the start up of the process, a decrease was observed in the pH due to formation of some organic acids from the microbial metabolism (Valente et al., 2009). Thereafter the pH values increased (Fig. 3). Kumar et al., (2007) reported similar results during poultry litter carcass composting by the windrow method. The increase in pH has been attributed to the alkaline humats formation from the reaction of humic acids with alkaline chemical elements present in the composting medium (Kiehl, 2004).

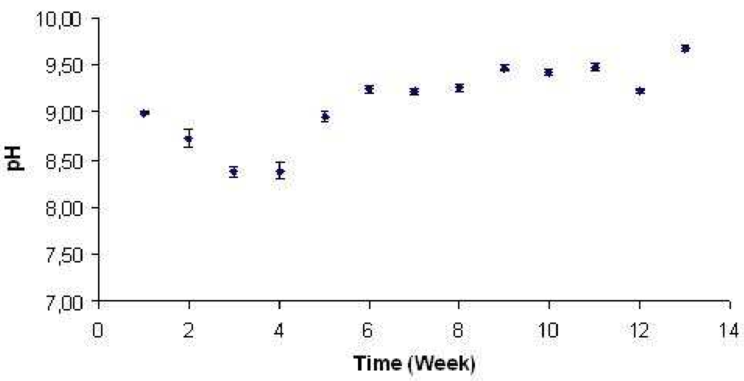

Figure 3 - pH variation of the medium along the time of the composting process.

Moisture is directly related to the metabolic activity of the microorganisms and consequently to organic matter decomposition. Hence, during composting, the optimum moisture content must be between 50 and 60% (Brazil, 1999). In the present study, the moisture level was maintained close to the recommended values but showed a decrease near the end of the experiment. With the decrease in the moisture, there was also a decrease in the A_W values. Water activity of a substrate is directly related to microbial metabolism. Lower A_W values can reduce the growth of the microorganisms, hence, it is important to maintain the moisture levels enough to sustain the microbial activity (Rodríguez León et al., 2008).

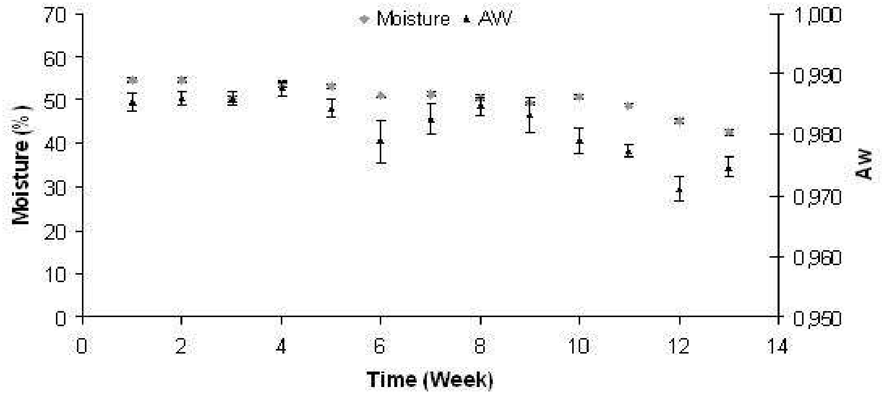

Figure 4 - Moisture and AW decrease as a time-function.

According to Roig et al., (1988), the cation exchange capacity of a soil is directly related to the functional groups of the humic substances, allowing reduction in the compost maturation degree. During compost formation there was an increase of approximately 50% of cation exchange capacity (Fig. 5). According to Pereira Neto (2007), CEC values for an organic fertilizer must be between 1000 and 3000 mmol. Kg^{-1}, but Kiehl (1998) found that good compost must show values between 600 and 800 $mmol.Kg^{-1}$. Thus, even increasing the CEC, the values obtained for the compost at the end didn't achieve as reported in the literature.

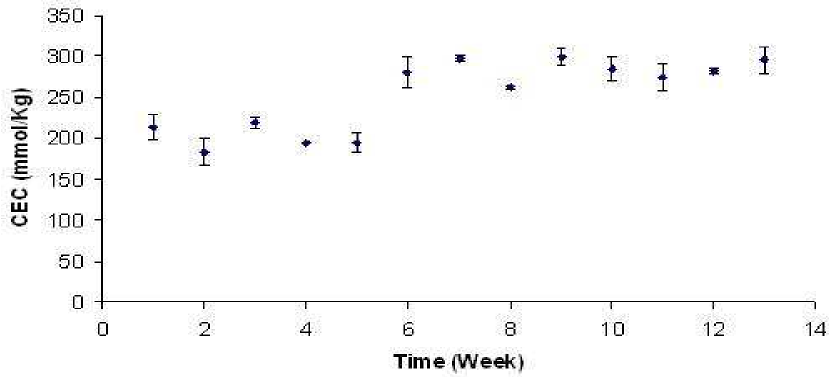

Figure 5 - Cation exchange capacity.

According to Jiménez et al., (1989), ashes and total volatile solids (TVS) of the compost are directly related to the organic matter concentration in the material. According to the results obtained in this study, there was an increase in the contents of the ashes and, consequently, a decrease in TVS values (Fig. 6). Decrease in the TVS values could be explained by the mineralization of the organic matter available for composting. Souza et al., (2002) observed similar variations for these parameters during urban organic matter composting.

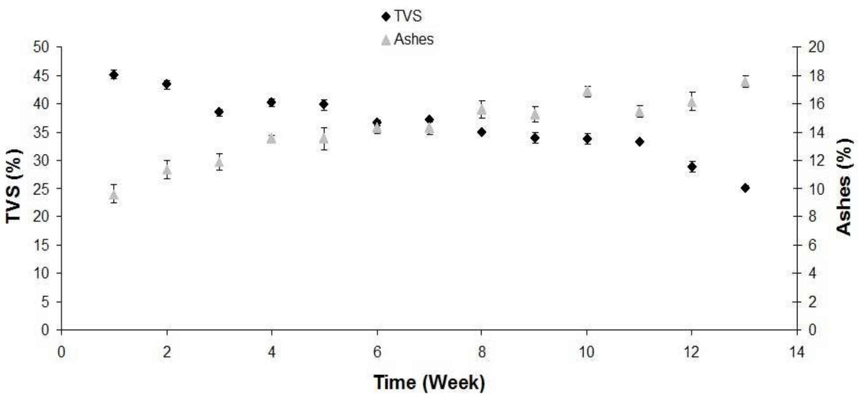

Figure 6 - Ashes and TVS values behaviors during composting.

At the end of composting, there was a decrease in the microbial diversity, as well as a changing in types of the organisms in the composting material (Fig. 7). Taiwo and Oso (2003) observed a similar behavior with the municipal solid residues composting process. According to Tiquia et al., (1998), the original and natural microbiota of the biomass to be composted determines the quality of material degradation. In addition, the composting process is characterized by a continuous change in the microbial species present at different time during the process (Miller, 1992).

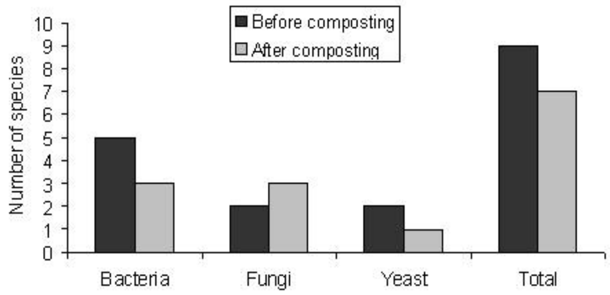

Figure 7 - Microbiological Diversity before and after the composting process.

CONCLUSION

Results showed that poultry litter could be used a substrate for composting and it did not require to carry out the composting process. The composted litter at the end of the process showed suitable physical-chemical and microbiological characteristics to be classified as a compost to be used as soil corrector and as a fertilizer. Besides, the composting process using the poultry litter would solves an environmental problem as this residue could be transformed into a useful product.

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