Using Residuals Oils and Fats into Composting Organic Waste - Residual Oils and Fats

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Abstract: The increase in the production of municipal solid waste causes for a serious problem regarding its environmentally adequate final destination and this fact has been a motivator for using as an organic matter source for the production of organic compounds. Composting is a recycling method of the organic fraction of the residues, which are turned into fertilizers. This present work consists of the construction and analysis of the applicability and effectiveness of the compound produced from three small scale windrows, which had in their compositions cattle manure and sugarcane bagasse, in addition two of the three windrows had residual oils and fats – Residual oils and fats (ROF) in their compositions. The composting happened in an aerobic way from the system of aerated windrows plowed at an open area directly into the ground. During the process, the following parameters were monitored: temperature, moisture and pH. At the end of the process, samples from the three windrows were collected for analysis in order to know their final compositions so that it could be used as an organic fertilizer. Generally, the ROF only influenced the moisture during the first days of composting, which didn’t relevantly change the final features of the produced compounds. Through monitoring, the process and the acquired results of the compound analysis, it is safe to say that the produced organic fertilizers displayed a good quality and applicability, which shows the effectiveness of the composting method as an alternative for waste management.

Key words: Residuals Oils and Fats, Composting, Organic Waste, Organic Fertilizer, Aerobic Process.
According to Marques and Hoagland [8] the development of small local scale composting systems is a good strategy with a great potential of success, because it can decrease significantly the costs of transportation and energy and reduce the emission of pollutants, generating a sustainable economy. Another positive point in creating local composting is the reduction of waste sent to landfills, reducing costs of its maintenance.

This technique is a possibility of ROF recycling and can be developed in a simple and cheap way, making it a plausible alternative and possibly well accepted in all levels of society. According to Oliveira et al. [9] due to high levels of salt and acidity present in ROF, it is important that their addition in the composting process does not exceed 20% of the fresh material volume, which are the sources of nitrogen. This work aimed to analyse the process of composting on a small scale with the use of residual oil and fat as efficient and applicable.

**MATERIALS AND METHODS**

The experiment was conducted into a space behind the Laboratorio de Catalise, Energia e Materiais (LCEM) located in the Instituto de Tecnologia e Pesquisa (ITP), in Universidade Tiradentes (UNIT) in Aracaju, Sergipe, Brazil. The composting process was carried out directly on the ground, while the windrows of composting method were aerated by turnings. This technique was developed between the 15th of April and 29 May 2015.

The materials used for into composting process consisted of sugarcane bagasse, fresh cattle manure and residual oils and fats (ROF). These were taken to the area where the composting was developed and was made a triage process in order to remove the unsuitable materials such as plastic cups, napkins and others, as well to obtain its mass for subsequent construction of the windrows. After screening, a grinding organic waste of the brand Trapp, model RT 200, was used to reduce the particle size of the sugar cane bagasse.

Three piles of compost composed of 10 kilograms of sugarcane bagasse and 4.2 kilograms of manure were built. These piles are differentiated by the amount of ROF introduced after its construction. The windrow named as Windrow 1 was considered the control of the experiment and the others were considered the tests. The piles were assembled from a sugarcane bagasse layer followed by a layer of manure. In this way, the process always happened with uniform levels of 15 cm, switching it for a sugarcane bagasse with another level of manure. Once assembled, Windrow 2 received 1 kg (1.1 L) of ROF,

<table>
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<th>Table 1: Windrows composition.</th>
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<td>WINDROW</td>
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<td>Windrow 1</td>
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<td>Windrow 2</td>
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<td>Windrow 3</td>
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totalling in 23.8% of the volume of fresh material (cattle manure). Windrow 3 was mounted with the purpose to observe how it behaves differently from Windrow 2 and for this reason, it was added 2 kg (2.1 L) ROF in its composition, totalling in 47% of manure volume (Table 1).

After the mounting of compost piles was provided a method of monitoring carried out three times a week (always on Monday, Wednesday and Friday) throughout the process, being always checked the variables temperature, humidity and pH in the composting process. Furthermore, was made a control of these parameters for revolving. To do this, had been used a pH' and humidity's measure, model Hydrofarm Three-Way and a digital thermometer model KT300.

Having completed the process, the mass of the compound was sieved to obtain the particle size desired, as well as for remove materials not useful for analysis. After this, samples were collected from the three piles and delivered for analysis of physical-chemical parameters of organic compounds (micro and macro nutrients, organic matter and pH) at the Instituto de Tecnologia do Estado de Sergipe - ITPS.

**RESULTS AND DISCUSSION**

Rezende [10] obtained comparable results using similar methods and conditions to the present work. In his study, it was observed that the use of different amounts of residual oils and fats didn’t cause changes in the final compost product. The monitoring of the compound’s temperature showed that the three piles had similar values, as presented in Fig. 1. Initially the values of Windrows 1, 2 and 3 were respectively 42.1, 41.3 and 37.9 °C, which indicates the beginning of the thermophilic phase. However, after the second day of the experiment, its temperature had declined and maintained below than 40 °C.

According to Fioreze et al [11], smaller piles tend to lose heat more easily and hardly reach the thermophilic phase, being this phase essential for the reduction of pathogenic microorganisms and sterilization of the organic compound [12]. In this study a pathogens count was not performed, however, there is the possibility that
these are present in the final compound, as occurred in the study made by Fioreze et al. [11], in which the composting process was performed into the same conditions of temperature and obtained values of coliforms and Escherichia coli above desirable. However, this problem can be solved by increasing compost windrows’ volume.

As composting being a biological process, the presence of water becomes indispensable for the physiological needs of the organisms [13]. According to Oliveira et al. [14], the optimal values for the microbial activity are between 40% and 60% of total humidity; values below 30% can prevent fermentation and above 70% reduce the metabolism of aerobic microorganisms. Because the windrows studied have been made in a small-scale, the control of humidity became easier, though more susceptible to change. Fig. 2 shows the variation in humidity content of all three windrows during the course of the forty-four days of composting.

The Windrow 1 presented in the second day of the experiment beginning an humidity amounting of 40%, while the others showed 60% of humidity each, probably caused by the large amount of water contained in the ROF [9]. The subsequent days of composting process, the humidity of the cells did not follow any pattern could indicate that the use of residual oils and fats in composting piles lead to some adversity in this parameter. However, it is emphasized that until almost 24 days of experiment, it was still possible observe the presence of the ROF in the cells of compound due to the consistency and yellowish colour present in the pile.

The high humidity present in the composting piles can be justified by the presence of rainfalls during the months in which the experiment was conducted. In contrast to these high values, the excess of moisture did not had influence on composting, whereas any anaerobic condition such as slurry formation, presence of insects, rodents and low pH were not observed [15, 16].

The development of the pH of three windrows in relation to the composting time is shown in Fig. 3. In general, the behaviour of the pH values of the compound masses were very similar. In the beginning of the process, all piles were with pH values below 7, which according to Richard et al. [16] indicates the beginning of metabolic activities of fungi which cause the breakdown of lignin and cellulose. At the end of the process, Windrows 1 and
Fig. 3: Behaviour of the piles' pH during the days of the composting process.

Table 2: Results of chemical analysis of the compost samples.

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<th></th>
<th>Windrow 1</th>
<th>Windrow 2</th>
<th>Windrow 3</th>
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<tbody>
<tr>
<td>Cooper (mg/dm³)</td>
<td>0.031</td>
<td>0.092</td>
<td>0.151</td>
</tr>
<tr>
<td>Iron (mg/dm³)</td>
<td>17.149</td>
<td>16.375</td>
<td>20</td>
</tr>
<tr>
<td>Manganese (mg/dm³)</td>
<td>1.82</td>
<td>1.92</td>
<td>1.5</td>
</tr>
<tr>
<td>Zinc (mg/dm³)</td>
<td>1.546</td>
<td>0.898</td>
<td>1.075</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td>3.74</td>
<td>0.493</td>
<td>0.553</td>
</tr>
<tr>
<td>Potassium (%)</td>
<td>2.82</td>
<td>1.69</td>
<td>1.73</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>17.69</td>
<td>10.48</td>
<td>7.07</td>
</tr>
<tr>
<td>Organic Matter (g/dm³)</td>
<td>47.6</td>
<td>33.7</td>
<td>34.3</td>
</tr>
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2 were closed with pH 7.5, while the pH value of the windrow 3 was 7. According to Filho [17], the compound in its maturation phase has a pH value between 7 and 8 indicating the end of the composting process.

Analysing and comparing the data obtained about the three physical parameters (temperature, humidity and pH) which can influence at most the composting of the windrows test and control, it was possible argue that the use of ROF did not affect the development of this process, even when used in higher proportions those recommended by Oliveira [9]. The disappearance of the physical characteristics of the ROF in the half of the composting process and further deterioration of manure and bagasse indicate that this substance is metabolized by microorganisms during this period. However, more studies are needed on the influence and degradation of this substance in larger-scale composting piles.

Table 2 presents the concentrations of micronutrients, macronutrients and organic material present at the end of the composting process. Although the analyses did not indicate a marked difference between the physical-chemical parameters about the use of ROF in composting, the results may have been influenced by the small sample space available for this study. Even the ROF having a high content of organic matter [9], the piles testing showed relatively lower values of this parameter in the end of the process. Probably the toxicity of ROF affects the microorganisms’ metabolism which transform organic substances of high molecular weight in smaller compounds which can be detected in the laboratory analysis.

For the different phosphorus and calcium concentrations found in the final compound, it was impossible find an exact explanation, since these values may have been modified by the own composition of the ROF or because its toxicity in microorganisms that acted in the composting process. For better understanding of how this substance can interfere with the chemical composition of the cured compound, studies are needed with larger sample units that focus on physiological processes of microorganisms responsible for decomposition of organic matter during the composting process.

CONCLUSION

In relation to the small sizes of the windrows, it was found that it had an influence on the composting time, making it faster. These sizes also influenced the maximum temperatures obtained, since the piles were more likely to lose heat due to its reduced volume.

Therefore, when analysed the results presented in this work after the monitoring of temperature, humidity and pH's, it was concluded that the addition of ROF in the compositions of the windrows tests did not influence significantly the cured compounds. Although these piles had presented phosphorus', calcium' and organic matter's levels relatively smaller than the windrow control, these deficits can be easily corrected with the use of others organic wastes rich in these nutrients. However, more studies are needed to the more understanding of the behaviour of composting method when consisted of ROF.

Finally, it could be concluded with this study that the small-scale composting of organic waste composed of ROF, when properly managed, has the potential to be
used as organic fertilizer improving the soil properties. These results also make possible the management of municipal solid waste in a better efficient way, reducing significantly the amount of residual oils and fats sent to landfills.

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REFERENCES