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PRODUCTION OF ORGANIC FERTILIZERS FROM MIXED COMPOSITION BETWEEN ORGANIC WASTE AND CLAY POWDER

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Abstract

The increasing production of urban waste has motivated its use as alternative sources of organic matter. Composting organic wastes is one of the oldest methods of recycling, during which the residue is transformed into organic fertilizer. The present work has as main objective: To optimize the technique of organic fertilizers production from mixed composting between organic waste and clay powder. In this work, two biodigesters were assembled on a small scale, using different initial compositions of urban waste from agricultural and clay powders. During the process the following parameters were monitored: temperature, pH, humidity and aeration. At the end of the composting process the different compounds generated were characterized in relation to their chemical and physical properties, taking into account the quality of the compound formed.

Key words: Organic waste, composting, compost quality, clay powder.

1. Introduction

The increase in the number of inhabitants on the Planet, combined with the concentration of populations in the cities, is aggravating the Earth's natural capacity to absorb waste. The generation of solid urban waste is an unavoidable phenomenon occurring daily in quantities and compositions that depend on the size of the population and the economic development of each city. The current development model is characterized mainly by the excessive and constant exploitation of existing natural resources and by the unrestrained generation of waste, which, for the most part, are inadequately disposed.

Increased pollution of soil, water and air, leading to a continuous and accelerated process of environmental degradation, with a series of implications on the quality of life of the population and natural resources.

The increasing production of urban waste has led to its use as alternative sources of organic matter. The constant and inexhaustible production of these materials, together with their low cost of production, make them attractive for use in agriculture, forests and recovery of degraded areas. Moreover, considering that the generation of waste is a problem in itself, their reuse helps to relieve the pressure on the environment.

Organic composting is one of the oldest methods of recycling, during which organic matter is transformed into organic fertilizer. In addition to being one of the solutions to the problems of organic solid waste, the composting process provides the return of organic matter and nutrients to the soil. This process is the result of biological decomposition of the organic substrate under conditions that allow the natural development of high temperatures, with formation of a product stable enough for storage and application to the soil, without undesirable environmental effects (Pereira, 2007). Another important contribution of the compound is that it improves soil conditions. In addition, the presence of organic matter in the soil increases the number of worms, insects and desirable microorganisms, which reduces the incidence of plant diseases.

The present work has as main objective: To optimize the technique of organic fertilizers production from mixed composting between organic waste and clay powder.

1.2 Method and Study Description

This section presents the main materials and methodology used in the monitoring of the mixed composting process of organic wastes and small-scale clay powder, as well as the physicochemical methods used in the characterization of the compound.

The process was preceded by the selective collection of organic waste from agricultural activities and organic waste, namely: banana peel, orange peel, corn husk, sugarcane bagasse, bean leaves, grass pruning of the Institute , among others and mineral part (clay powder / natural earth). The composting process occurred in the period from August to October 2016. The type of compost used in this research was aerobic in naturally ventilated biodigesters. The two biodigesters were constructed with wood and have the dimensions 70x60x50cm. Composting was carried out in an area of approximately 5m^2 in the Matacuane - Beira neighborhood.

a) Assembly of biodigester 1 with clay

The process of assembling the biodigester began with the grinding of the vegetable and clay residues with the aid of a traditional crusher. Particle sizes were varied by the number of times the organic wastes were passed through the grinder. For the larger diameter particles (eg. coconut shell) were often passed through the crusher, and to obtain the smaller particles of Clay powder were passed three times and finally sieved.

For mounting the biodigester 1 with clay, it was necessary to first weigh the different types of waste. Then, clay was placed in the base of the biodigester and alternating the organic waste and mineral part up to 76kgs and then did the first watering for the beginning of the process.

In the two biodigesters, different stages of conservation were used: fresh and dry and in both situations this material was completely submitted to composting with 46kg of organic waste and 30kg of red clay for biodigester I and 30kg of natural digester II soil.

The definition of the percentage of each organic material in the treatments of the present work was made from information found in a study by Silva (2008), which suggests as ideal the following mixture for composting: 70% of materials rich in carbon with 30% of nitrogen rich materials to thereby obtain an organic compound having the desired C / N ratio and of good quality by the use of clay powder.

b) Assembly of biodigester 2 without clay

As in the prior biodigester, the steps used were the same with the same amounts of residues. The only difference in this biodigester was the natural land in place of clay.

The layout of the biodigesters in the yard was made in such a way as to remain parallel and spacious to facilitate the revolving and watering, keeping the way in front of the biodigestors to facilitate the transit. The figure below illustrates the diversity of the residues and the assembly of the biodigesters.

Figure 1: Raw material used in biodigesters

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2. Discussion of Results

In this part the main results obtained during the development of the work were analyzed. The results are focused on the two biodigesters studied and are compared with results of other authors.

In the first stage of the process, which consisted in the thermostabilization of the organic residues, the temperature reached 53 - 57.8^{o} C, between 7 and 15 days after the start of the process, which indicates higher activity of thermophilic bacteria and fungi in the degradation of residues. Between 20 and 27 days, the temperature ranged from 27 to 30° C. This temperature indicates the colonization of fungi and actinomycetes in the compound (Madaleno, 2002). The curious is the maximum temperatures of the biodigestores were recorded in the center, which reached the class of 57° C. This behavior caused the rotting of the decomposing material to spread the heat at all points of the biodigesters.

At 27 days of composting, the C/N ratio of the organic residue to clay was higher than that of the natural soil residue. Mineralization of organic waste with clay was more intense than in natural soil treatment. However, in the treatment without clay, where the mineralization was less intense, the nitrogen was still in organic forms. The composting process originates from the activity of microorganisms that convert nitrogen into NH_3 during the decomposition of the organic material, which decreases the nitrogen content of the compound, since the clay helps to accelerate the decomposition of the organic matter.

The temperatures of the two biodigesters presented similar behavior, and the thermophilic phase started in the first days of composting. The explanation for this behavior may be associated with the type of residues used in the process. For another reason, during the period of collection and storage of the waste, the degradation process may have been started, since at the time of assembly of the biodigestors there was already a high amount of microorganisms responsible for the process. This behavior contributed to the fact that the mesophilic phase took 1 or 2 days before the thermophilic phase, according to the data recorded as far as the temperature measurement.

2.1 Analysis of temperature results

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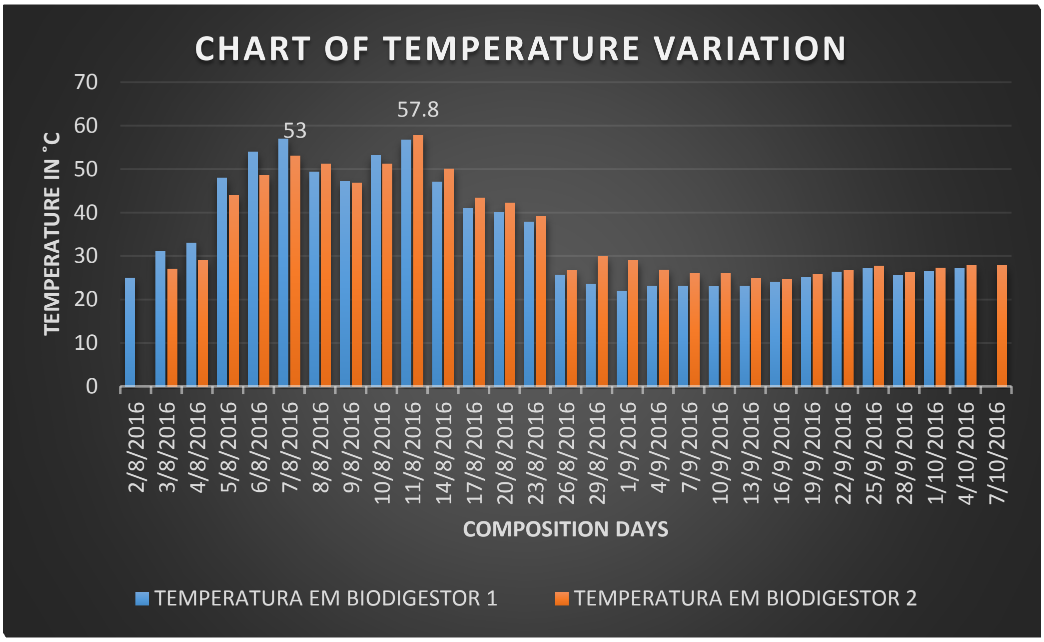


Graph 1: Evolution of temperature in biodigesters in the composting process

Temperatures in the clay digester varied from 47°C to 57^{o}C. This behavior may be related to the use of smaller size biodigesters. According to Marín et al. (2005) that maximum composting temperatures can reach up to 70°C. The elevation of the temperature in the biodigestor with clay in relation to the biodigestor with natural soil may be associated with the presence of clay, which in a certain way may contribute to the increase in temperature.

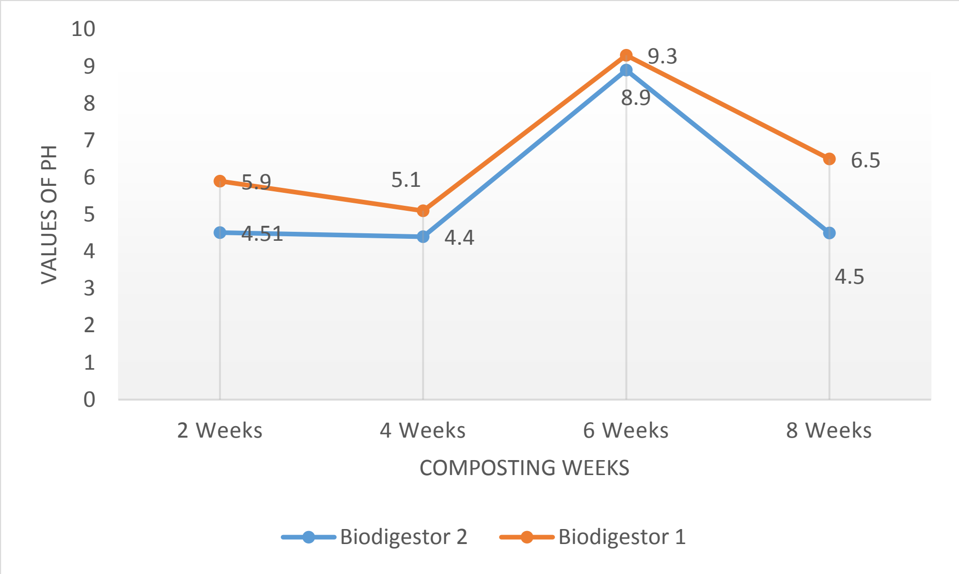
The biodigestors of the work presented dimensions of 70cmx60cmx50cm, much lower than those recommended by the literature of 1.5x1.5x1.5m (Brito, 2006). Another important factor that may have influenced in obtaining low values of maximum temperature (about 70^{o}C) is the fact that the heat loss is equal to the dimensions of the biodigesters.

In relation to the biodigestor with natural land, it was verified that the temperatures ranged between 45 to 56.8^{o} C, a behavior that does not defend much of the biodigestor with clay. This behavior is abnormal according to the literature based on the elaboration of the work.

In general terms it can be mentioned that the decomposition was more accelerated in the biodigestor 1 (with clay) than the biodigester 2 with natural earth. This is because the temperature greatly influences the decomposition of the matter in composting, in addition to that the decrease in temperature in the phase of bio stabilization may mean that the composting process is not going well.

2.2 pH monitoring

The pH was also monitored throughout the process, but monitoring was performed every two weeks. At the beginning of the process (15 days later) pH ranged from 4.51 to 5.9 and decreased to 4.4 to 5.1 in the third week. After the third week the pH evolved to maximum values of 8.9 to 9.3 between the third, fourth and fifth week. Up to the end of the process the pH ranged from 5.48 to 5.68. According to the literature this range of values are ideas for the practice of agriculture.



Graph 2: pH plot in the mixed composting process

The behavior differed from the standard behavior in relation to the maximum pH values during the composting process. According to Haug (1993), composting has the ability to neutralize high and low pH values during the process. This is due to the formation of a weak acid (CO_2) and a weak base (NH_3).

2.3 Humidity Monitoring

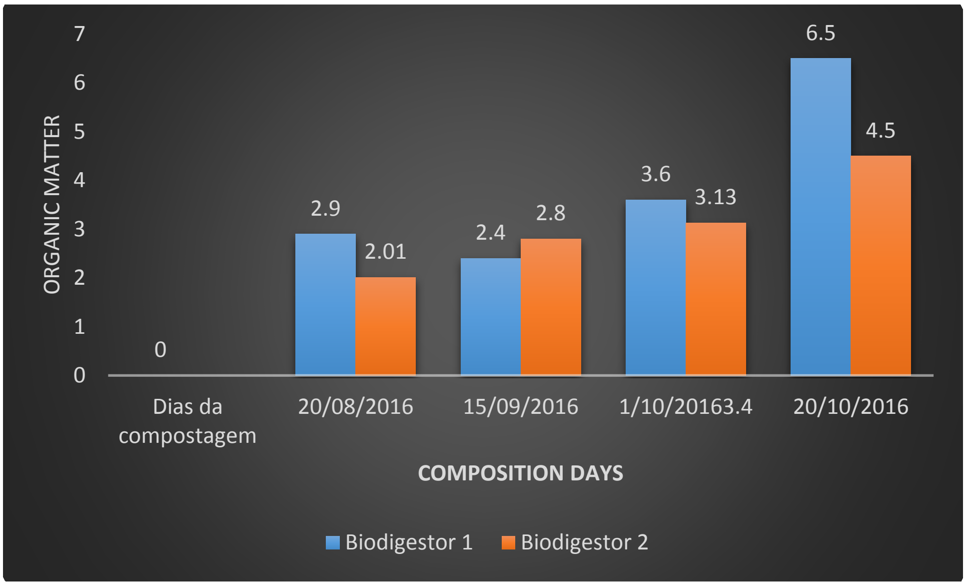
At the beginning of the process, the two biodigesters were monitored daily in order to visually check the degree of humidity. At the beginning of the process, when the biodigestors were assembled, the first irrigation was done. After seven (7) days, irrigation was necessary. After the fermentation period, watering was started every three days, because the moisture loss was greater due to the size of the biodigesters. This behavior is not common, since the recommended in the maturation period are weekly irrigations (Pereira 2007).

According to Kiehl (2002), smaller litters are more subject to moisture loss, which was verified during the monitoring of this parameter. During the composting process, as the degradation of organic matter increased, a very high loss of moisture was observed.

This loss of moisture could be seen as an advantage as regards moisture control, since there was no slurry formation during the process. On the other hand, at no point in the process was it necessary to reduce the humidity. But the humidity was in the range of 45% to 60%. One has the fact that excess humidity can cause several problems, such as reduction of temperature and oxygen in biodigestors, can cause bad smell and slurry generation.

2.4 Evolution of Organic Matter in Biodigesters

During the research, the evolution of organic matter in the whole process from the first days to the production of the compound was evaluated. The chart below illustrates the evolution of organic matter.



Graph 3: Evolution of organic matter in the two biodigesters

According to the graph, it can be seen that in the first month of the process the residues already contained a quantity of the organic matter, as the degradation process was increased the loss of the organic matter and arrived in the phase of maturation was observed, and when irrigation and rinsing were stopped to allow the death of the microorganisms and stabilization of the compound, organic matter registered a rise reaching values up to 6.5% for biodigester with clay.

In general, it can be concluded that during the composting process, there were variations in the organic matter alteration up to high values (4.5 and 6.5), as shown in the graph above. This behavior may be associated with the presence of the clay that already contains the mineral part that is very important for the growth of the plants.

According to Toro and Garcia (2000, p. 262), organic compost will have quality when the organic matter is above 2.5% the humidity <40% and 90% of its particles pass through a 25mm mesh (have fine particles).

According to the graph, it can be seen that during the first month of the process the organic matter was at a very low level, waking values 2.01%, this may be related to poor decomposition of the residues in this biodigester. From the graph, it can be noticed that the highest value of organic matter was found in the sixth week with 3.13% than in others, this behavior can be related to the fact that the natural land that already owns the organic matter of which it is not delayed the beginning of the degradation of the residues involved in composting. On the other hand until the end of the process the organic matter ascended up to 4.5% in the biodigestor with natural earth.

In general, the presence of organic matter (OM) was more noticeable in biodigester 1 (with clay) with about 6.5% of OM than in biodigester 2 (with 4.5% natural soil). This behavior may be that the quality of the compound is more in the first experiment than in the second, since the quality of the compound depends in addition to other element the presence of the organic matter.

2.5 Characteristics of the Compost after 60 days of Composting

a) Biodigestor with clay

The product obtained after 60 days of composting, in general, presented a dark appearance and typical odor of decomposed plant material. However, due to the great diversity of the residues and the still coarse granulometry, it was concluded that the decomposition of the material was not complete, requiring an additional stage of maturation of the compound. The phase of transformation of the decomposing material was approximately 60 days. There was a need to add 15 days to stabilize the compound.

At the end of the composting process the irrigations were stopped with the aim of reducing the humidity in the biodigesters to facilitate the killing of microorganisms and the storage of the final compound.

At 75 days all organic material and mineral part (clay powder and natural soil), has become a stable compound and rich in nutrients essential to improve agricultural soil quality. The compound was completely transformed after 60 days of the procedure. The normal is to reach the final product at 90 days, but this biodigestor was achieved the result up to 75 days the compound was already stabilized.

b) Biodigestor with Natural Land

For the biodigestor with natural soil, the product obtained after 60 days of the process, did not show good results in comparison to the biodigestor with clay. This behavior led to an increase of 10 days for the complete formation of the product, in the interval of time that was verified in biodigester 1. Composting, being an environmental biotechnology, brings integrated solutions to rural and urban problems representing a link of mutual benefits.

In addition, the results of the research showed that composting, besides being an inexpensive and practical way to take advantage of organic waste (urban and rural), serves as an excellent instrument for the promotion of environmental education, warning about the risk of disease spread and contamination of water and soil caused by management and non-cautious disposal of organic waste.

Figure 2: Presentation of final compost after 75 days of composting

Conclusions

- ✓ Mixed composting between organic waste and clay powder is an excellent tool to promote environmental education, as it provides recycling of unused organic waste that keeps soils alive and productive, and also enables the quality monitoring of these wastes to be monitored to produce compounds of high agronomic value and environmentally safe.

- ✓ Mixed composting between organic waste and clay powder contributed to the nutrient content of the compounds formed, the manures being fundamental to the equilibrium of the C/N and the pH of the final compounds.
- ✓ The use of clay powder contributed to acceleration of the process in 60 days and the quality of the compound formed, whose quality is recommended.
- ✓ Regarding nutrients, the small-scale composting method, using organic waste and clay powder, proved feasible for the production of organic compound with potential for fertilizer use in vegetables and small gardens.
- ✓ It was also found that all of the initial compositions of the biodigestors studied generated good quality compounds, their quality being dependent on the diversity of the organic residues and the mineral part used. However, it is worth noting that biodigester 1 (with clay) was much more outstanding, mainly due to the reduced composting time and better biodegradability compared to biodigester 2 (without clay).
- ✓ During the composting process, the rapid evolution of the biodigestor containing clay powder was observed in relation to the one containing natural soil. The selection and diversity of the residues as well as the monitoring of the parameters (Temperature, humidity and revolving) for the composting were factors that contributed to the rapid biodegradability of the material.
- ✓ The main contribution of the present work was to demonstrate that the mixed composting process between organic waste and small scale clay powder, when well conducted, does not present health risks, even in urban environments, offers good quality products, opportunities for applying a sustainable method for the treatment of urban solid waste.

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