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Essay the Recovery of Solid Household Waste from The City of Kindia by Composting, (Republic of Guinea)

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ABSTRACT

Background and Aim: In Guinea, waste management occupies a central place in the State's environmental policy. The objective of this study is to recover fermentable waste by composting as an alternative to landfilling and incineration of waste. This work was carried out in November and December 2022 in the composting center of the urban municipality of Kindia.
Method: This study is a continuation of research work on the management and recovery of solid household waste in the city of Kindia. The andean or elaborate heap method of composting was used. It covers the following steps: preparation of the material to be composted, on-site observation, evaluation of the compost material and physico-chemical analysis of the compost. Composting was carried out in a windrow over an area 2m long, 1.5m wide and 1.5m high, i.e. a volume of $4.5 m^3$.
Results: The results obtained show that with an initial quantity of 960 kg of household solid waste used, we obtained 380 kg of compost after almost 30 days of composting, i.e. 39.58% compost (biodegradable waste) and 60.15% rejection. During the composting process, the temperature in the ande varied from 29°C to 68°C, with an average of 47.32°C. In the ambient environment, it varied from 23.80°C to 34°C, with an average of 28.13°C. The evolution of the pH as a function of time showed three different phases (acidogenic phase, neutral phase and alkaline phase). The acidogenic phase lasts 15 days, for a pH varying from 5 to 6.5. The neutrality phase lasted 8 days (pH around 7). From the 23rd day there was the transition to the alkalinization phase (pH varied from 7.8 to 8.7). The humidity level has decreased significantly over time, around 75% in young compost, it is only around 15% in mature compost. At the start of composting the C/N ratio was about 25 and at the end of the process C/N was reduced to 10. During the process the EC content varied from 4.5 ms/cm (initially) to 7.3 ms/cm until day 25, followed by a gradual decrease until the end of the composting process (1.8 ms/cm).
Conclusion: This study made it possible to carry out a test for the recovery of solid household waste from the city of Kindia by the composting process for soil amendments. It remains to be popularized and encouraged by NGOs and government agencies in the country.

Keywords: Solid waste, recovery, household, composting, Kindia

INTRODUCTION

The demographic explosion of the population, the increase in production, consumption and the change in the way of life are the main cause of the multiplication of the quantity, quality and harmfulness of waste. These wastes are of different categories: household, agricultural, hospital, industrial and nuclear [1]. Waste management is one of the most pressing environmental issues for any city in the world. However, it is more complex for cities in developing countries, because the development of the collection service has not kept pace with urbanization and therefore a large volume of waste is not collected in a rational way [2].

Compost is the result of the decomposition of organic materials containing carbon and nitrogen through a natural process due to the action of microorganisms, air and water, which allows them to be easily used for cultures. By going through this process, we can recover waste such as crop residues, animal waste, household waste, etc. [3]. Composting is a natural process of breaking down or decomposing organic materials. Compost, an important source of organic matter, can be applied to soils, it plays an important role in the sustainability of fertility, thus for sustainable agricultural production [4].

METHOD AND MATERIALS

The urban municipality of Kindia is located 135 km from the capital Conakry. It covers an area of 500 km^2, with a population of 170437 inhabitants. It is between 10°04'00" north altitude and 12°51'00" west longitude. The urban municipality of Kindia has a composting center of 120 m2, with two sheds, a storage warehouse and a caretaker's house [5]. The materials used include: scales, shovels, bags, packaging bags, gloves, mufflers, rakes, wheelbarrow, three-wheeled motorcycle, sorting table, digital probe thermometer, oven, PH meter and conductivity meter.

METHODOLOGY

This study is a continuation of research work on the management and recovery of solid household waste in the city of Kindia. The andean or elaborate heap method of composting was used. It covers the following steps: preparation of the material to be composted, on-site observation, evaluation of the compost material and physico-chemical analysis of the compost [6].

Windrowing was done using wheelbarrows. The windrow was formed with a quantity of household waste of 960kg, over an area 2m long, 1.5m wide and 1.5m high, i.e. a volume of 4.5m3. The first reversal occurred on the 8th day after heap deposition and the second on the 15th day. The experimental stages of compost production are illustrated by the images in Figure 1.

Temperature was measured by a Multi-System digital thermometer; Humidity was assessed after drying the sample at 105°C for 48 hours; the organic matter (OM) was calculated from the ash after drying a sample of 20 g dry weight at 550°C for 6 h; Total Organic Carbon (TOC) and Total Kjeldahl Nitrogen (TKN) were measured by the Walkley-Black method and the Kjeldahl method, respectively. The C/N ratio is then calculated as a function of the TOC and NKT concentration pH and electrical conductivity (EC) were measured by sample-water mixture. The values were read on a pH meter and a conductivity meter respectively.

Reception of waste | Windrow formation | First reversal

Watering	Screening	Compost

Figure 1. Experimental stages of compost production

RESULTS AND DISCUSSIONS

With an initial quantity of 960 kg of waste, we obtained 380 kg of compost after nearly 30 days of composting, i.e. 39.58% compost (biodegradable waste) and 60.15% refusal (non-biodegradable waste). These values depend on the nature and origin of the waste. They are also due to the non-sorting or segregation of the different types of waste at the source of production.

Temperature trend

During the composting period, the evolution of the temperature in the ande and in the surrounding environment was monitored (figure 2).

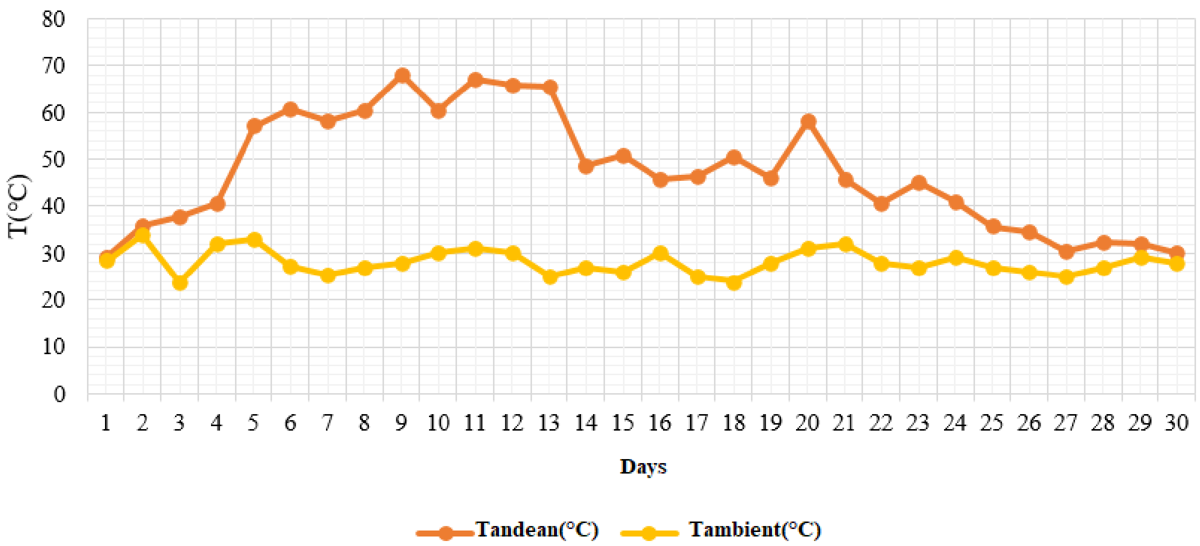

Figure 2. Temperature evolution

Temperature monitoring allows an indirect measurement of the intensity of aerobic degradation. For temperatures below 20°C, only psychrotrophic microorganisms are active. Between 20 and 40°C, it is the turn of those who are mesophilic, but thermophilic microorganisms are active only at temperatures between 40 and 70°C [7].

During the composting process (30 days), the temperature varied from 29°C to 68°C; with an average of 47.32°C in the Andean. In the ambient environment, it varied from 23.80°C to 34°C; with an average of 28.13°C (figure 2). These results are consistent with those of the literature for optimal compost production [7].

The change in temperature reflects a good composting process, by a succession of two phases of microbiological activity (stabilization phase and maturation phase). The stabilization phase is characterized by a maximum temperature rise of 68°C, which corresponds to the degradation of simple organic compounds. The Maturation phase is characterized by a decrease in temperature and will correspond to the degradation of lignocellulosic molecules and the process of humification. This phase corresponds to the period from the 22nd day to the 30th day, with a temperature variation of 45°C to 30°C [8].

Evolution of the pH

The pH is an important factor that influences most of the biochemical reactions catalyzed by enzymes which allows the bioavailability of nutrients and the solubility of mineral elements for microorganisms.

During the composting process the initial pH was 7.3. The evolution of the pH as a function of time showed three different phases (acidogenic phase, neutral phase and alkaline phase). The acidogenic phase lasts 15 days (1st to 15th day), for a pH varying from 5 to 6.5. The neutrality phase lasted 8 days (pH around 7). From the 23rd day there was the transition to the alkalinization phase (pH varied from 7.8 to 8.7). This phase results from the production on the one hand of ammonia from the degradation of protein amines during the ammonification process and on the other hand from the release of bases previously integrated into the organic matter. The final alkaline pH of 8.7 makes compost a product without risks for the soil and for the plants. The pH value obtained in this experiment agrees with the results of other authors [9].

Evolution of humidity

Good humidity is essential for the activity of microorganisms to be greater, which speeds up the composting process, hence the objective of regularly watering the ande during the first week. The humidity rate decreases significantly over time, around 75% in young compost, it is only around 15% in mature compost. This loss of water is due to leaching and evaporation due to the rise in temperature caused by the intense microbial activity during the composting [10].

Evolution of C/N

The C/N ratio presents a progressive declination due to the mineralization of the organic matter. The initial substrate has a C/N ratio of 25. As soon as the readily available carbon compounds have been exhausted, the rate of C/N reduction decreases. This decrease can be explained by the fact that microorganisms consume more carbon (main component of organic molecules) than nitrogen. At the start of composting the C/N ratio was around 25 and the end of the process was reduced to 10 (below 20). Some authors recommend a C/N ratio of 20 or less as a standard for mature compost [11]. Thus, the compost obtained is of good agricultural quality.

Evolution of the EC

Electrical conductivity (EC) reflects the degree of salinity of the compost produced and indicates its possible phytotoxic/inhibitory effects on plant growth. Compost with low EC can be used directly while compost with high electrical conductivity must be well mixed with soil or other materials with low electrical conductivity before it can be used for crops.

During the process the electrical conductivity content varied from 4.5 ms/cm (initially) to 7.3 ms/cm until the 25th day, followed by a gradual decrease until the end of the composting process (1 .8 ms/cm). The initial increase in electrical conductivity could be caused by the release of certain mineral salts (phosphates and ammonium ions) and by the decomposition of organic substances. The electrical conductivity of the final compost should not be less than 3 ms/cm, indicating that the EC could not harm plant growth [12].

CONCLUSION

Composting is currently considered an environmentally sustainable component in an integrated waste management system and would have a triple benefit in this regard: cleaning up the urban environment, reducing health risks and increasing productivity agriculture by renewing soil nutrients.

The results obtained show that household waste can produce composts successfully within 30 days and more. Operational indices such as temperature, pH, and off-gas were very useful in evaluating composting performance and revealed vigorous microbial activity. The compost produced in this study was satisfactory for its agricultural application in terms of C/N ratio and electrical conductivity as an index of its salt content, in addition it does not present phytotoxicity problems and contains elements nutrients that can enable it to act as a fertilizer.

Kindia in particular and Guinea in general being an agro-pastoral country of excellence, the recovery of biodegradable waste in compost would make a considerable contribution to the improvement of agricultural yields and the non-dependence of chemical fertilizers.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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