Journal of Environmental Science and Engineering B 12 (2023) 17-24
doi:10.17265/2162-5263/2023.01.002

Study of the Management and Recovery of Biodegradable Waste in the City of Kankan, Guinea

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Abstract: This research, carried out during September and October 2020 in the city of Kankan, made it possible to take stock of the city's household waste management. The quantities of waste from the four main landfills in the city are assessed, namely: Sogbè (1350.3 m^3), Station (195.5 m^3), Station University of Kankan (2491.5 m^3) and Salamani (369.6 m^3). Waste from three landfills/dumps was characterized for 26 days. This characterization covered 5,010.6 kg of waste, composed of 4263.9 kg of organic matter, 462.1 kg of recyclable matter and 284.6 kg of inorganic matter. The survey concerned a target population of 403 inhabitants, which made it possible to determine a production ratio per habitant per day of (0.48 kg/habitant/d). Finally, a composting experiment of 2000 kg of organic matter was carried out. The results obtained during this study constitute the basic elements allowing defining a better policy of management of household solid waste in the city of Kankan.

Key words: Management, household waste, characterization, recovery and composting.

1. Introduction

All over the world, households generate waste while seeking to meet basic needs such as food and heat. With population growth and the rigidity of urbanization, the uncontrolled production of waste has become so important that it poses a real problem of governance of urban agglomerations in developing countries. This is why the issue of waste management is high on the agenda of politicians, administrators, citizens' groups, international institutions and researchers [1].

In this context, one of the environmental issues associated with urban waste remains the very low collection rate in many African cities. Moreover, we note that in most African capitals, only less than 30% of waste is disposed of. The 70% not evacuated constitute wild deposits which litter the gutters and the streets. This insufficient collection rate has consequences on the health of populations and on the urban economy. The safe management and disposal of household waste are problems facing some cities in Africa in general and those in Guinea in particular [2].

Africa's population is estimated at 1.2 billion people in 2015 and will reach 2 billion by 2040 and nearly 40% of this population live in urban areas [3]. Estimates of the amount of waste generated in Africa are based on urban areas, as there are hardly any data available for the generation and management of rural waste. It is understood that the production of waste in rural areas is much lower, due to the lower level of consumption and purchasing power [4]. The amount of solid waste generated in the world is constantly increasing. This quantity was estimated in 2006 at 2.02 billion tones and at 4 billion tones in 2018 [5].

Africa being the least developed in the world with 38% urbanization. It is currently experiencing rapid development with a growth rate of almost 4% per year. Thus, African countries are now faced with problems

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of managing the solid waste produced, which has a direct impact on human health and environmental safety [6].

Studies in Kenya, Nairobi, Nakuru, Mombasa and Kisumu show that around 61% of the waste produced in these cities is residential waste, followed by industrial and other waste. Solid waste, without sustainable and appropriate treatment becomes a source of contamination for the environment as a whole, resulting in pollution of air, water and soil. The environmental, social and health impacts of this pollution are very high in low-income peri-urban areas where access to collection is difficult [7].

Due to the lack of waste management services in many African cities, their calcination or burning in landfills is a common occurrence. The Organization for Economic Cooperation and Development estimates that in 2013 around 712,000 people in Africa died from polluted air, which represents a 36% increase over 1990 [3].

The best approach to solid waste management in developing countries remains a major concern for researchers and policy makers. The choice of waste management systems depends on the decisions of city leaders as well as on structures related to the nature, quality and quantity of waste produced [8]. Waste characterization is the prerequisite for developing management strategies and/or updating data. The lack of data is due to the exorbitant costs of country-based methodologies, and their inappropriate transfer to less developed countries. These two aspects prevent efficient and sustainable waste management in developing countries [9].

The city of Kankan, Guinea's second largest after the capital Conakry, is not immune to the inconvenience of mismanagement of solid household waste. This city has experienced a population explosion in recent decades without adequate infrastructure for sanitation and waste management. However, the sustainable access of populations to sanitation and the management of household and other waste is a priority for African countries for the achievement of the Millennium Development Goals, because sanitation and household waste management are essential elements for improving the living conditions of populations.

Waste management in the city of Kankan is carried out by the Municipal Sanitation Service, SMEs (Small and Medium Enterprises) and NGOs (Non-Governmental Organizations). But, it turns out that the city is cluttered with rubbish here and there, especially in times of heavy rains, it is characterized by the absence of regulated dumps and household waste is thrown into gutters, backwaters and in the Milo river. Thus, the waste management of the city of Kankan must concern educational and research institutions in order to come up with proposals for solutions to this problem.

It is with this in mind that we proposed to work on the situation of household waste in the city of Kankan as part of this conference through the theme: Study of the management and recovery of biodegradable waste in the city of Kankan. The specific objectives of this study are to: determine the quantity of waste at the main landfills, characterize the waste from these target landfills and carry out a composting test.

2. Material and Method

2.1 Presentation of the Study Area

Kankan is the largest city in Upper Guinea. It is located 690 km from the capital Conakry. The city of Kankan has 27 neighborhoods with a population of 193,830 inhabitants, including 95,233 women, distributed in 20,125 households [10]. In recent years, it has seen a sharp increase in its rate of urbanization and covers an area of 46.45 km^2. It is located between 10°18″ and 10°23″ North latitude and between 9°21″ and 9°11″ West longitude. A plateau of about 370 m altitude on average dominates the relief, the climate is of the southern Sudanese type characterized by the alternation of two seasons: a dry season from November to April and a rainy season from May to October. The annual average rainfall is 1534 mm. The temperature varies between 25 ℃ and 35 ℃ and sometimes reaches 40 ℃ in March. The city is watered by the Milo river and its tributaries [11].

In the city of Kankan, there are four main dumps (Sogbè, Station, Station University of Kankan and Salamani) and several other small collection points in the neighborhoods. The map in Fig. 1 shows the locations of these different dumps.

2.2 Work Materials

The working materials used for sampling, transporting and sorting the waste are as follows: three scales of 65 g; 22 kg and 200 kg, two shovels, bags, packaging sachets, straps and covers, nose, two rakes, a wheelbarrow, a three-wheeled motorcycle, etc.

2.3 Methodology

Garbage or waste management refers to all the operations and means implemented for their elimination, reduction and recycling or recovery, in order to reduce their effects on human health and the environment. Waste management concerns all types of waste, whether solid, liquid or gaseous, each being a specific sector. The management of domestic or household solid waste generally results in: pre-collection, collection, transport, sorting and recovery [12].

This study was based on data collected on site, supplemented by surveys, extrapolations or estimates. It consisted in making: a description of the main landfills, a characterization of the waste, an estimate of the waste by landfill and the quantities of waste production per inhabitant. One of the experimental valuation techniques (composting) was carried out. The photos in Fig. 2.

2.3.1 Characteristics of Landfills

Determining the characteristics of the four dumpsites involves locating them, determining the perimeters, areas and heights of each dump. These parameters will make it possible to estimate the volumes of waste from each landfill in the city of Kankan during the survey period.

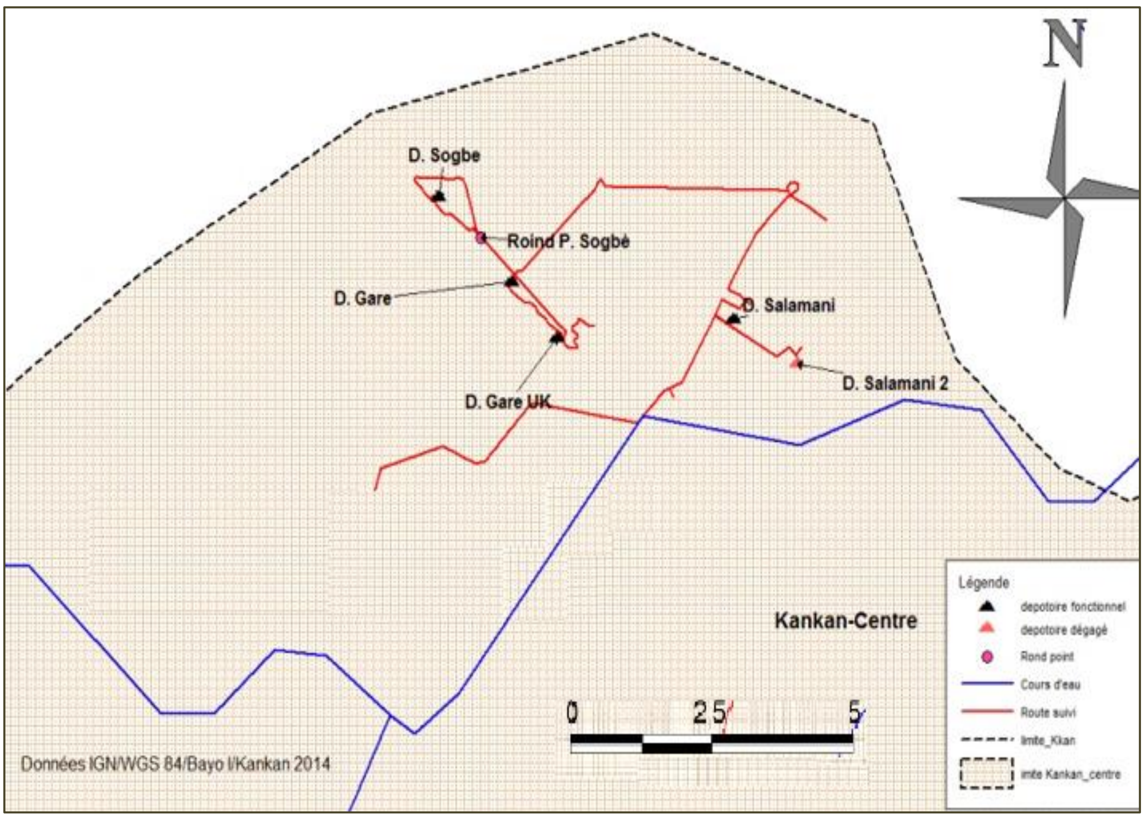

Fig. 1 Map of landfills in the city of Kankan.

Family reunification of garbage in the Farako I district

Gutters full of rubbish and strewn in the streets

Dump on the banks of the Milo

Sampling

Transport of waste Station to the sorting point

Samples taken from the station dump

Characterization of the samples from the dump Station

Less mature compost

Mature compost

Fig. 2 Illustrative photos.

2.3.2 Characterization of Waste in the City of Kankan

The study involved five (5) samples of 11 kg of waste collected at four points (East, West, North, South and at the top) of three target dumps (Station, University Station and Salamani) in the city. These samples were sorted and weighed according to the nature of the components (fermentable, plastics, batteries, gravel, bones, glasses, scrap metal, rags, hair/wicks and others). On the basis of these elements the average quantities per component, per landfill, and the corresponding percentages were determined.

2.3.3 Estimation of the Average Waste Production Rate

Household waste is produced continuously, in increasing quantity with the development of the lifestyles of societies. Knowing this quantity of waste produced by locality is one of the bases that define the contours of coherent management [13].

Thus, to better predict the size of the collection, treatment facilities and storage centers, and better plan the management system, knowledge of the quantity of waste produced in a given environment is essential. This quantity varies with space and time and whose quantification depends on climatic, geographic, demographic and economic factors [14]. The ratio of the daily amount of waste produced per capita is determined by the equation below [15].

$$R_j = \frac{Q}{P \times t}$$

Where:

R_j: Daily ratio of household waste per person in (kg/habitant/d);

Q: Total mass of waste collected at household level during time t (kg);

P: Total number of the population concerned during time t;

t: Time of characterization in days (d).

The determination of the ratio of the quantity of waste in the city of Kankan focused on certain households of five (5) typical neighborhoods, the numbers of people targeted by neighborhood are as follows: Farako I (83), Kabada (68), Timbo (57), Gare (95) and Briqueterie (100), for a total of 403 inhabitants. Twice a week, we collected and weighed the quantities of waste from the target families. The sorting was carried out taking into account the components. The collection lasted from 09/15/2020 to 10/10/2020, i.e. 26 days.

2.3.4 Biomass Recovery Techniques by Composting

Composting is a biological process for converting and recovering materials organic present in animal and plant forms which allows, under the action of bacteria aerobic, their transformation into humic substances. The choice of a material recovery channel by composting (low-cost treatment) generally appears to be the best solution for cities in developing countries due to the large proportion of organic or fermentable materials contained in several categories of waste. This technique of material recovery is very widespread and adopted [16].

In this present work, the experimental composting study was carried out at the Agronomic Research Center of Bordo de Kankan. The method used is the turning technique, for which a composting station with two compartments of the same dimensions has been created for this purpose (see photos (h) and (i) of Fig. 2). The dimensions of the compartments are: length (2.36 m); width (1.66 m) and height (1.76 m). So out of the 4263.9 kg of organic waste collected, we composted 2000 kg and the process lasted 45 days. The photos in Fig. 2 illustrate the present study.

3. Results and Discussions

The results obtained relate to the characteristics of the various landfills, the characterization, the quantity of waste produced per inhabitant, and the trial of recovery of organic biomass by composting.

3.1 Characteristics of the Landfills in the City of Kankan

The characteristics of the four main landfills in the city are given in Table 1.

These results show that the landfill at the Kankan University Station represents the largest volume of waste (2,491.5 m^3), followed respectively by Sogbè (1,350.39 m^3), Salamani (369.6 m^3) and Gare (195.56m^3). This inequality in the quantities of waste is due to the activities carried out in these areas and the density of the populations. These waste volumes also vary according to the season (dry or rainy).

3.2 Characterization

The results of the characterization of household waste in the city of Kankan are illustrated by the diagrams in Fig. 3.

The results of the characterization showed the differences between the quantities of the components of the waste per landfill, in relation to the position of the sampling point are very small. For example, we observe at the station's landfill that for fermentables: East (8.49 kg), West (8.10 kg), North (8.12 kg), South (8.31 kg) and Summit (8.20 kg), or approximately (0.006 kg), less than 1%. This shows a uniformity by composing different wastes of different origins.

Table 1 Characteristics of landfills in the city of Kankan.

No.	Landfill	Area (m^2)	Perimeter (m)	Height (m)	Volume (m^3)
1	Gare UK	4,983	314.50	0.50	2,491.5
2	Sogbè	1,718	2057	6.00	1,350.39
3	Salamani	924	189.8	0.40	369.6
4	Gare	1,137	130	2.00	195.56

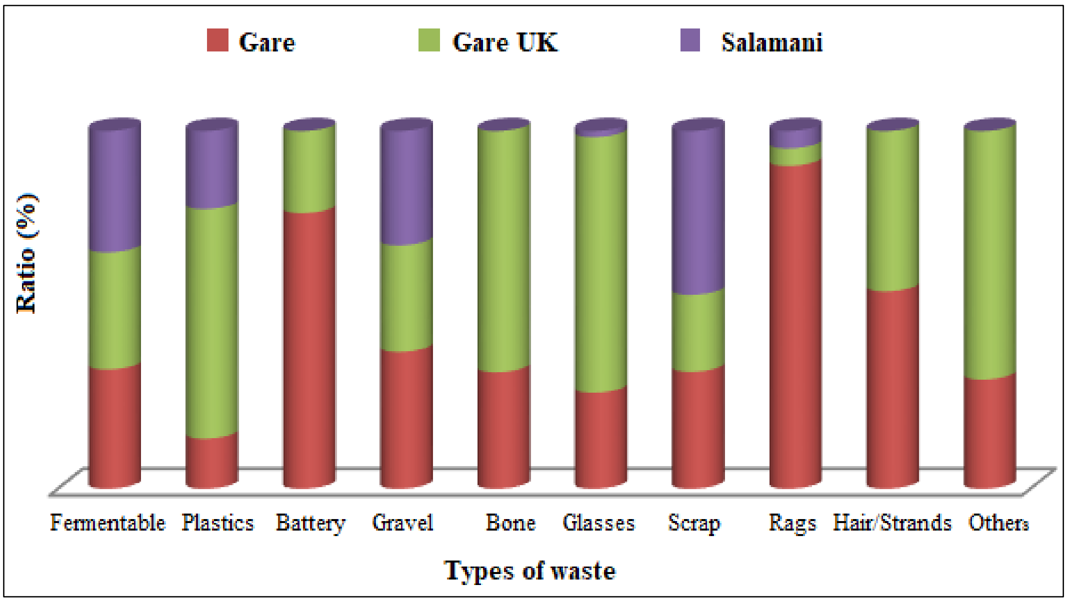

Fig. 3 Comparison of the component percentages of the three landfills.

The digraphs in Fig. 3 show that the percentages of fermentable materials are almost the same for the three landfills studied, namely Gare (74.95%), Gare UK (73.53%) and Salamani (73.13%). The value of the Salamani landfill results from its proximity to the Dibida market (paper, cardboard, vegetables, fruits, tubers, etc.). The other components (plastics, batteries, gravel, bones, glasses, scrap metal, rags, hair/wicks and others) have unequal proportions at the level of the three dumps.

The average values of the percentages of the different types of waste from the three studied dumps in the city show that the rate of fermentable or biodegradable materials is the highest, i.e. (74.87%), followed by gravel (11.49%), plastics (4.01%), scrap (2.20%) and other types are relatively small, less than 1%. The rate of fermentable or biodegradable materials being very high, shows the value of recovering this waste for the production of biogas and soil fertilizers (compost) locally.

3.3 Estimation of the Quantity of Waste Produced per Capita

The quantities of waste by type (organic, plastic and inorganic) as well as the number of inhabitants of five target neighborhoods in the city of Kankan are illustrated by the diagrams in Fig. 4.

The diagrams in Fig. 4 show that organic waste is in the majority in four districts, namely respectively: Kabada (906.4 kg), Gare (747 kg), Timbo (704 kg), Farako I (580 kg) and the smallest quantity is recorded in the Briqueterie district (83.2 kg). On the other hand, the greatest quantity of plastics is recorded in the Briqueterie district (1,326.5 kg), followed respectively by the Gare (142.5 kg), Timbo (121.5 kg), Kabada (90.7 kg) and Farako districts. I (24.2 kg). The largest amount of inorganic waste is recorded Farako I (113.8 kg).

It emerges from these results that the ratios (daily quantities of household waste produced per person) in the five study districts are respectively: Brickyard (0.57 kg/habitant/d), Timbo (0.57 kg/habitant/d), Kabada (0.56 kg/habitant/d); Station (0.40 kg/habitant/d) and Farako I (0.33 kg/habitant/d). With an average ratio value of the five districts equal to 0.48 kg/habitant/d, this value complies with the ratios of the cities of developing countries, i.e. (0.35 to 0.65 kg/habitant/d) and relatively higher than the average ratio of poor countries (0.25 to 0.45 kg/habitant/d) [17]. The amount of waste produced also varies from one neighborhood

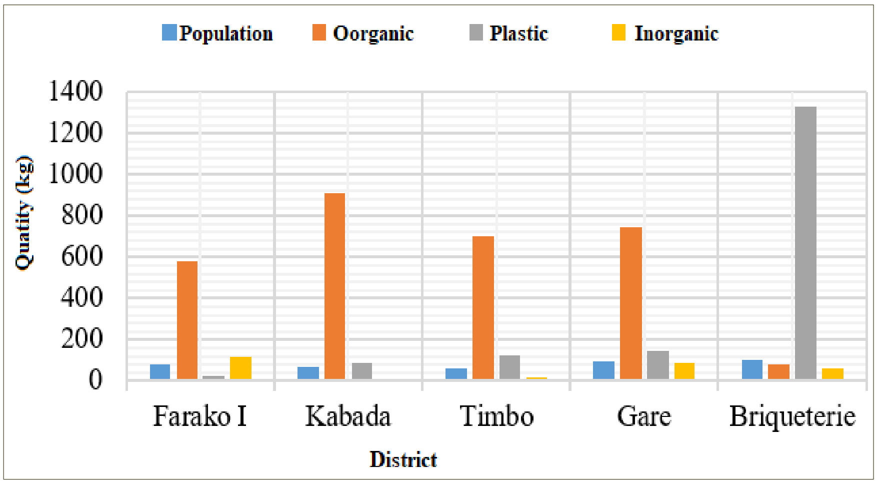

Fig. 4 Total amount of waste per component and the number of inhabitants of five neighborhoods.

to another, from one household to another in the same city, usually depending on the standard of living of the population. The production of waste is indicative of socio-spatial inequalities [18].

3.4 Valorization of Biomass by Composting

After 45 days of process, we obtained organic fertilizer (ripe compost), see Figs. 2i and 2h. The maturity of the compost is the final step in the composting process. It is one of the main criteria for assessing the quality of this product in agronomy. The maturity of composts corresponds to the stability of the organic matter on the physical, chemical and biological level, it is a function of the different proportions of the initial constituents and of the respect of the conditions (humidity, oxygenation) for the implementation of the composting process [19].

The compost obtained is well humified because it has the following characteristics: it does not stick, it does not emit an ammonia odor, its temperature is low, it is grainy and black in color and its original constituents are no longer distinguished with the naked eye (photo (i) in Fig. 2). This justifies that the organic fertilizer is of good quality [20]. The product (compost) was used by the market gardening groups of the Agronomic Research Center of Bordo de Kankan and the results were satisfactory.

4. Conclusion

This study is a test of the management and recovery of biodegradable waste in the city of Kankan, in order to propose a better strategy to the various actors in charge of the management of solid household waste, which floods the large cities of Guinea.

The results obtained during this research show that the sustainable management of household waste by promoting its recovery allows environmental protection, poverty reduction, satisfaction of food needs and job creation, which offers a sustainable future for future generations. It emerges from these results that, the need for the reorganization of SMEs, sanitation associations, the search for local, external and foreign financing, the sensitization of the authorities, populations and related services, remain strong links with good management and recovery of household waste from cities in Guinea.

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