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Conversion of Food Wastes into Compost for Home Gardening and Reduction of Global Warming on households in Zaria, Kaduna State Nigeria

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Abstract

This study focused on conversion of food waste into compost for home gardening as a means of reducing global warming in households in Zaria, Kaduna State, Nigeria. Food waste is a normal occurrence in households and food industries which happens on a daily basis. In Nigeria more than 50% of wastes generated is organic therefore, proper management of organic wastes will significantly decrease the amount of pollution arising from poor waste management such as combustion. Improper disposal of food waste has a negative impact on the global climate system, when food wastes are disposed, they generally end up in landfills and emit methane while decomposing. Methane is a greenhouse gas that is more potent than carbon dioxide (C_{02}) and this negatively impacts the environment. The problem of food waste in landfill poses great threat to human health, environment and has a negative impact on the global climate system. Food wastes can be prevented from ending up in the landfill by recycling food wastes into composts for fertilizing plants. The study was guided by 3 objectives. The study area was Zaria metropolis located in Sabon-Gari, Kaduna state, Nigeria. Experimental research design was adopted for this study; food wastes were disposed into pits and left to decompose for 18 days. In step I: various types of food wastes were collected, step II: food wastes were separated considering the various moisture content, step III: 1.0m long, 1.0m wide and 0.2m depth pit was dug and food wastes were disposed into the pit. After 18 days, the compost that had already turned black was used to fertilize crops and the harvest were used by the researchers to fertilize plants. Converting food wastes to compost has a positive impact on the global climate system. Compost is also economical, environmentally friendly, and reduces greenhouse gas emissions. It was recommended that composting food waste should be adopted by households in Nigeria as a means of fertilizing plants in gardens, composting in the communities should be undertaken in households by different age groups using simple implements. Home Economists should learn how to produce compose from food waste to fertilize plants in the home garden and the compost can also be packaged and sold in kilograms during the dry season to supply manure to the farms around the metropolis.

Key words: Food waste, Recycling, Compost, Greenhouse Gas, Climate change

Introduction

Improper waste management poses challenges to human health and environment in developing nations. Asides being unsightly, food wastes cause air pollution and depletes the ozone layer when burnt, thus increasing global warming. Wastes are often improperly managed using conventional methods such as burning (Aruna, Kavitha, Subashini and Indira 2018; Alam, and Ahmade 2013). In most cases, wastes are burnt, disposed into oceans, waterways, and dumped by the roadsides

(Ogwueleka, 2009). Improper disposal of wastes generated by households also breed pests, contaminates water and releases greenhouse gases (GHGs) during combustion.

Poorly managed wastes have adverse effects on humans, animals, plants, and the environment (Kumar, Mukherjee, Chakrabarti and Devotta, 2007). In Nigeria, about 50% of wastes generated is organic (Sharholy, Ahmad, Mahmood and Trivedi, 2008; Imam, Mohammed, Wilson, and Cheeseman, 2008; Getahun, Mengistie, Haddis, Wasie, Alemayehu, Dadi, Van Gerven and Van derBruggen, 2012). Organic wastes are biodegradable wastes these includes food wastes such as banana peels and yam peels, wood wastes, plant and animal wastes. Consequently, proper management of organic wastes will significantly decrease the amount of pollution arising from poor waste management such as combustion. According to Kumar, Mukherjee, Chakrabarti and Devotta (2007), when solid wastes are burnt, greenhouse gases such as carbon dioxide and nitrous oxide are released, these lead to ozone layer depletion and global warming. Other toxic substances which are harmful to human health and the environment are also released in the air, such as Hydrogen sulfide and methane. Many households in Zaria, Kaduna state, Nigeria produce high amount of food waste. Food wastes generated from these households presents various challenges such as odors, unsightly surroundings and attraction of pests. These pose a great threat to human health and environment. Parry (2011), noted that heat stress from global warming increases human mortality rate, irritates mucous membrane of the eyes leading to cataract, sore throat and environmental pollution.

Food waste is a major contribution in organic waste and is usually difficult to process by conventional methods, such as incineration, due to the high moisture content. When the wastes are burnt, pollutants are released which can lead to respiratory problems, cardiovascular diseases and adverse birth defects (Patz and Sadiq 2012)

Composting can be used to convert these food wastes into products that can be used as fertilizers, soil amendments thereby protecting human health and environment. It can increase soil moisture retention, nutrients, and reduce the need for chemical fertilizers. Food wastes are usually difficult to process by combustion, however various methods of food waste management exist, among these are landfill, composting and combustion however, composting which is decaying organic wastes by using biological processes is considered as a more suitable method (Rawat, Ramanathan and Kuriakose, 2013). Composting is a low cost biological decomposition process carried out by microbial activity. The physical-chemical parameter affected by this process include temperature, aeration, moisture content, carbon to nitrogen (C:N) ratio and Potential of Hydrogen (pH) (Fathi, Zangane, Fathi and Moradi, 2014).

Food wastes are mostly food scraps and peels which can be converted into useful products like fertilizer and biofuel. Sun-Kee (2004) noted that food waste has high energy content and it seems ideal to achieve dual benefits of energy production and waste stabilization. Sun-Kee (2004) further noted that degradation of each component of food waste is affected by environmental conditions, thus degradation of food waste can be increased by adjusting the environmental conditions. The compost produced from food wastes is appropriate for use as fertilizers because the slow release of Nitrogen supplied by food waste composts is ideally suited for urban landscapes where moderate, consistent rate of plant growth is highly desirable (Parry, 2011).

Composting is one of the four commonly accepted methods of waste disposal which has become a waste management alternative. It is a method of converting organic materials into a drier-odoriferous form through bacterial action, primarily to supply humus to the soil (Ayuba, 2005).

According to Toledo, Siles, Gutiérrez, & Martín (2018), composting is an aerobic process where complex degradable

materials are reduced and transformed by microorganisms into organic and inorganic by products. Composting is commonly referred to as nature's method of recycling and has become a low technology waste management alternative in recent times. Being a vital component in organic farming, it can be used for fertilizing the soil for increase food production.

Composting is a means of transforming different degradable wastes into products that can be used safely and beneficially as bio fertilizers and soil amendments (Cai, Mo, Wu, Zeng and Katsoyiannis, 2007; Bai, Shen, and Dong, 2010; Yu, Xie, Khan and Shen, 2019).

Compost from food waste is a valuable soil amendment that can increase soil moisture retention, nutrients, and reduce the need for chemical fertilizers.

According to Greenhouse Gas Protocol (2007), the decomposition of food waste in landfills generates methane, a green-house gas with twenty-one times the global warming potential to that of carbon dioxide. However, composting diverts food waste from landfills and converts it into a nutrient-rich soil amendment. At the simplest level, the process of composting simply requires making a heap of wetted organic matter (leaves, food waste) and waiting for the materials to breakdown into humus by undergoing biological decomposition after a period of weeks or months (Lodha, 2007).

Composting food waste reduces the amount of waste disposed in landfills and incinerators. In communities, residents can compost food waste behind the house backyard with food wastes generated within the household. There are many advantages that can arise from composting, including the reduction of volume, weight and water content of the waste as well as producing active pathogenic organ (Hangreaves, Adl and Warman, 2008). Therefore, the compost can contribute to the improvement of soil contents and nutrients required for harvesting plants and will significantly reduce the use of synthetic fertilizers (Hernandez, Castillo, Ojeda, Arras, Lopez and Sanchez, 2010). Risse (2012) also noted that compost also act as a soil intervention in improving soil structure, water infiltration rate, water holding capacity, tilth and reducing green gas emission.

In Nigeria food wastes have not been adequately processed or converted to compost at home for use in garden; the country still uses more of chemical fertilizers like nitrogen phosphate (NPK) and urea. Therefore, there is need to research the use of food wastes as compost in order to reduce greenhouse gas emissions and global warming. The focus of the study therefore, was to develop a composting process for managing food waste and assess its quality for use as fertilizers for home gardening by households in Zaria, Kaduna state, Nigeria.

Objectives of the Study

The main objective of the study was to use food waste to produce compost for fertilizing plants in home garden in order to reduce greenhouse emission

1. prepare compost from food waste which can be used as fertilizer
2. reduce the emission of greenhouse gas through composting food waste
3. observe the effect of compost applied on plants as fertilizer

Materials and Methods

Area of study

The study area Zaria metropolis is located in Sabon-Gari, Kaduna state, Nigeria, its geographical coordinates lies between 11° 4' 0" North, 7° 42' 0" East. In addition, around the study area, there are farming systems for instance home gardening and open space cultivation.

Zaria metropolis has been experiencing increase in population growth, and urbanization. This means increase in the number of people, residential and commercial areas which generate waste materials on daily basis (Ladan, 2017). The waste materials generated includes biodegradable food waste and non-biodegradable solid waste like polythene bags. Most of the food wastes generated are from residential houses for instance vegetable peelings and fruit peelings. These

wastes are organic in nature and thus decompose quickly (Gargi, Garg, and Garg, 2015).

The study was an experimental study. A scientific method called Berkley Rapid Composting was used. This is a fast composting method which takes between 14 to 22 days for composting to take place. In this method, food materials compost faster than other methods which takes between four to twelve months. In Berkley Rapid Composting method, when a pile is started, nothing should be added because when anything is added, the pile has to start from the initial breakdown stage.

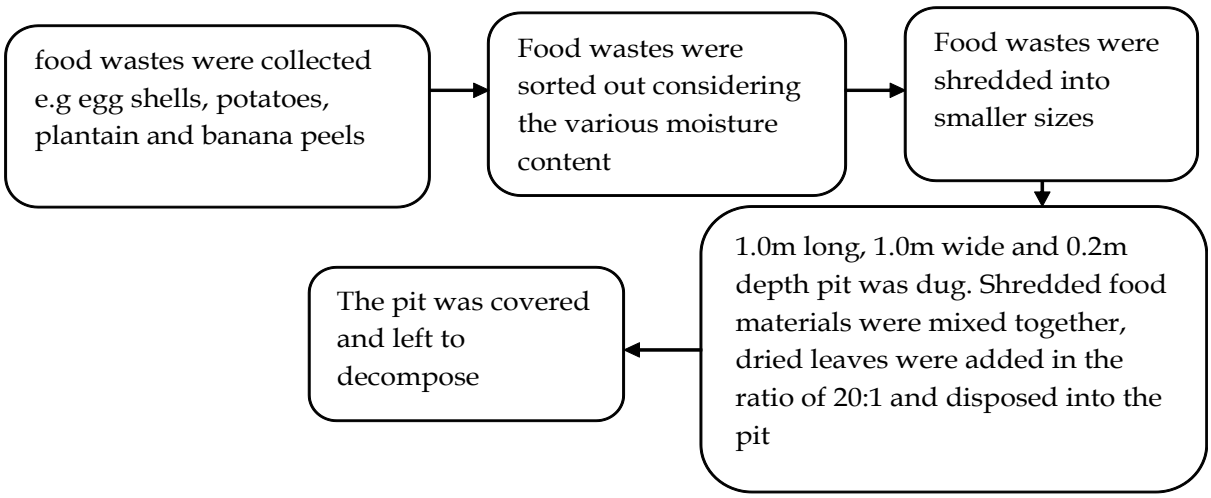
The enquiry was characterized by careful observation of nature and results were recorded.

At various levels of decomposition, the researchers checked to determine moisture content using gloves to squeeze a handful of the compost materials which released a drop of water, this showed that the pile had enough moisture. Temperature was also monitored using thermometer and when the temperature was between 50 and 55 ^{o}c it shows the temperature was adequate. On the final day, the compost was warm, dark brown and ready for use.

Materials

Materials used for the study were garden tools, saw dust dried leaves and food wastes obtained from neighboring households.

Flow Chart for Preparation of Sample



Food waste samples

The following food wastes were collected from neighboring households, sorted out considering the various moisture content, shredded into smaller sizes and used:

Corn husk, stale bread, fruit peels, citrus and melon rinds, grape stems, uneaten portions of fruits, vegetable stem, eggshells, potatoes, plantain and banana peels

Other materials used were dried leaves, saw dust and charcoal

Garden tools

Trash cans, digger, wheelbarrow, shovel and garden fork.

Other materials used were thermometer, weighing scale, gloves and plastic cover.

Steps

Food wastes were disposed into pits and left to decompose for 18 days.

Step I: various types of food wastes such as corn husk, stale bread, fruit peels, citrus and melon rinds, grape stems, uneaten portions of fruits, vegetable stem, eggshells, potatoes, plantain and banana peels were collected.

Step II: food wastes were separated considering the various moisture content and shredded in to smaller sizes

Step III: 1.0m long, 1.0m wide and 0.2m depth pit was dug and 100kg of food wastes and dried leaves were disposed into the pit.



Figure 1: Preparation of the pit for production of compost

The compost heap was located in an area sheltered from too much sun and heavy rain, in order to prevent the compost from drying out or becoming water-logged thus slowing down the composting process. Space used for the heap was 1.0m long, 1.0m wide and 0.2m depth

DAY 1
The shredded compost materials were mixed together into one pile in the C:N ratio of 20:1. The food wastes had a ratio of 20 and dried leaves were in the ratio of 1 and a total 100kg of material was layered in the pit. Initially the pile was dry; as a result, water was added and mixed thoroughly. A plastic was also used to cover the pile so the heat produced by the pile can be trapped properly. After 24 hours, the researchers dug into the pile and removed a handful of material from the center with the aid of hand glove. The material examined was hotter and darker than the material at the outer edges of the heap.

DAY 2
After two days the compost pile was turned with a garden fork as compost bacteria need plenty of air to survive.

DAY 3 to DAY 4
The compost pile was left to decompose.

DAY 5
The compost heap was turned with a garden fork; outside turned to inside and vice versa. The researchers ensured that moisture was constant, gloves were used to squeeze a handful of the compost materials which released a drop of water, this showed that the pile had enough moisture.

DAY 6
The compost pile was left to further decompose.

DAY 7 to DAY 9
The compost heap reached its maximum temperature between days seven to nine. The thermometer inserted into the heap showed that the temperature was between 50 and 55 ^{o}C. Each time the heap was smelly, the researchers added a handful of sawdust to remove the odor.

DAY 10 to DAY 17
The researchers continued to turn the compost every two days.

DAY 18
On the final day, the compost was warm and dark brown. The researchers also observed that earthworms moved into the compost, which showed that the compost was ready, cooled down and rich in nutrients. The researchers obtained over 72.5 kg of rich, dark, compost to use in the home garden. The compost had an excellent consistency and the initial materials could not be distinguished from the final product. The compost was used to fertilize plants in the home garden and after three weeks the plants were green and healthy.



Figure 2: The finished product

Results

The researchers used Berkley Rapid Composting method. According to Arumugam, Seenivasagan, Kasimani, Sharma & Babalola, (2017), when Berkley Rapid Composting method is used and a pile is started, nothing should be added because it takes a 18 to 22 days for the initial materials to breakdown, and anything added has to start from the initial breakdown stage—thus lengthening the decomposition time for the whole pile. After 18 days, the compost was warm and dark brown. The researchers also observed the presence of earthworms in the compost, which showed that the compost was ready, cooled down and rich in nutrients. The researchers obtained over 72.5 kg of rich, dark, compost to fertilize crops in the home garden. After three weeks, the researchers observed that the plants were green and healthy. The remaining compost could also be packaged and sold in local residents.

The result showed that food waste was converted to compost thus eliminating the combustion of food wastes which leads to emission of greenhouse gases. The result also revealed that compost can be used to fertilize plants in a home garden. After three weeks, the researchers observed that the plants were green and healthy thus, the result showed that compost can be used to fertilize plants as a substitute for chemical fertilizer.

Conclusion and Recommendations

The study revealed that composting can be adopted by households in Zaria, Kaduna state, Nigeria as the Berkley Rapid Composting method takes only 18 days for composting to occur. The study also revealed that compost can be used to fertilize plants as a substitute for chemical fertilizer as the researchers observed that the plants were green and healthy after three weeks of compost application on plants. The study also revealed that food wastes can be converted to compost thereby eliminating the combustion of food wastes which can lead to air pollution and depletion of the ozone layer

1. Composting food waste should be adopted by households in Nigeria as a means of fertilizing plants in gardens.
2. It is also recommended that composting in the communities should be undertaken in households by different age groups using simple implements.
3. Home Economist should learn how to produce compose from food waste to fertilize plants in the home garden
4. The compost also be packaged and sold in kilograms during the dry season to supply manure to the farms around the metropolis.

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