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Research Paper

Composting Water Hyacinth to Produce Organic Fertilizer; A Case of Kontagora Reservoir in Niger State, Nigeria

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ABSTRACT:*To overcome the danger of agrochemicals as fertilizers for the growth of crops, the agro scientists are working on bio-fertilizers and has come out with a new idea of using water hyacinth. Water hyacinth are available in many lakes, water ponds and such like other water bodies. Water hyacinth (*Eichhorniacrassipes*) is a free floating freshwater plant of the family Pontederiaceae that has proven to be a significant economic and ecological burden to many water bodies in Nigeria including the Kontagora reservoir. The objective of the study is to produce organic fertilizer from harvested water hyacinth from Kontagora reservoir. The fertilizer can be used by farmers around the lake and its environs in crop production especially rice and vegetable farming which is more common around the lake.*

A compost pit with dimensions of 5M x 3M x 0.5M was dug in a shaded place and in 4 places at layout site near the Kontagora reservoir which is the experimental site.

The chopped water hyacinth was filled into three of the compost pit alongside with the microbial consortia of pure culture isolates of Trichoderma virideand pure culture isolates of Pleurotussajor-cajuwhich are bio-fungicide and bio-degradation microbes respectively following the standard scientific procedures and the forth pit without the microbial consortia which serves as the control. Water was sprinkled as necessary to maintain a moisture level of 50 to 80 percent and thereafter, the surface of the heap was covered with a thin layer of soil.

Pits 1, 2 and 3 observed higher temperature compared to the control pit due to the presence of microbial consortia and higher rate of degradation and decomposition of water hyacinth as compared to the control pit which lacks a peculiar biological activity of microorganisms.

Percentage decrease in moisture content during the degradation and decomposition especially from the third day to the eighteenth day justified the higher temperature evaluation. Lower initial pH were observed in all pits especially during the nitrification process. pH decreases and pH values of the compost were directly related to nitrification. The full dark mass of compost was observed from the thirty-sixth day as an evidence of the full maturity of the compost and ready for use as fertilizers for soil amendment to enhance crop productivity in the riparian community and beyond.

It is recommended that the collected and stored compost samples should be analyzed for the following parameters; pH, EC, Ash, Total Nitrogen, NH_4-N and NO_3-N, TOC, Available and Total phosphorus, Potassium and Sodium and Calcium, Trace elements including Fe, Pb, Cr, Cu, Mn, As, Zn and Cd. This will give a detail information about the mineral information of the compost manure.

Other invasive aquatic plants such as Typha species should be composted in similar manners to find out if they are also useful in economical compost manure making. Composting invasive aquatic plants alongside other waste materials such as cattle dung, saw dust, rice straws etc. in experiments should also be conducted to investigate their economic advantages

KEYWORDS: *water hyacinth, organic fertilizer, kontagora reservoir, crop production.*

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I. INTRODUCTION

Chemical fertilizer which is readily available has been the alternative source of improving soil condition for crop production around water bodies (Omwoyo2012). The repeated use of chemical fertilizer in the catchment areas and around water bodies has led to eutrophication of the water bodies causing the temperature to rise in the process affecting most freshwater animals by causing ecological and socio- economic problems, death of fish and other creatures in the water ecosystem. Omwoyo (2012). There is therefore an urgent need to revolutionize the agricultural systems by using alternative ecologically friendly and sustainable source of soil nutrients.

To overcome the danger of agrochemicals as fertilizers for the growth of crops, the agro scientists are working on bio-fertilizers and has come out with a new idea of using water hyacinth. Water hyacinth are available in many lakes, water ponds and such like other water bodies. Water hyacinth (*Eichhorniacrassipes*) is a free floating freshwater plant of the family *Pontederiaceae* that has proven to be a significant economic and ecological burden to many water bodies in Nigeria including the Kontagora reservoir.

Water hyacinth (*Eichhorniacrassipes*) has been called the world's worst aquatic weed. It is capable to double its biomass in as little as five days.It grows in mats up to 2 meters thick which can reduce light and oxygen, change water chemistry, affect flora and fauna and cause significant increase in water loss due to evapotranspiration.It has proliferated in many areas and can now be found in all water bodies across Nigeria.

Kontagora Reservoir was created with major objective of providing domestic water to Kontagora town and its environment, however, fishing and irrigation have become other established uses of the reservoir.Water hyacinth is now gradually taking over the surface of the water body and causing menace which is gradually sabotaging the economic use of the reservoir. Composting this weed is suggested to overcome the problem of ‘water hyacinth’. The cost of inorganic fertilizers has also been in upward trend making it unaffordable by many small holder farmers (Argaw 2012). To enhance food crop production, there is need to adopt cheaper and environmentally friendly means of improving soil fertility. (Otieno*et al* 2009). Branched roots in water hyacinth can absorb plant nutrients and keep them into its trunks and leaves, therefore composting such plants can produce manure of high organic matter to improve the physical properties of soil. Also to improve soil structure, ventilate the soil and make it easy for water percolating through soil.Decomposition of this plant can be a sustainable source of organic fertilizer considering its high turnover.

The objective of the study is to produce organic fertilizer from harvested water hyacinth from Kontagora reservoir. The fertilizer can be used by farmers around the lake and its environs in crop production especially rice and vegetable farming which is more common around the lake.

II. METHODOLOGY

Establishment of a Simple Composting Facility: A compost pit with dimensions of 5M x 3M x 0.5M was dug in a shaded place and in 4 places at layout site near the Kontagora reservoir which is the experimental site.

Harvesting of Water Hyacinth: The water hyacinth was harvested manually from the Kontagora reservoirand transported to the experimental site.The fresh water hyacinth was then chopped into small pieces of about 5-10 cm in length using a chaff cutter to increase the surface area for microbial action. These was then spread and sun-dried for three days before being filled into the compost pit.

Production of Organic compost from water hyacinth: The chopped water hyacinth was filled into three of the compost pit alongside with the microbial consortia of pure culture isolates of *Trichodermaviride*and pure culture isolates of *Pleurotussajor-caju*which are bio-fungicide and bio-degradation microbes respectively following the standard scientific procedures and the forth pit without the microbial consortia which serves as the control. Water was sprinkled as necessary to maintain a moisture level of 50 to 80 percent and thereafter, the surface of the heap was covered with a thin layer of soil.

Monitoring and Data collection: Turning of the compost was done at designated intervals to reduce the compaction and improve aeration of the composting materials which enhances further decomposition. Turning also helped to reduce the moisture of the composting materials. The moisture was measured using a soil moisture meter.The pile was turned thoroughly on the 21st day and continuously with one week interval. Temperature, moisture content and pH data were recorded at 3 days intervals and throughout the experiment which lasted for 42 days.

Water Hyacinth Compost Analysis: Compost samples for nutrient analysis was collected at weekly intervals from all experimental compost pits to monitor changes in the compost properties with time in order to determine the quality and maturity of the compost. A homogenized composite sample of about 100 g was kept at 4^oC. The process was repeated until the heaps turned fully into a dark mass. The water hyacinth compost collected at weekly intervals from the pit waskept for laboratory analysis.

Data analysis: All results reported are the means of three pits as replicates and also the control pit. The results were statistically analyzed at $P = 0.05$ using one-way analysis of variance (ANOVA) and Tukey's HSD test was used as a post-*hoc* analysis to compare the means (SPSS Package, v. 16).

III. RESULTS AND DISCUSSIONS

Temperature: The variation in temperature of composting materials with time is illustrated in Figure 1. The temperature determines the rate at which many of the biological processes took place and it plays a selective role on evolution and succession on the microbiological communities (Hassen, 2001). Pit 1, 2 and 3 containing the microbial consortia of pure culture isolates of *Trichoderma viride*and pure culture isolates of *Pleurotussajor-caju* reached 60°C (maximum in all the compost pits) and enters into thermophilic phase within a day and the next six days indicating a quick establishment of microbial activities. Higher rise in temperature at the beginning of composting was attributed to higher content of easily biodegradable carbon and bio-degrading agents (Kalamdhad and Kazmi, 2009).Afterwards cooling period was observed until the end of the composting process. The control pit shows a maximum temperature of 52.3°C which was the highest within the first six days and later maintained a lower temperature averaged at 30°c till the end of composting time similar to pit 1, 2 and 3.

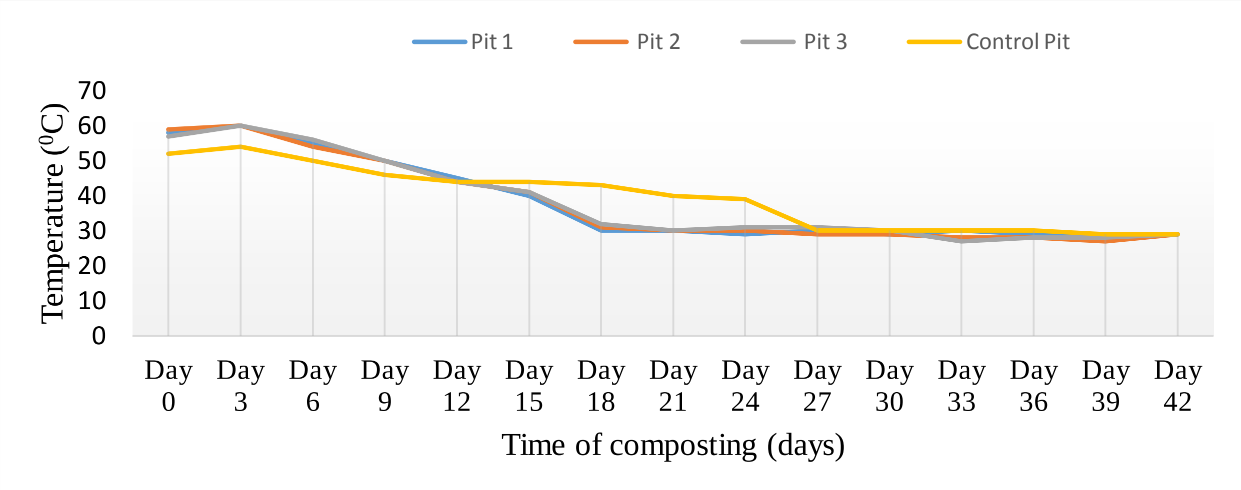

Figure 1: Temperature variations of composting mixtures

Moisture Content: Moisture loss during the composting process can be viewed as an index of decomposition rate, since heat generation which accompanies decomposition drives vaporization or moisture loss (Liao *et al.*, 1996).Higher initial moisture content of 80.5% was observed at the beginning due to large proportion of water and water hyacinth which further dropped to an average of 47.3% at the end of 42 days of pile composting.

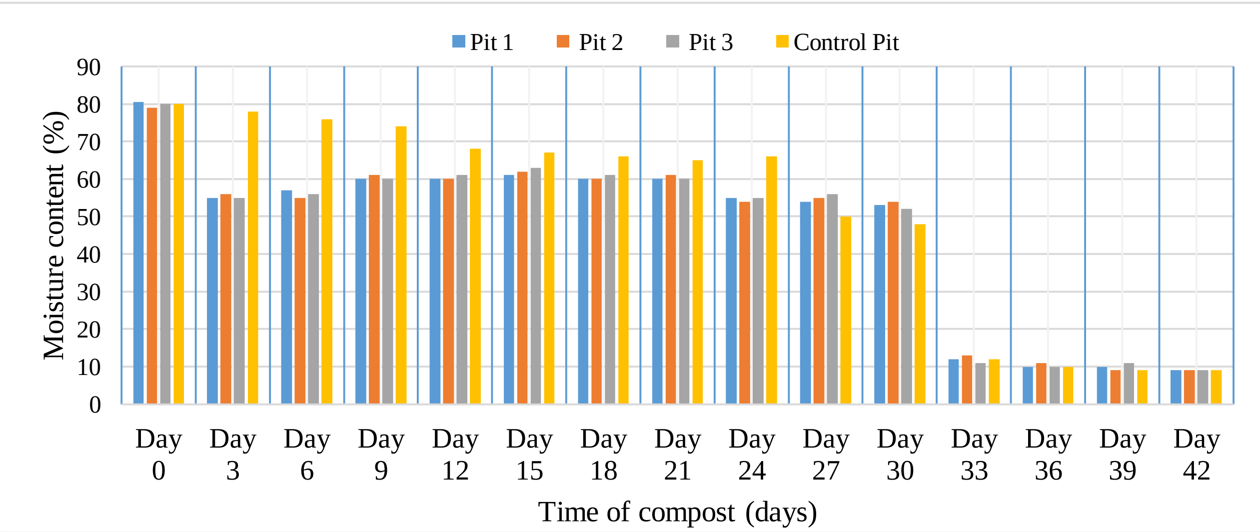

Figure 2: Percentage moisture content variations of composting mixtures

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pH: Table 1 shows the results of the monitored pH of the composting mixtures. During the nitrification process, the nitrifying bacteria lower the pH of the medium due to the liberation of hydrogen ions and once nitrification had begun after the thermophilic stage, pH decreases and pH values of the compost were directly related to nitrification as described by Sanchez-Monedero*et al*., 2001. As composting proceeds, the organic acids become neutralized and compost material tends toward a neutral pH, this observation is in agreement with Ko*et al.*, 2007. Similar observations were found in all trials as pH reduced during initial 6 days, further increased up to 8 from the 27th day. Increased rates of aeration will tend to decrease CO_2 level in the compost, which in turns will tend to increase pH (Haug,1993). Lower initial pH were observed in the control pit which could be due to higher amount absence of the microbial consortia. Significant differences in pH were observed between the pits ($P < 0.05$).

Days	Pit 1	Pit 2	Pit 3	Control Pit
Day 0	7.3±0.3abc	7.3±0.1ab	7.2±0.1abc	7.3±0.1ab
Day 3	7.0±0.2a	7.1±0.3ab	7.2±0.3bc	7.1±0.2b
Day 6	7.1±0.2ab	7.2±0.3ab	7.2±0.1abc	7.3±0.2a
Day 9	7.4±0.3abcd	7.3±0.3abcd	7.2±0.2abc	7.3±0.2bc
Day 12	7.5±0.1abcd	7.5±0.2ab	7.5±0.3bc	7.4±0.3b
Day 15	7.5±0.2bcd	7.5±0.2bcd	7.5±0.3abc	7.5±0.1bc
Day 18	7.6±0.3bcde	7.5±0.2abc	7.5±0.1bc	7.5±0.2bc
Day 21	7.7±0.2bcde	7.8±0.2bcd	7.8±0.1bc	7.8±0.3b
Day 24	7.8±0.1cde	7.7±0.3cd	7.6±0.3cd	7.5±0.3cd
Day 27	8.1±0.1de	8.2±0.3cde	8.3±0.2cd	8.4±0.2d
Day 30	8.2±0.2e	8.3±0.2be	8.2±0.2bc	8.3±0.2c
Day 33	8.3±0.2e	8.3±0.1bcd	8.3±0.2cd	8.4±0.2cd
Day 36	8.2±0.1de	8.1±0.1cd	8.2±0.1cde	8.1±0.1c
Day 39	8.4±0.1de	8.3±0.1ab	8.3±0.3ab	8.1±0.3bc
Day 42	8.3±0.1de	8.4±0.1cd	8.2±0.3bcd	8.1±0.2cd

Mean value followed by different letters in columns is statistically different (ANOVA; Tukey's test, $P < 0.05$)

Table 1: pH of composting mixtures

Plate 1: Compost pit

Plate 2: Harvested Water Hyacinth

Plate 3: Chopped water hyacinth.

Plate 4: Spreading chopped plant in compost pitPlate 5: Application of microbial consortia

Plate 6: Water application for moisturePlate 7: Surface covered with thin layer of soil.

IV. CONCLUSIONS AND RECOMENDATIONS

Pits 1, 2 and 3 observed higher temperature compared to the control pit due to the presence of microbial consortia and higher rate of degradation and decomposition of water hyacinth as compared to the control pit which lacks a peculiar biological activity of microorganisms. Percentage decrease in moisture content during the degradation and decomposition especially from the third day to the eighteenth day justified the higher temperature evaluation. Lower initial pH were observed in all pits especially during the nitrification process. pH decreases and pH values of the compost were directly related to nitrification. The full dark mass of compost was observed from the thirty-sixth day as an evidence of the full maturity of the compost and ready for use as fertilizers for soil amendment to enhance crop productivity in the riparian community and beyond.

It is recommended that the collected and stored compost samples should be analyzed for the following parameters; pH, Electrical conductivity (EC) (1:10 w/v waste:water extract), Ash (550°C for 2 h) (loss on ignition), Total nitrogen using the Kjeldahl method, NH_4-N and NO_3-N using KCl extraction, Total organic carbon (TOC) to be determined by Shimadzu (TOC-VCSN)Solid Sample Module (SSM-5000A), Available and Total phosphorus (acid digest) using the stannous chloride method (APHA, 1995), Potassium and Sodium and Calcium (acid digest) using flame photometry, Trace elements including Fe, Pb, Cr, Cu, Mn, As, Zn and Cd (acid digest) and analyzed using atomic absorption spectroscopy (APHA, 1995). This will give a detail information about the mineral information of the compost manure.

Other invasive aquatic plants such as Typha species should be composted in similar manners to find out if they are also useful in economical compost manure making. Composting invasive aquatic plants alongside other waste materials such as cattle dung, saw dust, rice straws etc. in experiments should also be conducted to investigate their economic advantages.

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