INFLUENCE OF PHYSICOCHEMICAL AND MICROBIOLOGICAL PROPERTIES ON THE COMPOSTING OF AGRO WASTES USING COW DUNG AS A BOOSTER

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ABSTRACT

The influence of physicochemical and microbiological properties on composting of agro wastes using cow dung as a booster was evaluated. The physicochemical parameters measured include pH, temperature and moisture. Titrimetric and spectrophotometric measurements of chemical nutrients as well as microbial assay using spread plating technique on several selective media were done. The results of pH, temperature and moisture content revealed lower pH (acidity) to higher pH (alkalinity) (7.5 – 9.0), slight temperature increased (24.9 – 27.3 °C), increased (20.33 – 66.00 %) and later declined in moisture content. The result of the chemical composition revealed significant increase in all nutrients except potassium with slight decrease (5.74 – 5.06 ppm). The result of the microbial analysis revealed that there were increased microbial count (0.413 X 10^5 – 6.78 X 10^5 cfu/ g) for all isolated microbial groups except total bacteria, fungi and anaerobes with numerous count. The cow dung which acts as booster improved the early maturity and nutrient contents of the composting depending on the levels of application. Statistically, there were significant differences detected among the four compost treatments throughout the composting period at p<0.05. Thus, the significant transformation of these organic materials into resourceful dark brown composts made composting a promising waste recycling process and promoter of soil quality.

Keywords: Agro wastes, Environmental pollution, Composting, Microbes, Pollution control

INTRODUCTION

Soil fertility management is one of the main challenges to food security in several parts of Sub-Saharan Africa, mostly, among indigent farmers; and has led to the present food crises in numerous rural households. This is mostly ascribed to the reduced soil productiveness and speedy exhaustion of nutrients on farmed fields due to negative intrinsic soil features. The condition is aggravated by farmers' wrong soil nutrients management practices and other environmental hazards such as erosion that worsen soil degradation (Masowa *et al*., 2015).

Composting can also be said to be controlled decay of organic matter in a warm moist environment by action of bacteria, fungi and other organisms. The process can either be anaerobic or aerobic, but it is much faster and less odouriferous if done aerobically (Adegunloye and Adetuyi, 2009). Composting is a dynamic process which occurs quickly or slowly depending on the process used (Adegunloye *et al*., 2007). Various factors are necessary for successful composting such as type of organic material or food factor, carbon to nitrogen ratio, air, moisture, temperature, particle size, volume factor and rate of turning (Adegunloye and Adetuyi, 2009). Cow dung

manure is a nitrogen rich material and is of economic importance as fertilizer, feed supplement or as energy sources. Cow dung manure has been collected and used to supply nitrogen, potassium, phosphorus and calcium to the soil for plant production. Cow dung has a relatively high carbon to the nitrogen ratio (Adegunloye *et al.,* 2007).

Adegunloye and Adetuyi (2009) reported that the bacterial and fungal counts in compost ranged from 4.0 x 10^6 to 1.3 x 10^{10} cfu/ mL and 2.0 x 10^4 to 8.0 x 10^7 cfu/mL respectively. The temperature of decomposing materials ranged from 26 °C to 43 °C, pH ranged from 4.37 to 9.50, and moisture content ranged from 26.19 to 58.14 %. Few of the microorganisms like *Klebsiella pneumoniae* and *Proteus mirabilis* (Enterobacteriaceae) isolated in the early weeks of composting are associated microbes with pig and cow dungs used as booster in composting pile. Bacteria and fungi are the microorganisms usually isolated from compost. The groups of microorganisms isolated from the compost were able to survive under the mesophilic range of temperature, fairly neutral pH and moderately high moisture content of the compost. Although, reports abound on composting of food and agro wastes using pig and cow dungs, there is still need to explore cheaper, available and quality composting materials with better soil fertility enhancement. The present study was undertaken to examine the influence of physicochemical and microbiological properties on composting of agro wastes using cow dung as a booster.

MATERIALS AND METHODS

Sample Collection: The organic waste materials used in the composting process include: potato peels, cassava peels, plantain peels, saw dusts, Bambara (okpa) leaves, ground nut wastes, and cow dung. Cow dung was collected inside a sterile polythene bag from Abattoir of Eke Uli market. The cassava, potato and plantain peels were collected from the sellers at Chukwuemeka Odumegwu Odumegwu University (COOU) market, Uli Campus. Bambara leaves were collected from okpa sellers along Onitsha-Owerri Expressway in Ihiala environs. Ground nut wastes were collected from the sellers and the University (COOU) dumpsites and environs while saw dusts were collected from timber sheds and local carpentry workshops at Ihiala and Uli, respectively. All these sample collection centres mentioned above are located in Ihiala LGA Anambra State, Nigeria.

Compost Preparations: All the non-compostable materials contained in the waste were sorted out and not included in the compost preparation (Adegunloye *et al*., 2007; Adegunloye and Adetuyi, 2009). The waste materials with the exception of the cow dung were shredded to smaller sizes with a shredder. Five hundred gram (500 g) of each of the waste materials was measured with an electronic weighing balance and put into four compost bin set ups designated: Compost, Compost + 500 g Cow Dung, Compost + 1 kg Cow Dung and Compost + 1.5 kg Cow Dung. The waste materials in the compost were then thoroughly mixed with cow dung in the ratio of 1:2:3 (500 g of cow dung to the first bin, 1 kg to the second and 1.5 kg to the third compost bin set ups). A control was also set up in which 500 g of each waste materials were mixed together in a compost bin to form a compost mound without the addition of cow dung. The content of the compost bins were mixed properly and then were left open for proper aeration as well as allowed to decompose for the period of 6 weeks. The decomposing materials were frequently watered and turned according to Adegunloye *et al*. (2007) and Adegunloye and Adetuyi (2009).

Composting Analysis: Samples were collected from the various decomposing set ups: Compost, Compost + 500 g Cow Dung, Compost + 1 kg Cow Dung and Compost + 1.5 kg Cow Dung, respectively using spatula sterilized with 70 % ethanol. The sterile spatula was used to mix the decomposing materials slightly, transferred into sterile wide - mouthed plastic containers, sealed tightly and labelled appropriately before being taken for analysis. The physicochemical and microbiological

analyses were performed at seven days intervals for six weeks.

Physicochemical Parameters

pH: By adopting the method described by Association of Analytical Chemists (AOAC) (2012), a bench pH meter was used by firstly standardizing it against standard buffer solutions of known pH values. The electrode of the meter was then washed with distilled water and then immersed in the sample contained in a beaker. The pH of the samples were then read on the pH meter scale and noted.

Temperature: The temperature of the compost samples was determined according to Adegunloye and Adetuyi (2009) using a mercury in glass thermometer graduated in degree centigrade by dipping the thermometer weekly into the compost and taking the readings for each treatments.

Zinc: This was determined by dried digestion and atomic absorption spectrophotometer according to the method of the American Public Health Association (APHA, 2012).

Nitrogen: The nitrogen content was determined using Kjedhal technique as described by AOAC (2012).

Total organic carbon: The total organic carbon was determined colorimetrically using the method described by AOAC (2012).

Potassium, calcium and magnesium: These were determined after extraction using Varian AA240 atomic absorption spectrophotometric technique as described by AOAC (2012).

Phosphorus: The phosphorus content of the samples were determined spectrophotometrically using the standard method described by AOAC (2012).

Moisture content: The moisture contents were determined by dry weight procedure in oven using the standard method described by AOAC (2012).

Microbiological Analysis

Preparation of media: The media used for hydrocarbon-utilizing bacteria, actinomycetes, *Salmonella* and *Shigella, E. coli, P. aeruginosa, S. aureus, C. albicans*, total coliform, total heterotrophic bacteria, total anaerobes, total fungi and total yeasts are Mineral Salt Medium (MSM), International Streptomyces Project 2 (ISP 2), Salmonella and Shigella agar, Eosin Methylene Blue agar (EMB), Cetrimede agar (CA), Manitol Salt agar (MSA), Corn Meal agar (CMA), MacConkey agar (MCA), Nutrient agar (NA), potato Dextrose agar (PDA) and Malt Extract agar (MEA). All the media were prepared, sterilized and used according to the Manufacturer's instruction (Adegunloye *et al*., 2007; Geetha and Fulekar, 2008; Adegunloye and Adetuyi, 2009; Orji *et al*., 2012).

Dilution technique and isolation: A ten-fold serial dilution of the samples were carried out by adding 1 g of compost samples aseptically into test tubes containing 9 mL of 0.85 % of normal saline solution labeled 10^{-1} to 10^{-3} dilutions with the aid of a sterile pipette in a repeated manner. With another sterile pipette, 0.1 mL aliquots of 10^{-2} dilutions (dilutions that produce colony counts between 30 - 300 colonies) were aseptically spread on the solidified media in triplicate using a glass spreader. The mineral salt inoculated plates contained engine oil soaked filter paper on the covers which serves as source of carbon and energy and all plates were incubated by inversion in the dark at 25 ± 2 °C for 24 – 72 hours (Adegunloye *et al*., 2007; Geetha and Fulekar, 2008; Adegunloye and Adetuyi, 2009; Orji *et al*., 2012).

Enumeration of Bacteria and Fungi: The bacterial and fungal populations present in the compost treatments were determined by adopting the methods of Adegunloye *et al*. (2007), Geetha and Fulekar (2008), Adegunloye and Adetuyi (2009) and Orji *et al*. (2012). After incubation, the developed colonies were counted in the plates using electronic colony counter and the average number of colonies per plates was determined from the formula below.

The numbers of bacterial and fungal groups from each compost treatments were expressed as:

$$CFU/g = \frac{\text{Number of Colonies X Dilution Factor}}{\text{Amount Used}}$$

Analysis of Data: Statistical analyses were carried out using statistical package for social sciences (SPSS, Version 20.0). T-test and Analysis of Variance (one-way ANOVA) were carried out at 95 % level of confidence limit. The obtained means were compared to determine the significance levels among the various compost treatments (Orji *et al.*, 2012).

RESULTS AND DISCUSSION

Composting provides a means of recycling solid wastes and has the potential to manage most of the organic material in the waste stream including restaurant waste, leaves, farm wastes, animal manure, paper products, sewage sludge and domestic wastes. The organic waste materials mainly of animal and plant origin are potential sources of organic matter and plant nutrient (Adeniran *et al.,* 2003) and the benefits derived from the utilization of this organic materials ranges from improvement of soil fertility to a reliable means of waste transformation (Adegunloye *et al.*, 2007).

The result of weekly pH of decomposing waste materials is shown in Figure 1.

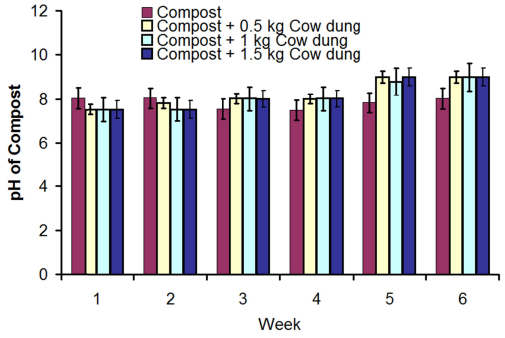

Figure 1: Weekly pH of decomposing waste materials

From the result, the pH increases from 7.5 – 9.0 as the week of composting progressed from week 1 to week 6. The pH at early and later (maturity) stages of the composting indicates neutral to alkaline nature of the composting materials. Statistically, there were significant differences among the means of the four compost treatments at $p<0.05$ using one-way ANOVA. The result is similar to the work done by Adegunloye and Adetuyi (2009), who reported that the pH values of the compost were observed to consistently increase as the composting process progresses. The pH of compost in the first week of composting was considerably low indicating the acidic nature of the organic materials. The pH values were observed to significantly increase by second week of composting crossing over to the alkalinity range of the pH scale. These alkalinity natures of compost were observed with little variations throughout the composting process to maturity.

The result of the weekly temperature (°C) of the decomposing waste materials is shown in Figure 2.

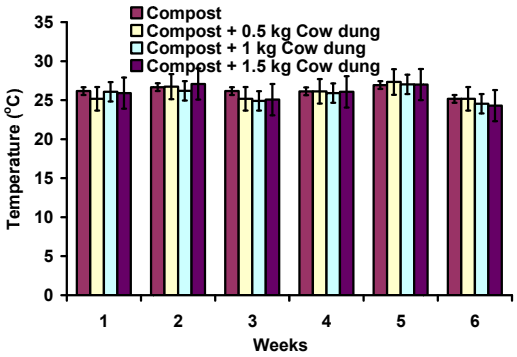

Figure 2: Weekly temperature (°C) of the decomposing agro wastes

There was increase in temperature from week 1 to week 2 (25.2 °C – 27.0 °C), then decrease (27.0 °C – 24.9 °C) for 2-3 weeks, increase from week 3 to week 5 (24.9 °C – 27.3 °C), and later decrease (27.3 °C – 24.3 °C) for 5-6 weeks. From this result, it is evident that the ambient temperature range of the composting support mesophiles which could be the most prevalent microbes in this composting. Also, the changes observed could be attributed to increase and decrease in metabolic activities in the compost. Statistically, there were significant differences among the means of the four compost treatments at $p<0.05$ using one-way ANOVA. Previous study reported that the

temperature pattern for the compost varies somewhat with the size of the pile, the ambient temperature, the moisture content, the degree of aeration and the nature of composting material. The temperature conditioning of composting determines the duration of decomposition and maturity of compost (Adegunloye and Adetuyi, 2009).

The results of chemical characteristics of decomposing waste materials before and after composting are presented on Figure 3.

From these results, there were increase in nitrogen (7.34–18.4), phosphorus (1.76 – 10.3), calcium (4.85 – 7.42), magnesium (10.0 – 10.28) and zinc (0.98–2.50), increase and decrease (1.30 – 2.37) in percentage carbon and decrease in potassium contents (5.74–5.06) of decomposing waste materials after six weeks of composting. These changes could be due to the addition of cow dung to the compost which releases a lot of these nutrients during the decomposition. Statistically, there is significant differences between and among the means of the four compost treatments before and after at $p<0.05$ using T-Test and one-way ANOVA. Previous study reported that during the initial stage of composting, the water extractable P and K as well as Cu and Zn of compost heaps ranged from 3.96 to 6.28 mg/ g, 5.59 to 9.30 mg/ g, 6.20 to 28.68 ppm and 21.47 to 69.22 ppm respectively. At mature stage, these levels increased and decreased from 10.62 to 17.75 mg/ g for extractable P, 15.29 to 29.36 mg/ g for extractable K, 1.64 to 5.90 ppm for water extractable Cu and 6.01 to 12.22 ppm for water extractable Zn, respectively (Selim *et al*. 2012).

The result of weekly moisture content of decomposing waste materials is shown in Figure 4. From the result, the moisture content values increased (20.33 – 53.3) from week 1 - 3 and declined (53.3 – 37.3) at week 4 and later increased (37.3 – 66.0) at later stage before reaching maturity. These changes could be attributed to the addition of water which enhanced microbial decomposing activities in a moist condition. Statistically, there was significant differences among the means of the four compost treatments at $P < 0.05$ using one way ANOVA. The result is similar to the work done by Adegunloye and Adetuyi (2009) who reported that the moisture content values of the composting increased gradually as the decomposing waste materials matured indicating that composting microorganisms utilize the moisture and that they thrive in the moist conditions. The considerably large surface areas of the organic materials made the microorganisms to digest more materials, multiply more rapidly and generate more heat which invariably speed up the composting process.

Microbial load of the composting was observed to increase any time the composting were aerated by turning suggesting that the turning procedure increased oxygen level in the composting pile which favours the growth of microorganisms. The results of the microbial counts of decomposing waste materials during 1 - 6 weeks of composting are presented on Tables 1 – 6. From the results, there were increase ($0.413 \times 10^5 – 2.86 \times 10^5$ cfu/ g) on the microbial counts for the first three weeks and later declined ($2.86 \times 10^5 – 2.70 \times 10^5$ cfu/ g) from week 3 – 4 with the exception of fungi, bacteria and anaerobes with numerous counts and later increased ($2.70\times10^5 – 9.58 \times 10^5$ cfu/ g) from week 4 – 6 for *S. aureus,* coliform*, E. coli,* actinomycetes*, Candida albicans,* mould, fungi, bacteria, anaerobes and hydrocarbon utilizing bacteria, *Salmonella-Shigella* and *P. aeruginosa* counts. The reasons for these changes might be due to the synthesis and utilization of the various nutrients by microorganisms and favourable environmental conditions present in the composts. The groups of microorganisms isolated in the early and later weeks of composting could be suggested to be accompanying microbes with the cow dung used as booster in composting pile. There was no growth (NG) detected in the hydrocarbon utilizing bacteria count in the first week showing that the hydrocarbon could be toxic to the composting organisms and the organisms are still adapting to it. Also, the fact that hydrocarbon utilizing bacteria were isolated from week 2 to 6 shows the potential of the compost to stimulate biodegradation of hydrocarbons.

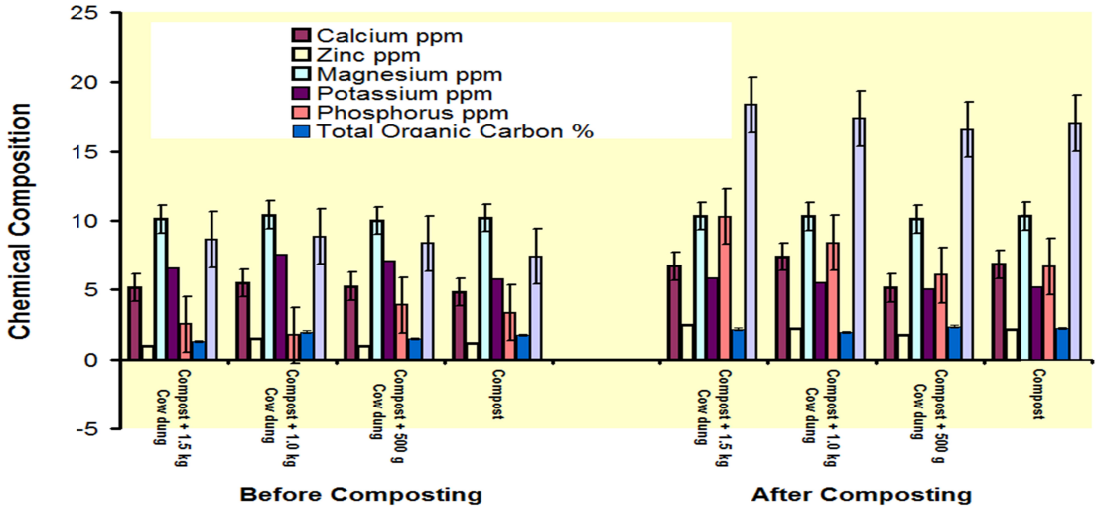

Figure 3: Chemical characteristics of decomposing agro wastes before and after composting

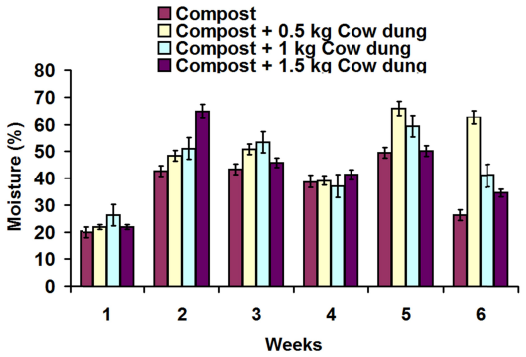

Figure 4: Weekly moisture content of decomposing agro wastes

Statistically, there were significant differences among the means of the four compost treatments at $p<0.05$ using one-way ANOVA. Previous study reported that there was increase in the microbial growth in the first three weeks of composting due to the synthesis and utilization of the various nutrient as well as favourable environmental conditions present in the composting by microorganisms (Hargerty *et al*. 1999; Adegunloye and Adetuyi, 2009).

Conclusion: In general, the transformation of different organic wastes materials of food, plant and animal wastes into matured high quality dark brown composts were enhanced by the actions of microorganisms which were affected by appropriate environmental conditions and factors such as pH, temperature, moisture content and chemical composition of the organic materials evaluated in this study. The cow dung which acts as booster improved the early maturity and nutrient contents of the composting depending on the levels of application. Statistically, there was significant differences detected among the four compost treatments throughout the composting period at $p<0.05$. Thus, this significant transformation of these organic materials into resourceful dark brown composts made composting a promising waste recycling process.

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Table 1: Microbial counts of decomposing waste materials after one week interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	1.62 ± 0.026	1.98 ± 0.010	0.63 ± 0.001	1.20 ± 0.005
Coliform	0.81 ± 0.003	.44 ± 0.032	0.86 ± 0.003	4.39 ± 0.040
E. coli	1.77 ± 0.015	1.75 ± 0.027	1.66 ± 0.010	7.39 ± 0.068
Actinomycetes	0.00 ± 0.00	1.00 ± 0.007	0.90 ± 008	1.12 ± 0.005
Candida albicans	0.48 ± 0.020	0.67 ± 0.002	3.91 ± 0.030	0.59 ± 0.005
Mould	2.33 ± 0.025	4.11 ± 0.038	0.85 ± 0.003	2.77 ± 0.015
Fungi	2.24 ± 0.010	4.38 ± 0.040	1.32 ± 0.030	4.00 ± 0.038
Bacteria	2.01 ± 0.008	4.81 ± 0.040	0.57 ± 0.010	6.10 ± 0.056
Anaerobes	2.34 ± 0.050	2.33 ± 0.020	2.81 ± +0.025	5.16 ± 0.048
HUB	NG	NG	NG	NG
Salmonella shigella	0.77 ± 0.002	0.97 ± 0.020	0.77 ± +0.010	1.85 ± 0.011
P. aeruginosa	0.93 ± 0.048	0.41 ± 0.005	0.62 ± 0.001	1.49 ± 0.020

NG = No growth; HUB = Hydrocarbon utilizing bacteria

Table 2: Microbial counts of decomposing waste materials after two weeks interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	0.47 ± 0.020	1.42 ± 0.020	0.48 ± 0.015	1.17 ± 0.025
Coliform	1.96 ± 0.020	1.20 ± +0.010	1.00 ± 0.064	1.62 ± 0.010
E. coli	0.78 ± 0.010	0.56 ± 0.015	1.62 ± 0.015	1.00 ± 0.010
Actinomycetes	4.24 ± 0.040	0.51 ± 0.02	4.00 ± 0.039	5.44 ± 0.048
Candida albicans	1.00 ± 0.015	0.65 ± 0.025	NG	0.70 ± 0.015
Mould	3.50 ± .0.029	3.79 ± 0.029	4.00 ± 0.038	5.20 ± 0.0480
Fungi	4.10 ± 0.040	5.11 ± 0.048	6.30 ± 0.058	2.72 ± 0.015
Bacteria	3.23 ± 0.029	0.89 ± 0.015	3.20 ± 0.029	0.47 ± 0.020
Anaerobes	0.75 ± 0.015	1.07 ± 0.025	0.72 ± 0.015	0.57 ± 0.020
HUB	0.47 ± 0.015	0.45 ± 0.010	0.77 ± 0.010	0.87 ± 0.015
Salmonella shigella	0.63 ± 0.020	2.02 ± 0.055	2.14 ± 0.010	2.26 ± 0.015
P. aeruginosa	0.41 ± 0.015	3.70 ± 0.028	0.54 ± 0.020	0.29 ± 0.0010

NG = No growth; HUB = Hydrocarbon utilizing bacteria

Table 3: Microbial counts of decomposing waste materials after three weeks interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	2.56 ± 0.020	1.59 ± 0.032	2.19 ± 0.030	2.34 ± 0.015
Coliform	1.51 ± 0.020	1.35 ± 0.020	1.17 ± 0.020	0.94 ± 0.020
E. coli	1.00 ± 0.015	1.11 ± 0.026	1.08 ± 0.045	1.37 ± 0.015
Actinomycetes	2.10 ± 0.005	2.12 ± 0.020	2.54 ± 0.020	2.29 ± 0.015
Candida albicans	3.10 ± 0.025	4.00 ± 0.038	5.00 ± 0.046	3.51 ± 0.029
Mould	3.67 ± 0.030	1.37 ± 0.025	3.70 ± 0.030	3.60 ± 0.030
Fungi	5.00 ± 0.048	0.72 ± 0.005	2.87 ± 0.020	4.10 ± 0.038
Bacteria	3.21 ± 0.028	4.00 ± 0.035	5.10 ± 0.048	5.00 ± 0.048
Anaerobes	3.40 ± 0.029	3.22 ± 0.028	4.31 ± 0.0390	3.20 ± 0.028
HUB	1.63 ± 0.020	2.14 ± 0.025	1.74 ± 0.015	1.51 ± 0.025
Salmonella shigella	0.90 ± 0.015	0.70 ± 0.015	0.71 ± 0.002	1.16 ± 0.025
P. aeruginosa	1.90 ± 0.051	0.66 ± 0.015	0.70 ± 0.015	0.97 ± 0.020

NG = No growth; HUB = Hydrocarbon utilizing bacteria

Table 4: Microbial counts of decomposing waste materials after four weeks interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	1.50 ± 0.010	1.30 ± 0.015	0.50 ± 0.026	1.10 ± 0.015
Coliform	0.50 ± 0.015	0.63 ± 020	2.70 ± 0.020	0.89 ± 0.020
E. coli	3.57 ± 0.030	5.18 ± 0.040	1.37 ± 0.010	4.31 ± 0.037
Actinomycetes	0.65 ± 0.015	2.65 ± 0.015	2.25 ± 0.020	1.14 ± 0.020
Candida albicans	0.46 ± 0.01	0.35 ± 0.010	1.07 ± 0.020	1.32 ± 0.010
Mould	1.60 ± 0.005	1.77 ± 0.020	1.82 ± 0.020	1.40 ± 0.010
Fungi	5.71 ± 0.049	1.47 ± 0.010	6.55 ± 0.058	6.16 ± 0.057
Bacteria	3.57 ± 0.030	3.54 ± 0.030	4.19 ± 0.038	4.31 ± 0.039
Anaerobes	6.63 ± 0.059	4.22 ± 0.038	4.40 ± 0.038	4.68 ± 0.039
HUB	5.65 ± 0.049	7.25 ± 0.069	6.18 ± 0.058	8.85 ± 0.079
Salmonella shigella	0.90 ± 0.052	0.97 ± 0.010	0.90 ± 0.015	0.30 ± 0.010
P. aeruginosa	0.66 ± 0.011	0.57 ± 0.020	2.65 ± 0.015	1.09 ± 0.036

NG = No growth; HUB = Hydrocarbon utilizing bacteria

Table 5: Microbial counts of decomposing waste materials after five weeks interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	1.70 ± 0.010	1.20 ± 0.005	1.40 ± 0.005	1.10 ± 0.05
Coliform	0.99 ± 0.015	1.60 ± 0.036	1.75 ± 0.015	1.29 ± 0.015
E. coli	1.50 ± 0.015	0.66 ± 0.010	1.40 ± 0.010	0.66 ± 0.010
Actinomycetes	1.71 ± 0.025	1.26 ± 0.020	1.28 ± 0.015	1.04 ± 0.015
Candida albicans	0.88 ± 0.020	1.60 ± 0.015	1.86 ± 0.020	1.45 ± 0.032
Mould	0.97 ± 0.020	0.80 ± 0.020	1.04 ± 0.041	1.04 ± 0.015
Fungi	3.10 ± 0.028	4.50 ± 0.39	3.91 ± 0.029	6.00 ± 0.057
Bacteria	4.30 ± 0.040	4.00 ± 0.038	5.00 ± 0.048	4.10 ± 0.038
Anaerobes	3.20 ± 0.028	3.45 ± 0.030	3.42 ± 0.029	6.71 ± 0.060
HUB	1.70 ± 0.020	2.00 ± 0.010	1.20 ± 0.005	2.10 ± 0.01
Salmonella shigella	1.76 ± 0.015	1.70 ± 0.010	1.48 ± 0.020	3.74 ± 0.030
P. aeruginosa	1.54 ± 0.041	1.49 ± 0.015	1.17 ± 0.015	1.83 ± 0.020

NG = No growth; HUB = Hydrocarbon utilizing bacteria

Table 6: Microbial counts of decomposing waste materials after six weeks interval (Cfu/ g x 10^5)

Organisms	Compost	Compost + 500 g Cow Dung	Compost + 1 kg Cow Dung	Compost + 1.5 Kg Cow Dung
S. aureus	0.92 ± 0.004	3.92 ± 0.032	1.04 ± 0.015	1.90 ± 0.051
Coliform	3.42 ± 0.030	6.00 ± 0.058	3.24 ± 0.029	3.90 ± 0.032
E. coli	4.00 ± 0.038	5.10 ± 0.049	3.40 ± 0.039	4.00 ± 0.038
Actinomycetes	3.59 ± 0.031	4.99 ± 0.040	3.20 ± 0.028	3.95 ± 0.033
Candida albicans	5.89 ± 0.052	6.20 ± 0.059	3.80 ± 0.032	4.78 ± 0.043
Mould	1.52 ± 0.025	5.00 ± 0.048	3.76 ± 0.031	4.10 ± 0.039
Fungi	4.21 ± 0.039	6.78 ± 0.059	4.57 ± 0.039	5.42 ± 0.049
Bacteria	3.56 ± 0.029	4.56 ± 0.039	3.21 ± 0.022	3.58 ± 0.029
Anaerobes	3.22 ± 0.0210	9.58 ± 0.089	7.65 ± 0.069	9.00 ± 0.088
HUB	2.69 ± 0.026	1.17 ± 0.005	2.23 ± 0.020	3.45 ± 0.029
Salmonella shigella	1.90 ± 0.002	0.38 ± 0.015	0.50 ± 0.011	0.72 ± 0.015
P. aeruginosa	0.81 ± 0.015	1.17 ± 0.010	6.54 ± 0.059	3.99 ± 0.031

NG = No growth; HUB = Hydrocarbon utilizing bacteria

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