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REGULAR ARTICLE

COMPARISON OF COMPOST MATURITY, MICROBIAL SURVIVAL AND HEALTH HAZARDS IN TWO COMPOSTING SYSTEMS

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ABSTRACT

Data collected on germination index, temperature, moisture content, pH, total viable count, total coliform count and total fungi count were determined during composting in HV and FA systems at VREL Farms for a period of thirteen weeks and analysed to ascertain the effects of temperature, moisture and pH on compost maturity and microbial survival. There were no significant differences in germination index, pH and moisture content values for both systems as ANOVA results at $\alpha = 5\%$ yielded p-values of 0.17, 0.98 and 0.13 respectively. Moisture content and pH values ranged between 40%-70% and 7.20 - 8.30 respectively. Temperature values recorded however were significantly different (p-value = 1.2×10^{-5}, $\alpha = 5\%$) in both systems and affected the microbial distribution during the process. The temperature recorded in HV and FA systems ranged between 45.19 ºC – 65.44 ºC and 29.00 ºC – 50.83ºC respectively. Germination Index values were >150% in different systems at the end of week 12. *Listeria spp*., known to be zoonotic, and *Staphylococcus spp*. survived in compost processed in FA system; and *Penicillium spp*. in both systems.

Keywords: viable count, coliform count, fungi count, passive aerated systems, active aerated systems

INTRODUCTION

Background

Composting is an aerobic and exothermic process used in treating biodegradable waste for use as a soil conditioner and fertilizer worldwide. In addition, it is also the most environmentally friendly method of waste treatment comparative to other known methods such as incineration, landfill and anaerobic digestion **(Eriksson, 2003)**. It is a process in which microorganisms degrade organic waste. As a microbial process, it is influenced by all factors that affect microbial life: temperature, pH, moisture, air (oxygen) and nutrients.

There are several systems used in composting of which the most common methods for composting include passive heaps, static heaps, windrows and in-vessel composting systems. All the different composting systems can be classified into two broad systems according to the mode of aeration: Passive aerated systems, these are given little attention; active aerated systems, those that are maintained through forced aeration or frequent mechanical turning **(Sherman, 2005)**.

During composting heat is released as a result the metabolic activities of microbes. The heat released increases the temperature of compost masses and consequently inactivates pathogens present. However, when excessive heat generated is not dissipated quickly, it leads to the drying of compost masses and killing of beneficial microbes, and thus, resulting in complete failure of the process **(Miller, 1993)**. Different systems would allow dissipation of the heat generated during the process at different rates depending on their designs; and this, affect the dynamics of compost microbial community. In the selection of composting systems for organic waste treatment, there is a need to consider systems' effectiveness in reducing or eliminating pathogens in the final product via temperature development: in order to prevent the penetration of pathogens into the food chain.

Although there are several parameters used in monitoring compost maturity such as temperature, oxygen uptake rate, C/N ratio among others, germination index is one of the most reliable method used in quantifying compost maturity. Germination index is a measure of the phytotoxicity and maturity level of compost. **Ikeda *et al.* (2006)** compared the germination index method with other methods, using both immature composts and mature composts sold as products and concluded that the germination index method is a highly

accurate maturity parameter, under the conditions of setting more than 150% as a maturity standard, using 5 days for seed cultivation. Thus, the rate of compost maturity is expected to differ in different systems as a result of variations in the factors that affect the compost process.

Problem Statement

Though compost microbial community comprises beneficial microbes for the degradation of organic waste, there are also harmful microbes that are pathogenic and zoonotic, which need to be inactivated at the end of the compost process to prevent their entry into the food chain, and thus eliminate the threats to animal and human health.
Temperature regulation in different composting systems is shown in literature as the most used and reliable indicator of compost safety, but literature however, reveals the lack of enough data on the inactivation of pathogenic microorganisms in different systems.

Objectives

The study seeks to quantify and identify the various microorganisms present in both systems from the start to the end of the composting process; and also determine the rate of maturity of compost in the systems. The results obtained would allow one to ascertain and compare the systems' rate of compost maturity; effectiveness and efficiency in inactivating pathogens present; and the possible health hazards likely to be presented to the public by the survived pathogens. The findings would help farmers and compost manufacturers to consider choosing appropriate composting systems to safeguard the safety of finished compost from pathogen penetration into the food chain. Also, it intends to inform all food handlers of the possible threats of the survived pathogens on human health.

Review of Literature

Several pathogens known to cause diseases and death in humans have been identified in manure and foodwaste. Some of these microorganisms include *Samonella spp., Listeria spp*. *Clostridium spp. Staphylococcus spp.*, *Escherichia spp*., *Aspergillus spp*. and *Penicillium spp.* For instance, *Listeria monocytogenes*, *Salmonella spp*. and *Escherichia coli* O157:H7 infections are important to food safety as these classes of pathogens combine to cause

approximately 1.5 million illnesses and 60% of all deaths related to foodborne illnesses **(Mead *et al.*, 1999)**. Esherichia *coli O157:H7* is responsible for 20000 cases of infection and 250 deaths per year in the United States as a result of diarrhoea and haemorrhagic colitis while Salmonella *spp.* caused human salmonellosis, which is associated with 2,000,000 infection cases and 50 to 2000 deaths per year **(Lung *et al.*, 2001)**. Since these microorganisms are found during composting, it becomes important to treat animal wastes and plant materials harbouring these pathogens, to limit the risks of pathogenic microorganisms entering the food chain via the use of the compost on the farms.

It is also important a system is able to churn out compost at high maturity rate as this gives a measure of compost stability and quality. Germination index gives a good measure of compost maturity and also shows the direct effect of the compost produced in the systems on seed germination and plant growth.

MATERIALS AND METHODS

The study was carried out at Volta River Estate Limited Farms (VREL), one of the leading organic banana and pine apple producing farms in the country. Compost materials included: River reed, harvested into canoes and brought to the site; banana stock, obtained from VREL Farms; cocoa seed husk, rice husk, cow and poultry manure, obtained from farms and households nearby. The composition of the feed stocks are given as follows: River Reed (RR)-75%, Clay(C)-10%, Banana Stalk/Stem (BS)-5%, Cow Manure/Dung (CM)-4%, Rice Chaff (RC)-4%, Cocoa Seed Husk (CSH)-1% and Poultry Manure (PM)-1%. A starter containing genetically modified organisms such as *Bacillus spp.* and *Corynebacterium spp.* was mixed in the proportion 500g: 40L (m/v) water and added to the feed stocks to facilitate the decomposition process.

Description of Compost Systems Understudy

Horizontal-Vertical Aeration Technology

The horizontal-vertical aeration technology is also known as the T-aeration. For the set-up, 6 in. diameter uPVC pipes with perforated holes were used to effect the passive aeration. The pipes are inverted T-shaped, it has perforations on the horizontal section allowing ambient air to move into the pile and that of the vertical, allow warm and waste

gases to exit compost mass. The dimension of the pile is: 6.8m (L) × 2.6 (B) m×1.7m (H); and is covered with the Toptex (fleece) sheet after mounting the piles. The vertical pipe was perforated to about 1.2m high from the bottom.

Forced Aeration Technology

This method uses an electrical blower controlled intermittently by timers (Timer ON – 2 minutes and Timer OFF -12 minutes) with a specified flow rate of 18m^3/min and power rating of 0.4kW. Air is blown through perforated pipes 3m long. The pile was mounted with dimensions as follows: 4m (L) ×2m (B) ×1.5m (H), with the same material composition which had been turned four (4) times with the Sandberger ST 300 pulled by 96HP tractor. The pile was mounted a day after turning the mixture.

Sampling of Compost Mass for Physico-chemical, Microbiological Analysis and Germination Index Determination

Compost masses were sampled at the top, middle and bottom locations in the different systems mounted weekly for laboratory study on moisture, pH and microbial analysis. However, temperature measurements of compost masses were done in situ. The samples taken were bulked to obtain a representative sample, packed with ice cubes in an ice chest and transported each and every week to the laboratory. The samples were kept in freezer at a temperature of 4ºC for a day before microbial analysis performed.

Germination Index Determination

Two sterile Petri-dishes were taken and labelled to represent the systems under study. 5 layers of filter paper pad were fitted into each Petri-dish and then wetted with 5ml of 1:10 compost aqueous extract from samples representative of each system. A third Petri-dish was taken and fitted with 5 layers of filter paper and distilled water used as the medium of wetting the filter paper pads to serve as control. 30 tomato seeds were placed in each Petri-dish and incubated in the dark at 25ºC for 5 days. The germinated seeds were counted and their root lengths measured in each Petri-dish using a rule and a thread in all the set-ups. The germination index was then computed using the formula below:

$$GI = \frac{Nt}{Ng} \times \frac{AvRLt}{AvRLc} \times 100$$

Where GI = Germination index

Nt =Number of germinated seed in the treated

Ng =Number of germinated seed in the control

AvRLt = Averaged root length of germinated seeds in the treated

AvRLc = Averaged root length of germinated seeds in the controlled

Physico-chemical parameters Analysis

Temperature Determination

Temperature readings from three different locations; The top, middle and bottom of compost masses from the different systems understudy were taken daily using the long stem thermometer (Salmoiraghi Co. thermometer model 17506) at the site. The daily ambient temperatures were also determined.

pH Determination

The representative samples from each system were thawed. Three sub samples of 10g were taken from the representative sample of each system and poured into labeled beakers for the pH determination. The triplicated sub samples were suspended in distilled water in the ratio (1:10) and shaken on a rotary shaker for 30mins.The supernatant was then poured into a beaker and pH determined using a pH meter (Scientific Instruments Co. (Italy) model 9000/3).The pH of the triplicated samples for each system were averaged to represent pH of compost mass in each system.

Moisture Determination

10g each of the representative samples from the different systems were weighed and triplicated for moisture content determination using the oven method. Samples were kept in the oven at 105ºC for 24hrs and changed in weight of samples were averaged and used as the measure of moisture content of compost mass in each system.

Microbiological Analysis

Serial Dilution for Total Viable, Coliform and fungi Count

A gramme of representative samples taken from each of the systems mounted for study was weighed into 9ml of 0.1% peptone water contained in 4 different McCartney bottles and incubated at 37ºC for 15minutes.They were well mixed and 1ml of the supernatant was drawn from each of the bottles and diluted using 10-fold dilution into 4 other McCartney bottles each containing 9ml of sterile 0.1% blank peptone water. Different pipettes were used for each of the dilution. 1ml of the diluents taken from dilution factors: $1:10^3$,$1:10^4$ and $1:10^5$ were transferred into 2 sets of 3 different McCartney bottles one set containing 9ml of molten Plate Count Agar (PCA) for viable count and the other set 9ml of Violet Red Bile Agar for coliform count. Both sets were kept in water bath at 45ºC to prevent solidification **(Collins & Lyne, 1983)**. They were mixed by swirling and then poured into sterile Petri-dishes aseptically and allowed to set. For fungi enumeration, 1ml of the neat representing compost mass taken from each system was transferred onto the Sabouraud agar in labelled Petri-dishes. The whole set was incubated at 37ºC for 24hours and at 30ºC for 2-7 days respectively for bacteria and fungi. Cultures showing between 30-300 colonies were counted using the colony counter **(AOAC, 1983)**.

Cultures and subcultures

Cultures were made from the neat dilutions onto Blood agar, MacConkey agar and Sabouroud agar using plate-out technique as described by **Heritage *et al.* (1996)**.The cultures were incubated for 24h at 30ºC made on Blood agar and MacConkey plates, and 2-7 days at 30ºC for those made on Sabouraud agar. After growth was observed, identified colonies were purified by subculturing on Blood agar, MacConkey agar and Sabouroud agar. Subcultures were made on Brilliant Green agar and Eosin Methylene Blue agar in order to isolate the Salmonella *spp.* and coli forms present

Isolation and Identification

The colonial morphology and cultural characteristics were studied for size, shape and colour on the different media used for the subcultures. Bacteria were Gram stained and their

reactions examined by using the light microscope at x100 magnification with oil immersion. The colonial morphology and cultural characteristics of bacteria identified were compared with characteristics of bacteria outlined in **Cheesbrough (1984)** for confirmation. With the fungi, after incubation, colonies of different shape and colours were observed on the plates. A pure culture of each colony type on each plate was obtained and maintained. The maintenance was done by sub-culturing each of the different colonies onto the Sabouraud agar plates and incubated at room temperature again for 5 days **(Jha, 1995)**. Fungi were stained with lactophenol cotton blue stain and examined at x10 magnification. They were identified using microscopy and colonial morphology in accordance with Schneierson **(1960)** and Cheesbrough **(2000)**. This was because the API (Analytical Profile Index) for bacteria and fungi were not available.

Data collected on moisture content, hydrogen ion concentration, temperature, germination index, fungi counts, total viable count and colifom counts were processed, summarized and analysed using Excel Statistical Application.

RESULTS

Moisture Content

The curve in fig.1 illustrates the pattern of moisture in the two systems studied. Moisture content in both systems follows the same pattern.

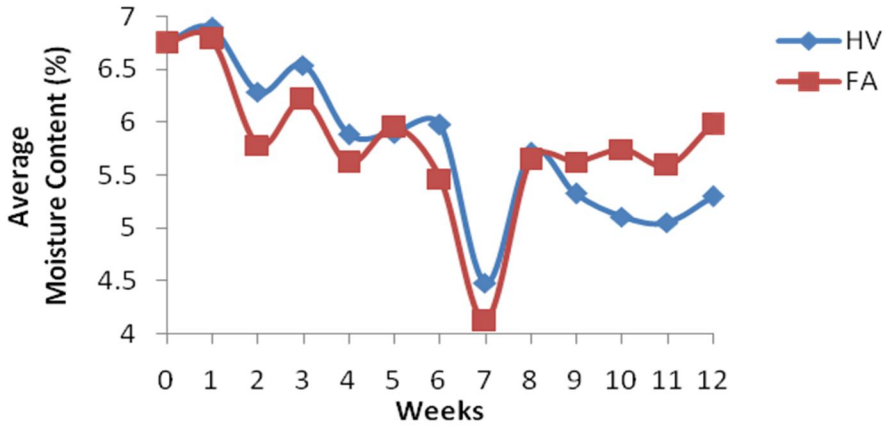

Figure 1 Average moisture contents in the composting systems understudied

Hydrogen Ion Concentration (pH)

The hydrogen ion (pH) concentration of the compost masses in the two systems were measured for the 13 weeks with their average weekly readings determined and used in plotting the graph in fig.2.

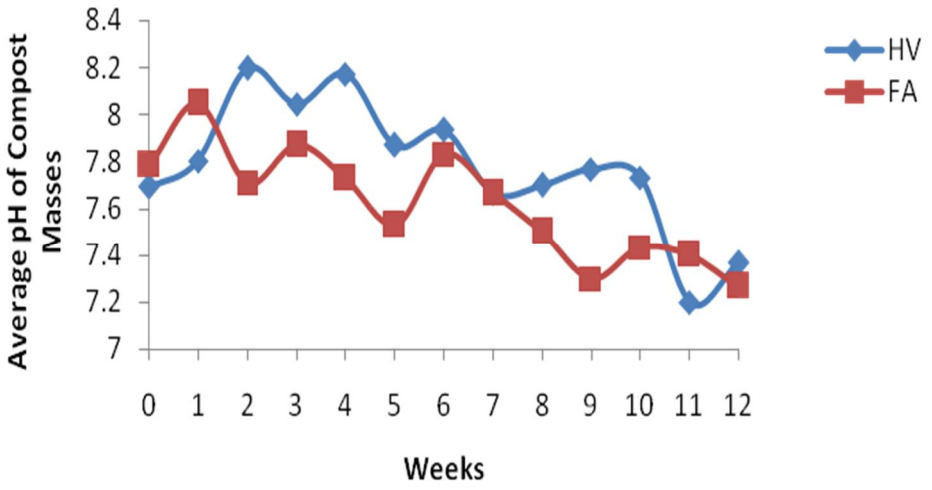

Figure 2 Average pH readings in the systems understudied

Germination Index

Graph of Germination Index values recorded in both systems determined from week 0 to week 12 are shown in fig. 3.

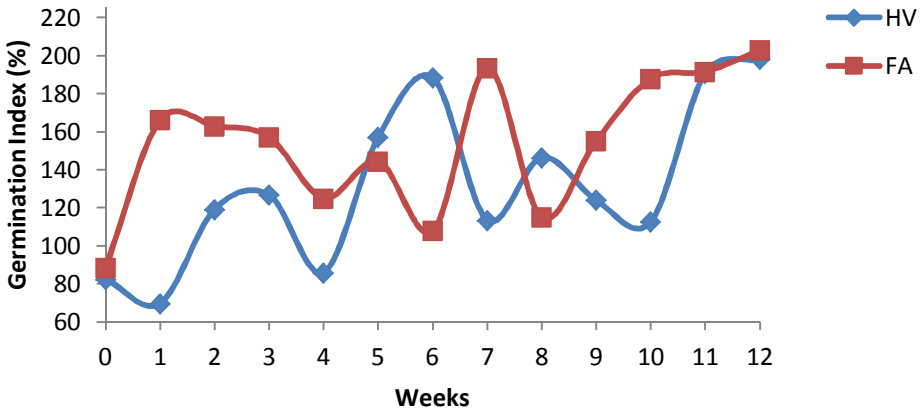

Figure 3 Germination Indices of Compost Masses in the Systems

Temperature

The temperature recorded in HV and FA ranged between 45.19ºC – 65.44ºC and 29.00ºC – 50.83ºC respectively as shown in fig. 4.

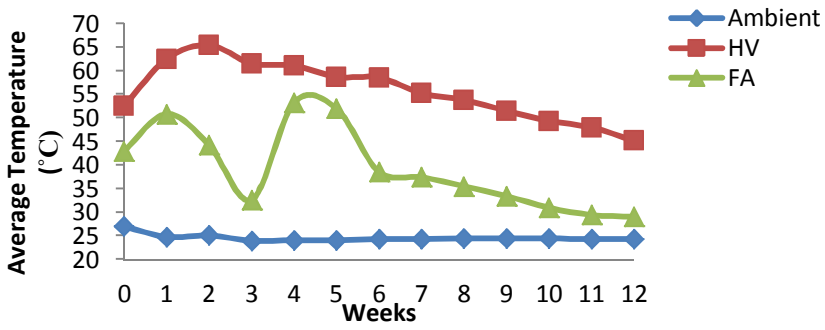

Figure 4 Average Temperature Readings Recorded in the Systems Understudied

Effect of temperature on microbial survival in FA System

Figure 5 shows the relationship between temperature and microbial survival in the FA System.

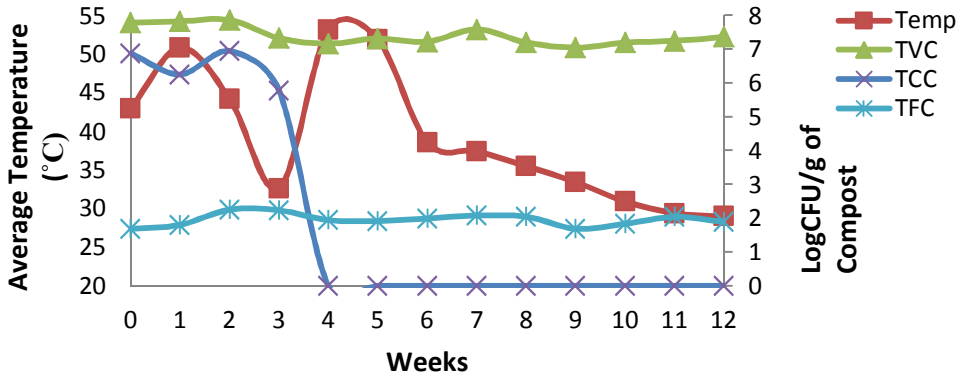

Figure 5 Temperature and microbial survival in FA System

Effect of temperature on microbial survival in HV System

The relationship of temperature and microbial survival is shown in fig 6.

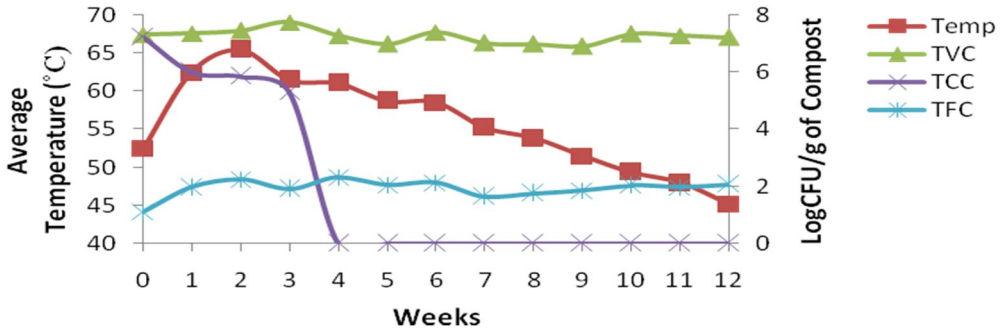

Figure 6 Temperature and microbial survival in HV System

DISCUSSION

Moisture Content

The rise and fall in the moisture content in compost masses in the different systems were due to variation in the temperature and aeration, causing different rates of evaporation of moisture in the systems. The correlation between temperature and moisture in both systems were r = 0.61 and r = 0.25 in HV and FA respectively. The positive correlation coefficient values achieved in both systems were as a result of regular rehydration of compost mass to avoid drying up by the heat produced during the process. However, ANOVA performed on such values yielded a p-value of 0.98 at α = 5%, thus indicates no significant differences in the systems in terms of moisture content. The moisture values recorded during the process ranged from 40% - 70% in both systems with values from the last 6 weeks ranging between 46% - 60%. These values are desirable since the optimum moisture content for efficient composting was identified to be 50-60% **(Tiquia *et al.*, 1998; McKinley *et al.*, 1986)**. The mositure content of initial materials composted by work of **Cofie *et al.*(2009)** ranged from 42 – 68%.

Hydrogen Ion Concentration (pH)

The pH values in both systems ranged from 7.20 - 8.30 during the process. The pH values recorded in the systems varied in the systems from week 0 to week 12. Though the values recorded in the HV system (7.20-8.30) were slightly higher than those recorded in FA

system (7.37-8.05). However ANOVA result yielded a p-value of 0.13 at $\alpha = 5\%$, showing no significant differences in the pH values recorded in both systems. The peculiar trend taken by the pH values recorded in the both systems may be due to the inclusion of 500g/40L of starter containing genetically modified microorganisms such as *Corynebacterium spp.* and *Bacillus spp.* that might have eliminated the organic acids, thus preventing the characteristic initial low pH of 4-5. The pH values recorded in the systems fell within the basic zone of 7.20 - 8.30.This confirms **Sundberg (2005)** results that during successful and fully developed composting, the pH often rises to 8-9. Also, **Cofie *et al.* (2009)** observed at the end of maturation, pH values of 7.8 and 8.1 respectively in two compost heaps which also fall within range obtained in HV and FA.

Germination Index

The values ranged between 82.54 to 198.11 and 88.58 to 202.83 in systems HV and FA respectively from week 0 to week 12. Variations in the germination indices show that the rate of compost degradation differed at different times during the process in both systems. ANOVA performed for the recorded results in the different systems at $\alpha = 5\%$ gave rise to a p-value of 0.17, indicating no significant difference in the Germination Index in both systems. Though Germination Indices greater than 150% were recorded in FA system from week 9 to week 12 and that of HV system from week 11 to 12, it however revealed that both systems gave quality compost of Germination Index values greater than 150 at the end of week 12 as confirmed by experiment done by **Ikeda *et al.* (2006)**.

Temperature

It was observed that temperatures fell gradually in both systems but at different rates and to different extent. Temperature values recorded were higher in the HV system than the FA as a result of better aeration in the latter. The temperature values in HV system rose from 55ºC in week 0 to the peak recorded value of 65.44ºC during week 2 and then started falling gradually till week 12 to a temperature of 45.19ºC. However temperature in the FA system rose from 42.97ºC in week 0 to 50.83ºC in week 1 as seen in fig 4. The temperature of all compost treatments regularly dropped off gradually towards during the maturation as reported by **Rashad *et al.* (2010)**. The sudden fall and rise in temperature during week 3 and week 4 was due to heavy downpour and power outage respectively. Thus, the variations in

temperature in both systems implied the succession of different microbial communities in all the systems and hence the different rate of decomposition. However, the ambient temperature took nearly a linear pattern ranging from 27ºC in week 0 to 24.33 ºC in week 12.

The distribution of microorganisms in the systems in relation to temperature variations are shown in fig.5 and 6. In the forced aeration system, as temperature increased from 42.97˚C to 50.83˚C during week0 to week1, there was a slight rise in the total viable count from 7.79logCFU/g of compost to 7.83logCFU/g of compost. Total viable count further increased to 7.87logCFU/g of compost when temperature dropped to 44.23˚C in week 2.This occurred because thermophilic microorganisms such as *Bacillus spp.* and *Cornybacterium spp.* dominated the process during week 0 to week 2. The initial rise in temperatures in both systems was due to heat generated by the presence of large quantity of bacteria which are fast growers responsible for the initial decomposition of organic matter and the generation of heat as reported by **Saludes *et al.* (2008)**. A further fall in temperature to 32.59˚C reduced the total viable count to 7.33logCFU/g of compost in week 3. The drastic change in temperature from thermophilic to mesophilic condition might have caused the fall in total viable count in week 3. When temperature rose to the thermophilic zone in week 4 and 5, the total viable count began to increase from 7.17logCFU/g of compost to 7.32logCFU/g of compost. A change again in the temperature from the thermophilic to mesophilic condition reduced the total viable count in week 6.

Effect of temperature on microbial survival in FA System

The gradual fall in the temperature from week 6 to week 12 in the FA system showed variations in the total viable count. There was a rise in the total viable from week 9 to week 12 because of the low temperature development in the system making the mesophilic organisms dominate the process while the thermophilic organisms reduced towards the end. This confirmed the work of **Stentiford (1996)** that temperatures above 55^{o}C, maximizes sanitisation; between 45 and 55^{o}C, improves the degradation rate; 40^{o}C- 35 ^{o}C, improves microbial diversity. The low temperature development was due to the cooling effect of the forced aeration.

Total coliform count in FA system decreased from 6.88logCFU/g of compost to 6.26logCFU/g of compost when temperature rose from 42.97˚C to 50.83˚C during week 0 to week 1. The rise in temperature during week 4 from 32.59ºC to 53.20˚C reduced the total

coliform count to 0 since temperature is an important factor in the inactivation of these organisms **(Hassen *et al.*, 2001)**.The only coliform identified during the process was *Enterobacter spp.* and can be used generally monitored faecal matter in compost to ensure compost quality **(Sidhu *et al.*, 1999).**

Thus the exposure of compost temperature range between 32.59ºC to 53.20˚C for a period of four weeks might have inactivated the coliform identified as this is in consonance with findings by **Hanajima *et al.* (2006)** and **Tiquia and Tam (1998)** that the duration of exposure of compost to a temperature above 55 ^{o}C for at least 16 consecutive days in inoculated piles were quite enough for sanitizing the produced composts from the sanitarian indicators, fecal coliform and salmonellae.There was a slight rise in the total fungi count from 1.68logCFU/g of compost to 1.81logCFU/g of compost during week 0 to week 1 when there was a rise in temperature from 42.97˚C to 50.83˚C. ANOVA performed on the total viable counts of the microganisms in FA yielded a p-value of 1.32×10^{-13} at $\alpha = 5\%$ for the composting period. The fall in temperature during week 2 and 3 brought about increases in the total fungi count.

The temperature rise in week 4 caused a decrease in the total fungi count. The total fungi count increased from week 5 to week 8, with a fall in week 9, a subsequent rise in week 10, 11 and a fall in week 12 as temperature fell during week 5 to week 12 from 51.94˚C to 29.00˚C.The total fungi count recorded during week 12 (1.89logCFU/g of compost) was higher than the initial total fungi count recorded (1.68logCFU/g of compost). This confirms with the findings by **Saludes *et al.* (2008)** that the cooling phase of composting is dominated by fungi and other main decomposers in breaking down the lignocellulosic components.The fungi identified during the process were *Penicillium spp., Aspergillus spp. Mucor spp.,* and *Rhizorpus spp. Penicillium spp*. was the only fungi that survived the process in the FA system. However, the total fungi counts recorded in FA for the composting period differed significantly (p-value = 1.21×10^{-14}, $\alpha = 5\%$)

Effect of temperature on microbial survival in HV System

Fig.6 shows that as temperature increased from 52.49˚C in week 0 to 65.44˚C in week 2, there was a slight rise in the total viable count from 7.31logCFU/g of compost to 7.46logCFU/g of compost. Rise in temperature during week 3 caused a fall in the total viable count. The total viable count ranged between 7.28logCFU/g of compost and 6.90logCFU/g of

compost from week4 to week10 with a fall in temperature from 61.07˚C to 49.35˚C. Temperature fell gradually from the week 3 to week 12. However, the total viable count began to fall from week 10 to week 12. The rise and fall in total viable count between week 2 and week 6 shows that some microorganisms were being inactivated at different temperatures during the composting process leading to succession of different organisms at the different stages of the process. However, **Pourcher *et al.* (2005)** showed even temperature as high as 66^{o}C did not inactive completely this microorganism.

The gradual fall in temperature and total viable count towards the end of process indicate the depletion of nutrients and the process approaching stability, hence less heat was generated. The temperature values recorded in the HV system during the composting period show that only thermophilic conditions were created. There was significant differences in the total viable counts of microganisms in HV(p-value = 1.05 x 10^{-23}, α = 5%) for the composting period. The bacteria identified in HV system during the process were *Bacillus spp., Staphylococcus spp., Streptococcus spp., Clostridium spp., Campylobacter spp., Listeria spp., Corynebacterium spp., Yersinia spp* and *Enterobacter spp*. However *Bacillus spp*. (42.86%) and *Cornybacterium spp.* (57.14%) survived the process and these were the organisms found in the starter used to facilitate the decomposition process. Total coliform count decreased during week 0 to week 2 from 7.21logCFU/g of compost to 5.85logCFU/g of compost with temperature rise from 52.49˚C to 65.44˚C which confirmed similar results registered by **Hess *et al.* (2004).** Further fall in temperature from 65.44˚C to 61.07˚C in week 2 to week 4 led to a fall in the total coliform count from 5.85logCFU/g of compost to 0, indicating the reduction in faecal contamination as confirmed by **Hanajima *et al.* (2006)** and **Tiquia and Tam (1998)**. *Enterobacter spp*. was the only coilform identified. There was a rise in the total fungi count observed in the HV system from 1.11logCFU/g of compost to 2.25logCFU/g of compost with rise in temperature from 52.49˚C to 65.44˚C during week 0 to week 2. The subsequent weeks experienced fluctuations in the total fungi count with a fall in temperature from week 3 to week 7. The total fungi count began increasing during week 8 to week 12 from 1.76logCFU/g of compost to 2.06logCFU/g of compost with a fall in temperature from 53.80˚C to 45.19˚C as reported by **Saludes *et al.* (2008)**. The total fungi count recorded during week12 was greater than that obtained in week 0. The various fungi identified during the process were *Penicillium spp., Aspergillus spp., Mucor spp.* and *Rhizopus spp.,* with only *Penicillium spp*. surviving the process at the end of week 12. ANOVA performed on the total fungi count from week 1 to week 12 yielded a p-value of 2.79 x 10^{-17} at α = 5%.

Germination index, temperature, moisture content, pH, total viable count, total coliform count and total fungi count values were determined during composting in HV and FA systems at VREL Farms for a period of thirteen weeks were analysed to ascertain the effects of temperature, moisture and pH on compost maturity and microbial survival. There were no significant differences in germination index, pH and moisture content values for both systems. Moisture content and pH values ranged between 40%-70% and 7.20 - 8.30 respectively. Temperature values recorded however were significantly different in both systems and affected the microbial distribution during the process. The temperature recorded in HV and FA systems ranged between 45.19ºC – 65.44ºC and 29.00ºC – 50.83ºC respectively.
Bacillus spp. (42.86%) and *Corynebacterium spp*. (57.14%) survived the process in HV system while *Bacillus spp*. (20%), *Staphylococcus spp*. (6.67%), *Listeria spp*. (6.67%) and *Corynebacterium spp*. (66.67%) survived the process in FA system; only *Penicillium spp.* (100%) survived in systems HV and FA. There was also a significant difference between the total viable counts and total fungi count recorded in both systems yielded p-value = 3.53×10^{-32} and 2.54×10^{-28} respectively at $\alpha = 5\%$ over the composting period.

CONCLUSION

Some members of the compost microbial community identified in compost masses in the two different systems that survived the compost process are responsible for causing diseases in humans. Though a higher stable germination index was recorded early in the FA system, both had high germination index of greater than 150% at the end of week 12. Though moisture content and pH were not significantly different in both systems, temperatures record in both systems during the composting period varied significantly with the highest temperatures recorded in HV. The variation in the temperatures recorded in both systems caused differences in the total viable counts, fungi counts, and coliform counts in HV and FA. *Listeria spp., Staphylococcus spp* and *Penicillium spp*. survived in FA; only Penicillium survived in HV. The others were isolated in the starter added to the compost mass to facilitate its decomposition. Enterobacter *spp.*, the only coliform identified in both systems was inactivated.The speed of the blower in the FA system needs to be regulated in order that high compost temperature in the compost matrix can be maintained to inactivate pathogens survived the process. Since *Listeria spp*., known to be zoonotic, and *Staphylococcus spp*. survived in compost processed in FA system; and *Penicillium spp.* in both, protectives need be worn by compost manufacturers and farmers to safeguard their health.

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