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Improved Composting Through Fermented Activators

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ABSTRACT

Composts are important components in improving or restoring soil fertility. However, it takes long time for it to prepare and buying starter cultures of beneficial microorganisms to speed-up composting can be expensive. Thus, a study was conducted to quantify microorganisms from the different fermented activators and EM using PCA, determine the duration of compost maturity, percent recovery of compost, and nutrient content and pH of compost as affected by different fermented activators and EM. Significant lower temperature were registered on the compost (30% Browns + 30% Greens + 40% Banana Bract) applied with commercial effective microorganism (EM) from five to eight weeks of composting than those applied with fermented activators and tap water. Such is a sign of earlier maturity. Meanwhile, application of Fermented Swamp Cabbage Juice alone improved the percent recovery of compost by 0.36 times (46.70%) compared to those applied with tap water only (34.33%). Furthermore, application of commercial EM and Fermented Swamp Cabbage Juice alone also improved the nutrient contents (N, P_2O_5 and K_2O) of the compost after four and eight weeks of composting.

Keywords - agriculture, composting, fermented activators, experimental research, Philippines

INTRODUCTION

Compost used as soil amendment provides nutrients, support beneficial soil life, reduces soil diseases, increases water retention in sandy soils, add drainage to clay soils, and promotes weed and erosion control (Hospitals for a Healthy Environment, 2007).

With continuous increase in price of crude oil in the international market, price increase of chemicals has continued to rise. This increases the demand for good quality compost that can either supplement or substitute chemical fertilizer inputs (Cobb and Rosenfield, 1991).

Compost production, however, is far from sustainable mainly because it relies heavily on chicken manure and other animal waste materials. Lignocellulosic waste such as grass clippings, twigs and leaves make up 44.5% of the typical municipal solid waste in the Philippines (Delos Santos, 2009) making it a good prospect for composting. Sadly, conventional composting takes three to four months before it can be used as farm input.

One of those technologies to accelerate composting is the use of effective microorganism (EM). It contains various organic acids due to the presence of lactic acid bacteria and other beneficial microorganisms, which have strong sterilizing compound that suppresses harmful microorganisms and enhances decomposition of organic matter. Without beneficial microorganisms, indigenous microbes in the soil will facilitate the decomposition of available organic materials that may produce phytotoxic substances which hinder seed and plant development (Diver, 2001).

However, buying starter cultures of beneficial microorganisms can be expensive for farmers thus there is a need to create fermented activators out of readily available materials hence this study.

OBJECTIVES OF THE STUDY

The study evaluates the efficiency of the swamp cabbage and the golden snail singly and in combination as different fermented activators in accelerating composting process. Specifically, it determines the duration of compost maturity, percent recovery and nutrient content and pH of compost as affected by fermented activators and EM®.

MATERIALS AND METHODS

Sample Collection

Each compost component was grouped together according to browns: low nitrogen content dried corn (*Zea mays*) stalks; greens: high nitrogen content kakawate (*Gliricidia sepium*) leaves and phosphorus and potassium source, banana (*Musa balbisiana*) bract.

After collection of compost materials, they were shredded into particles having approximately 2-5cm in length to increase the surface area of the materials. The lignocellulosic waste combination of 30% Browns + 30% Greens + 40% Banana Bract served as the test compost for study. Preliminary experiments showed that the lignocellulosic waste combination of 30% Browns + 30% Greens + 40% Banana Bract produced the highest percent nitrogen and phosphorus in the compost product.

Swamp cabbages with green leaves were used while those that show yellow discoloration were discarded. These were cut approximately 50cm from the tip. For golden snail, only the live ones were used.

Preparation of Activator and Fermentation

The compost activators were prepared through anaerobic fermentation using swamp cabbage alone, golden snail alone and 1 part swamp cabbage + 1 part golden snail ($^{w}/_{w}$). The freshly collected swamp cabbages were chopped to about 10cm while fresh golden snails were crushed. From these materials, 2kg each of chopped swamp cabbage alone, crushed golden snail alone and 1kg of chopped swamp cabbage + 1kg of crushed golden snail were placed in three individual identical buckets and added with 0.67 kg molasses. Then it was covered and allowed to ferment for one month. The fermented extract produced was diluted with water and molasses at a ratio of 1L extract: 1L molasses: 48L tap water following the procedure of Salapare (2008).

Commercial EM Activation

Commercial EM was available in a dormant state and required activation before application. Activation was done by the addition of 45L of water to 3L of dormant EM according to the specified dilution of the commercial EM. The solution was placed in a clean plastic drum (50L capacity) covered and allowed to ferment for one week.

Experimental Design and Treatments

A Completely Randomized Design (CRD) with three replications was used.

The following fermented activators served as treatments:

T0 – Control (Tap Water)
T1 – FCGS alone (Fermented Crushed Golden Snail)
T2 – FSCJ alone (Fermented Swamp Cabbage Juice)
T3 – 1 Part FCGS + 1 Part FSCJ ($^{w}/_{w}$)
T4 – Commercial EM
T5 – Compost Manure (Cow Manure)

All fermented activators and EM were applied one week after activation. The remaining activated fermented activators and EM, however, were used only up to 30 days before they were replaced with a newly activated fermented activators and EM.

For activated EM, a rule of thumb is 30 days longevity.However, its peak efficacy occurs at about 14 to 16 days (FutureTechtoday, 2004).

Composting Procedure

The compost materials were placed in compost basin measuring 70cm diameter and 30cm depth. A distance of 30cm between basins was maintained.

All materials were mixed according to the specified ratio to total 10 kg and was soaked in 10L treatment solution overnight and completely covered with plastic sheet to prevent excessive evaporation of water.

Turning over the pile was done weekly up to the seventh week to provide adequate aeration and obtain uniform rate of decomposition. All the compost materials were harvested after eight weeks of decomposition.

Data Gathered

Quantification of Microorganisms

One liter sample from each activated fermented activators and EM were brought to Techno lab Analytical Group, Inc., Cebu City, Philippines for microbial analysis using aerobic plate count (PCA). Analysis was done from activation until four weeks of storage to determine the longevity of activated fermented activators and EM.

A sufficient quantity of culture medium was prepared to fill the number of plates needed for counting the number of samples desired. The medium was placed in a water bath (42°C-45°C) and it was made certain that the medium was mixed before pouring by gently swirling the bottle or flask so as to avoid foaming. A range of three to four dilutions that is suspected to yield plates ranging 30 to 300 colonies per plate was selected. From each of these dilutions, after thorough mixing, 1.0ml aliquot was transferred to the labeled sterile plates. After distribution of inocula, approximately 15 to 20ml of molten agar medium was poured, the inoculum was then distributed by swirling counter clockwise the plate three to five times, and the medium was allowed to solidify then the plates were inverted for incubation at 25°C to 28°C for four to seven days. The dilutions which exhibit 30 to 300 colonies were determined. The number of bacteria was calculated. The number of colonies appearing on the replicate plates was averaged and the mean of the colony number was multiplied by the reciprocal of the dilution.

Compost Maturity

The maturity of the compost was determined by monitoring the compost temperature and pH. Initial and weekly temperature and pH were gathered to monitor the composting process. Temperature and pH readings, using digital thermometer and pH meter, were taken at the center of the pile, approximately 15cm from the surface.

According to Rynk (1992), at optimal composting condition, decomposition of organic matter proceeds through three phases: the mesophilic (40°C and above), thermophilic phase (55°C and above), and maturation phase (cooling down).

Maturity of compost was also based on percent organic matter (OM). Compost is defined as any product of plant and/or animal origin that has undergone decomposition through biological, chemical and/or any other process as long as the original materials are no longer recognizable, free from plant or animal pathogens, soil-like in texture, contains not less than 20% organic matter (OM.) oven-dry basis and can supply nutrients to plants (FPA, 1996).

Percent Recovery

From the 10kg of fresh materials, the decomposed materials were weighed to determine the percent recovery of the compost fertilizer. The percentage recovery was computed as follows:

$$= \frac{\text{Weight of Compost Fertilizer (kg)}}{\text{Weight of Fresh Compost Materials (kg)}} \times 100$$

Recovery (%)

Nutrient Analysis and pH of Compost

On the fourth, sixth and eighth week of composting, approximately 100g fresh compost was taken from each treatment in composite and brought to the Bureau of Soils, Mandaue Experimental Station, Mandaue City, Cebu, Philippines for nutrient analysis. Percent organic matter was analyzed using Walkey-Black Method, total nitrogen using Kjeldhal Method and phosphorus using Vanadomolybdate Method, while the total potassium was analyzed using Flame Photometer Method. Also, the pH of the compost was determined as well as the C:N ratio of the compost was computed.

Statistical Analysis

Raw data were gathered and analyzed using Analysis of Variance (ANOVA) for a Completely Randomized Design (CRD) to test the significant differences among the treatments. Comparison among means was done using Duncan's Multiple Range Test (DMRT) to determine the specific significant differences among treatment means.

RESULTS AND DISCUSSION

Although effective microorganism (EM) mechanisms are not yet clearly understood, they are still popularly used in composting and farming technologies (Hiraoka, 2002). The microbial population colony forming unit (cfu)/ml in fermented activators and EM upon activation until four weeks of storage are presented in Table 1. Populations of microorganisms are observed to increase with storage time among all activated fermented activators and EM. The highest population of microorganisms was observed in commercial EM at 2.12 x 10^3, 7.96 x 10^4, 1.2 x 10^6 and 2.50 x 10^6 cfu/ml upon activation, after one, two and three weeks of storage, respectively. Generally, it is expected that the commercial EM contains higher initial amount of microorganisms as it already contains photosynthesis bacteria. However, after four weeks of storage, the highest microbial population was observed in 1 Part Fermented Crushed Golden Snail and 1 Part Fermented Swamp Cabbage Juice at 1.77 x 10^9 cfu/ml. Amino acids such that of golden snails promote growth of beneficial microorganisms (The Gardeners Network, 2008). Moreover, this may also be true with Fermented Swamp Cabbage Juice from *Ipomoea aquatica*; leaves are also very rich in proteins, carotenes and amino acids like aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, leucine, tyrosine, lysine, histidine and arginine (Prasad et al., 2007).

Table 1. Microbial population (cfu/ml) in different fermented activators and EM upon activation until four weeks of storage

TREATMENT	INITIAL	WEEK 1	WEEK 2	WEEK 3	WEEK 4
E1 – FCGS alone (Fermented Crushed Golden Snail) at 2% concentration	59	2.29×10^3	1.5×10^4	7.8×10^4	6.8×10^6
E2 – FSCJ alone (Fermented Swamp Cabbage Juice) at 2% concentration	7	640	9.0×10^3	7.0×10^5	1.2×10^9
E3 – 1 Part FCGS + 1 Part FSCJ at 2% concentration	62	480	3.9×10^4	8.3×10^4	1.77×10^9
E4 – Commercial EM (BIOEM) at 6% concentration	2.12×10^3	7.96×10^4	1.2×10^6	2.50×10^6	1.35×10^9
Mean	562	2.07×10^4	3.15×10^4	8.40×10^5	1.08×10^9

The weekly temperature of compost pile as affected by application of different fermented activators and EM is presented in Table 2 and their appearances on the fourth and eighth week shown Figure 1. Significant differences in temperature were immediately noted from one week until termination or eight weeks of composting. Also at eight weeks, appearance of compost fits the Von Post Scale under Moderately Decomposed Refusal. From the first week until the compost was harvested, compost manure had significantly lower temperatures compared to the rest of the compost pile regardless of fermented activators and EM used. On the other hand, compost pile applied with commercial EM had comparable temperature to those applied with fermented activators (Fermented Crushed Golden Snail alone, Fermented Swamp Cabbage Juice alone and 1 Part FCGS + 1 Part FSCJ) and tap water from the first week up to the fourth week. However, significantly lower temperatures were registered on those compost pile applied with commercial EM from the fifth up to the eighth week of composting compared to those applied with activated fermented activators and tap water. This is a sign of early compost maturity for compost applied with commercial

EM. Moreover, temperature of compost pile applied with fermented activators was comparable to those applied with tap water from first to eighth week of composting.

Presented in Figure 2 is the weekly variation of temperature of compost pile applied with different fermented activators and EM. Generally, in all compost piles regardless of fermented activators, EM and material, temperature was lowest at the start of composting, highest after two weeks and declined until the eighth week of composting. According to Trautmann (2007), compost heat is produced as a by-product of microbial breakdown of organic materials. Also at second week until three weeks of composting, in compost pile containing 30% Browns + 30% Greens + 40% Banana Bract regardless of fermented activators and EM, fungi were observed at the upper surface of the compost. As reported by Trautmann and Olynciw (1996), fungal species are numerous during both mesophilic and thermophilic phases of composting. Most fungi live in the outer layer of compost when temperatures are high. Moreover, according to Rynk (1992), at optimal composting condition, decomposition of organic matter proceeds through three phases: the mesophilic (40^0C and above), thermophilic phase (55^0C and above), and maturation phase (cooling down). However, throughout the entire process of composting, temperature measurements were all below 40^oC in all compost piles regardless of substrate, fermented activators and EM. Similar low temperatures were also noted by Salapare (2008) on composting rice straw. This may be attributed to two things, (1) the amount of browns in the medium (30%) as carbon source which may not be sufficient to support microbial growth. According to Rynk (1992), carbon provides both energy source and the basic building block making up about 50% of the mass of microbial cells. (2) The size of pile. According to Trautmann (2007), the heat production in compost depends on the size of the pile, its moisture content, aeration and C:N ratio.

Table 2. Weekly temperature (^{o}C) of compost pile as affected by application of different fermented activators and EM

TREATMENT	INITIAL	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
T0 – Control (Tap Water)	28.06	31.10^{a}	33.23^{b}	31.10^{a}	31.16^{ab}	30.90^{a}	30.23^{a}	30.20^{a}	28.93^{a}
T1 – CGSAA alone (Crushed Golden Snail Amino Acid)	28.23	30.80^{a}	34.43^{ab}	30.93^{a}	30.76^{ab}	30.67^{a}	30.40^{a}	29.76^{a}	28.96^{a}
T2 – FSCJ alone (Fermented Swamp Cabbage Juice)	28.23	31.50^{a}	33.03^{b}	30.80^{a}	30.83^{ab}	30.63^{a}	30.33^{a}	29.73^{a}	28.86^{ab}
T3 – 1 Part CGSAA + 1 Part FSCJ	28.10	30.86^{a}	34.76^{a}	30.93^{a}	31.23^{a}	31.03^{a}	30.13^{a}	29.76^{a}	29.03^{a}
T4 – Commercial EM (BIOEM)	28.23	31.36^{a}	32.80^{ab}	30.33^{a}	30.10^{b}	29.76^{b}	29.36^{b}	29.10^{b}	28.63^{b}
T5 - Compost Manure (Cow Manure)	28.20	28.40^{b}	30.33^{c}	28.73^{b}	28.70^{c}	28.33^{c}	28.30^{c}	28.23^{c}	28.20^{c}
Mean	28.17	30.67	33.09	30.47	30.46	30.22	29.79	29.46	28.76
C.V. (%)	0.50	1.31	2.30	2.05	1.90	1.48	1.30	0.94	0.50

Means within the same column followed by a common letter are not significantly different from each other at 5% level using Duncan Multiple Range Test (DMRT)

Figure 1. General appearance of compost after four (top) and eight (bottom) weeks of composting as affected by different fermented activators and EM (left to right – T0, T1, T2, T3, T4 and T5)

Legend:

T0 – Control (Tap Water)
T1 – FCGS alone (Fermented Crushed Golden)
T2 – FSCJ (Fermented Swamp Cabbage Juice)
T3 – 1 Part FCGS+ 1 Part FSCJ
T4 – Commercial EM
T5 - Compost Manure (Cow Manure)

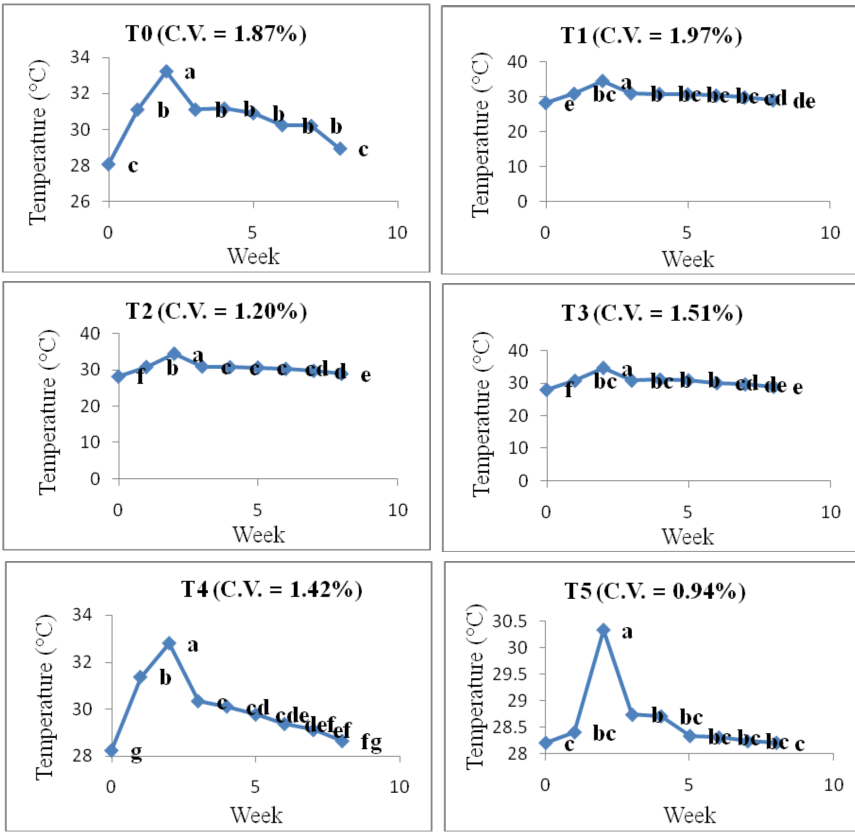

Figure 2. Weekly variation of temperature of compost pile applied with different fermented activators and EM. Different letters indicate significant differences among weekly temperatures at P ≤ 0.05 determined by Duncans Multiple Range Test.

Legend:

T0 – Control (Tap Water)
T1 – FCGS alone (Fermented Crushed Golden Snail)
T2 – FSCJ (Fermented Swamp Cabbage Juice)
T3 – 1 Part FCGS + 1 Part FSCJ
T4 – Commercial EM
T5 - Compost Manure (Cow Manure)

The weekly pH of compost pile as affected by the application of different fermented activators and EM is presented in Table 3. The initial and weekly pH of compost manure significantly differ from the compost containing 30% Browns + 30% Greens + 40% Banana Bract regardless of fermented activators and EM application. The initial pH of the compost manure was significantly higher up to the third week of pH reading. However, at fourth to eight week of composting, the compost manure had significantly lower pH compared to the compost containing30% Browns + 30% Greens + 40% Banana Bract regardless of fermented activators and EM application. The most acidic pH was all recorded on compost containing 30% Browns + 30% Greens + 40% Banana Bract and applied with Fermented Swamp Cabbage Juice alone at the start of composting up to the third week at 5.16, 5.86, 5.96 and 6.06, respectively. These, however, were comparable to the compost containing the same compost component applied with fermented activators (Fermented Crushed Golden Snail and 1 Part Fermented Crushed Golden Snail + 1 Part Fermented Swamp Cabbage Juice) during the initial reading, to Fermented Crushed Golden Snail alone on the first week and to Fermented Crushed Golden Snail and Commercial EM on the second and third week. According to Cobb and Resenfield (1991), in the early stages of composting, the acids often accumulate which results in drop of pH. The resulting drop in pH encourages the growth of fungi and the breakdown of lignin and cellulose. Usually, the organic acids become broken down further during the composting process.

Moreover, all compost piles were near pH 7 regardless of material, fermented activators and EM application during the fourth up to the eight week of composting. At acidic pH (during the second and third week), fungal growth was observed in all compost pile (Figure 3), except for compost manure. According to Trautmann and Olynciw (1996), in compost, fungi are important because they break down tough debris, enabling bacteria to continue the decomposition process once most of the cellulose has been exhausted. They spread and grow vigorously by producing many cells and filaments, andthey can attack organic residues that are too dry, acidic, or low in nitrogen for bacterial decomposition.

The weekly variation of pH across all compost piles containing 30% Browns + 30% Greens + 40% Banana Bract applied with different fermented activators and EM revealed an increasing pH level with the lowest pH during initial reading, except for those applied with tap water only, and highest readings on the eighth week. According to Richard and Trautmann (2007), pH can be used to follow composting and drop of pH generally occurs during the early stages of composting due to the accumulation of acids in the compost. For the compost manure, however, no significant variation in pH was observed from initial up to the eight week of pH reading. All initial pH readings were based on the pH of fermented activators, EM and of the tap water applied. Thus, a neutral pH reading was observed initially for the compost pile applied with tap water and acidic pH were then noted on the first up to the third week of composting (Figure 4). Furthermore, across all compost piles from the first to eighth week of composting regardless of material, fermented activators and EM, the pH range was from 5.86 to 8.09. A pH between 5.5 and 8.5 is optimal for compost microorganisms (Cobb and Rosenfield, 1991).

Percent recovery of compost was highest in compost manure (68%) followed by compost containing 30% Browns + 30% Greens + 40% Banana Bract applied with Fermented Swamp Cabbage Juice alone (46.70%). Salapare (2008) also reported increased percent recovery (41.67) with the application of fermented golasiman extract on rice straw compost. This, however, is not significantly different to the compost of same material and applied with commercial EM at 37%. On the other hand, percent recovery of those applied with commercial EM was not significantly different from the rest of the compost applied with fermented activators and tap water (Table 4). These findings are supported by Acevedo (2006) who revealed that there are no differences in the efficiency in composting process neither on compost quality between inoculated compost using commercial EM nor those that are not. The same was reported by Salapare (2008) that application of 2% golasiman extract as compost activator was comparable to using commercial EM of the same concentration.

Table 3. Weekly pH of compost pile as affected by application of different fermented activators and EM

Treatment	Initial	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
T0 – Control (Tap Water)	7.23[a]	6.90[ab]	6.86[b]	6.90[ab]	7.52[e]	7.47[d]	7.43[ab]	7.70[ab]	7.97[b]
T1– FCGS alone (Fermented Crushed Golden Snail)	5.26[c]	6.10[cd]	6.13[cd]	6.20[c]	7.60[d]	7.52[c]	7.44[a]	7.63[b]	7.83[d]
T2– FSCJ alone (Fermented Swamp Cabbage Juice)	5.16[c]	5.86[d]	5.96[d]	6.06[c]	7.70[b]	7.56[b]	7.42[bc]	7.65[ab]	7.88[c]
T3 – 1 Part FCGS+ 1 Part FSCJ	4.96[c]	6.53[bc]	6.56[bc]	6.73[b]	7.89[a]	7.65[a]	7.41[c]	7.75[a]	8.09[a]

T4 – Commercial EM (BIOEM)	5.93^{b}	6.36^{c}	6.40^{bcd}	6.46^{bc}	7.67^{c}	7.51^{c}	7.37^{d}	7.63^{b}	7.90^{c}
T5 - Compost Manure (Cow Manure)	7.23^{a}	7.30^{a}	7.33^{a}	7.36^{a}	7.47^{f}	7.36^{e}	7.26^{e}	7.25^{c}	7.24^{e}
Mean	5.96	6.50	6.54	6.61	7.64	7.51	7.38	7.60	7.81
C.V. (%)	2.82	3.96	3.87	4.15	0.16	0.13	0.13	0.71	0.31

Means within the same column followed by a common letter are not significantly different from each other at 5% level using Duncan Multiple Range Test (DMRT)

Figure 3. Fungal growth after two weeks of composting on compost containing 30% Browns + 30% Greens + 40% Banana Bract (P_2O_5 and K_2O Source)

The nutrient analysis and pH of the different compost piles on the fourth, sixth and eighth week of composting is shown in Table 5. Results revealed that at four weeks of composting, percent nitrogen (total N of air dry materials) and phosphorus (total P_2O_5 of air dry materials) are highest in compost containing 30% Browns + 30% Greens + 40% Banana Bract applied with commercial EM at 2.00% and 0.72%, respectively. On the other hand, percent potassium (total K_2O of air dry materials) is highest on the compost containing the same component and applied with Fermented Swamp Cabbage Juice (1.60%). Moreover, both pH and percent organic matter among different compost materials and fermented activators were generally within the values of a typical compost pile reported by Pauwels, as cited by Van Haute and Van Haute (2007) and FPA (1996).

On the sixth week of composting, percent nitrogen (total N of air dry materials) and phosphorus (total P_2O_5 of air dry materials) are highest in compost of the same compost materials and applied with only tap water at 1.36% and 0.51%, respectively. Similar value was also recorded on the phosphorus (total P_2O_5 of air dry materials) content of compost with the same compost materials and applied with Fermented Swamp Cabbage Juice alone (0.58%). Furthermore, the same compost materials applied with Fermented Swamp Cabbage Juice alone had the highest potassium (total K_2O of air dry materials) content of 1.48%.

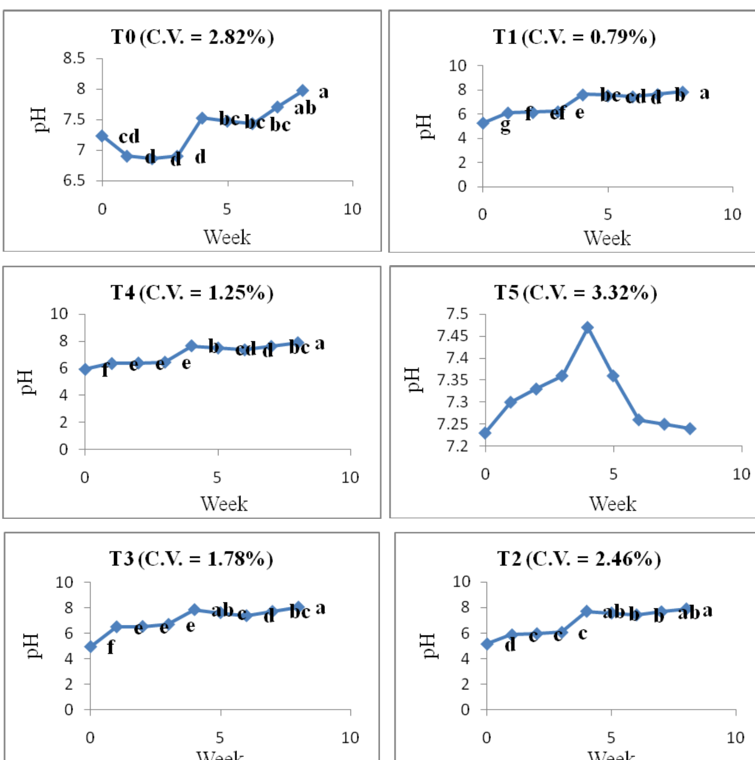

Figure 4. Weekly variation of pH of compost pile applied with different fermented activators and EM. Different letters indicate significant differences among weekly pH at P ≤ 0.05 determined by Duncans Multiple Range Test.

Legend:

T0 – Control (Tap Water)
T1 – FCGSalone (Fermented Crushed Golden Snail)
T2 – FSCJ (Fermented Swamp Cabbage Juice)
T3 – 1 Part FCGS+ 1 Part FSCJ
T4 – Commercial EM
T5 – Compost Manure (Cow Manure)

Table 4. Percent compost recovery as affected by application of different fermented activators and EM

TREATMENT	INITIAL WEIGHT (kg)	FINAL WEIGHT (kg)	PERCENT RECOVERY (%)
T0 – Control (Tap Water)	10	3.43	34.33^{c}
T1 – FCGSAA (Fermented Crushed Golden Snail)	10	3.33	33.33^{c}
T2 – FSCJ (Fermented Swamp Cabbage Juice)	10	4.67	46.70^{b}
T3 – 1 Part FCGS+ 1 Part FSCJ	10	3.16	31.66^{c}
T4 – Commercial EM (BIOEM)	10	3.70	37.00^{bc}
T5 - Compost Manure (Cow Manure)	10	6.80	68.00^{a}
Mean	10	4.18	41.83
C.V. (%)			15.80

Means within the same column followed by a common letter are not significantly different from each other at 5% level using Duncan Multiple Range Test (DMRT)

On the eight week, the same compost containing 30% Browns + 30% Greens + 40% Banana Bract applied with Fermented Swamp Cabbage Juice alone had the highest potassium (total K_2O of air dry materials) content of 3.00 and nitrogen (total N of air dry materials) content of 1.12. On the other hand, phosphorus (total P_2O_5 of air dry materials) content was highest in compost with the same compost materials and applied with commercial EM at 0.61%. This increased nutrient content with the application of Fermented Swamp Cabbage Juice alone could be attributed the nutrient supplied by the plant extract into the compost. According to Carandang (2003), bionutrients in the form of fermented plant extracts can improve soil fertility, and in this case, fertility of compost.

From four to eight weeks, nitrogen (total N of air dry materials) contents were greatly reduced with the duration of composting. Similar reduction of nitrogen content with duration of composting were also reported by Salapare (2008) on rice straw compost applied with 2% golasiman extract as compost activator. Organic nitrogen sources provide a natural "time release" that makes them at a rate comparable to the rate of growth of microorganisms in the compost, so they are utilized efficiently (Richard and Trautmann, 2007). In general, maturity of compost is accompanied by the decline in microbial population, thus, also the decline in nitrogen content. Nitrate is the form that can be moved out by leaching or lost by denitrification. The conversion of ammonium to nitrate and the conversion of nitrate to N gases are both microbial processes (Sawyer, 2007).

Table 5. Nutrient analysis and pH of composite compost samples as affected by fermented activators and EM application after four, six and eight weeks

TREATMENT	pH	% OC (AIR DRY)	% N (AIR DRY)	% P_2O_5 (AIR DRY)	% K_2O (AIR DRY)	C:N RATIO
Fourth Week						
T0 – Control (Tap Water)	7.52	22.70	1.43	0.51	1.19	15.87:1
T1 – FCGSalone	7.60	18.66	1.26	0.53	1.37	14.81:1
T2 – FSCJ alone	7.70	20.34	1.52	0.51	1.60	13.38:1
T3 – 1 Part FCGS+ 1 Part FSCJ	7.89	20.34	1.68	0.60	1.44	12.11:1
T4 – Commercial EM (BIOEM)	7.67	20.69	2.00	0.72	1.37	10.34:1
T5 - Compost Manure (Cow Manure)	7.47	19.18	1.34	0.49	0.36	14.31:1
Mean	7.64	20.31	1.53	0.56	1.22	13.28:1
Sixth Week						
T0 – Control (Tap Water)	7.43	24.36	1.36	0.58	1.21	17.91:1
T1 – FCGSalone	7.44	23.22	1.05	0.56	1.30	22.12:1
T2 – FSCJ alone	7.42	22.93	0.80	0.58	1.48	28.67:1
T3 – 1 Part FCGS+ 1 Part FSCJ	7.41	23.63	1.12	0.54	1.33	21.10:1
T4 – Commercial EM (BIOEM)	7.37	23.63	1.07	0.56	1.29	22.08:1

T5 - Compost Manure (Cow Manure)	7.26	18.31	1.05	0.49	0.49	17.44:1
Mean	7.35	22.68	1.07	0.55	1.18	21.19:1
Eighth Week						
T0 – Control (Tap Water)	7.97	24.36	0.92	0.53	1.75	26.47:1
T1 – FCGSalone	7.83	21.04	0.92	0.41	2.35	22.86:1
T2 – FSCJ alone	7.88	24.33	1.12	0.51	3.00	21.72:1
T3 – 1 Part FCGS + 1 Part FSCJ	8.09	24.33	0.68	0.46	2.50	35.78:1
T4 – Commercial EM (BIOEM)	7.90	23.63	0.70	0.61	2.15	33.76:1
T5 - Compost Manure (Cow Manure)	7.24	20.46	0.64	0.56	0.49	31.97:1
Mean	7.81	23.02	0.72	0.51	2.04	31.97:1

CONCLUSIONS

Commercial EM produced the most number of microorganisms upon activation until three weeks of storage. However, for four weeks of storage, the use of 1 Part Fermented Crushed Golden Snail and 1 Part Fermented Swamp Cabbage Juice is more favorable for microbial growth. Moreover, significantly lower temperature was registered on the compost applied with commercial EM from the fifth up to the eight week of composting which is a sign of earlier compost maturity. Also, application of Fermented Squash Cabbage Juice alone improved the percent recovery of compost containing 30% Browns + 30% Greens + 40% Banana Bract and application of commercial EM and Fermented Swamp Cabbage Juice alone improved the nutrient contents (N, P_2O_5 and K_2O) of the compost after four and eight week.

Therefore, application of Fermented Swamp Cabbage Juice alone is recommended for improved percent recovery of compost containing 30% Browns + 30% Greens + 40% Banana Bract. Furthermore, application of commercial EM and Fermented Swamp Cabbage Juice alone is needed for improved the nutrient contents (N, P_2O_5 and K_2O) of the compost after four and eight weeks of composting.

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