Vermicomposting of palm oil empty fruit bunch (EFB) based fertilizer with various organics additives

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Abstract. This work aimed at increasing the nutritional content of EFB vermicompost using organic additives at specific initial C:N ratio. Seven batches of composts namely EFB+POME (A) in 1:1 weight ratio; fishmeal (B); bonemeal (C); bunch ash (D) and combinations EFB+POME, FM, BM and BA in different proportion to achieve the initial C:N ratio of 35 (Compost E), 42 (Compost F) and 47 (Compost G) were prepared. Sawdust was added into Compost E, F, G as Carbon regulator. The results indicated that the compost maturation was achieved on day 40 based on stable temperature and pH profiles. The changes in initial to final C:N ratio were at 59.8 to 29 (A), 3.69 to 7.4 (B), 8.13 to 10.8 (C), 42.3 to 23 (D), 35 to 16 (Compost E), 42 to 15 (Compost F) and 47 to 22 (Compost G). Fishmeal and bonemeal could enhance the nitrogen (N) and potassium (P) of compost but it was found that composting them alone resulted in pest problem due to the pungent rotten smell. Compost G with initial C:N of 47 produced final compost of C:N 22, suggesting for suitable organic formulations for a healthy compost C:N value and possibly with enhanced quality as compared to EFB compost alone. Future work will focus on establishing the quality of compost in terms of NPK and other elemental compositions.

1. Introduction
At yearly generation volume of 19 million tonnes and 53 million m³, EFB and Palm Oil Mill Effluent (POME) are some of the most prevalent byproducts of palm oil industry. Majority of palm oil mills sell raw EFB as cheap fertilizer while POME is treated via open pond oxidation [1]. There are some mills produce higher quality EFB-compost by mixing raw EFM with POME and Effective Microorganism (EM) as the decomposing agent.

For agricultural application, Carbon to Nitrogen (C:N) of compost should remain in the range of 20 to 30. Raw EFB, however, has a very high C:N ratio of 148.96 which leads to extremely slow decomposition and low Nitrogen (N), Phosphorus (P) and Potassium (K) content of 0.3x10⁻³, 0.1x10⁻³ and 3x10⁻² mg/kg respectively as compared to typical fertilizer [2]. A current practice of enhancing nutrient content of compost is by adding artificial N, P, K elements, which is only beneficial in promoting plant growth but has detrimental effect towards the environment. Therefore, much interests have been invested to enhance nutrient properties of EFB based compost by blending it with various organic additives to ensure the aspect of environmental sustainability is taken care of.
One specific method of composting is by vermicomposting; the biological, physical and chemical transformations of solid organic materials through worms and microorganisms [3]. Vermicomposting only takes up half of the time needed in a 12 week period conventional compost, while able to produce finer compost structure for efficient nutrient uptake by plants and better essential macronutrient retaining ability [4]. Vermicomposting also maintains the soil in aerobic state, hence ensuring no release of harmful methane gas as a source of greenhouse gas. It also allows the compost to work as a slow releasing fertilizers to ensure the nutrients in the soil does not get leached out by rain easily.

This paper discusses the vermicomposting of pristine EFB, Fishmeal (FM), Bonemeal (BM), Bunch Ash (BA) and combination of EFB+POME with FM, BM and BA in different proportions to achieve initial C:N ratio of 25, 30 and 35 respectively. FM and BM are organic Nitrogen and Phosphorus sources extracted from rotting fish and animal bone scraps while BA, the leftover ash from incineration of oil palm, is the Potassium source. The work serves as a baseline to any related future work on establishing the quality of compost in terms of NPK and other elemental compositions.

2. Material and Methods

2.1. Material
Empty Fruit Bunches (EFB), Palm Oil Mill Effluent (POME) and Bunch Ash (BA) was obtained from VATA VM Synergy Sdn Bhd upon harvesting the palm oil from the fruits. EFB and POME is mixed in 1:1 mass ratio in accordance to the study made by Hayawin, Astimar, Anis, Ibrahim, Khalil and Ibrahim [2], stating that this is the most optimum mass ratio for healthy decomposition of EFB. Fishmeal (FM) is obtained freely from Dindings Poultry Manjung while Bonemeal (BM) is purchased from Promise Earth (M) Sdn Bhd. Sawdust, the C:N adjustment material, is provided in kind by WanSang Sawmill Enterprise S/B. 50 earthworms and 3kg of soil bedding were also prepared for each batch of compost.

2.2. Methods
2.2.1. Determination of moisture content. Moisture content of individual raw material was analysed using a HX-240 Moisture Analyser by Mettler Toledo. The overall moisture content of the EFB mixed-compost is then calculated using equation (1).

\[ MC_{\text{avg}} = \frac{\sum m_i (MC_i)}{m_T} \]  

where \( m_i \) is the individual weight of each material in the compost, \( MC_i \) is the individual moisture content and \( m_T \) is the total weight of the compost.

2.2.2. Vermicompost preparation. In this work, the base fertilizer is EFB+POME fertilizer in the weight ratio of 1:1. The organic additives that was added into the base fertilizer are Fishmeal (FM) – Nitrogen source, Bonemeal (BM) – Phosphorus source and Bunch Ash (BA) – Potassium source, whereby the theoretical C:N ratio of the raw material are tabulated in Table 1. Table 2 shows the composition of all 7 batches of composts, where compost E, F and G are the mixture of EFB+POME fertilizer blended with different quantity of FM, BM and BA along with some sawdust as C:N adjustment to achieve an initial theoretical C:N ratio of 25, 30 and 35, which is the optimum range of compost C:N ratio. This is done by using equation (2).

\[ C:N_{\text{avg}} = \frac{\sum m_i (C_i \times (100 - MC_i))}{\sum m_i (N_i \times (100 - MC_i))} \]  

where \( C:N_{\text{avg}} \) is the average mixture C:N ratio, \( m_i \) is the weight of the material, \( C_i \) is the carbon percentage of material, \( MC_i \) is the moisture content of material and \( N_i \) is the nitrogen percentage of material. The theoretical C and N for bonemeal was provided by the manufacturer, while the theoretical C and N for sawdust was obtained from the result of previous research student in UTP.
EFB+POME, FM, BM and BA were also composted by themselves to determine whether pre-mixing or post-mixing the material together is feasible. After grinding all the raw materials to 3 mm in size, 7 batch of 3 kg vermicomposts were prepared with the composition as tabulated in Table 2.

Table 1. Theoretical Carbon and Nitrogen value for raw material

| Material       | Theoretical value |  |
|----------------|-------------------|---|
|                | Carbon (%)        | Nitrogen (%) | C/N |
| Fishmeal       | 37.79 [5]         | 11 [5]       | 3.44 |
| Bone meal      | 15.75             | 4.5          | 3.5  |
| Bunch ash      | 0.55 [6]          | 0.08 [6]     | 6.88 |
| EFB+POME       | 38.6              | 1            | 38.6 [2] |
| Sawdust        | 45.93             | 0.125        | 367  |

Table 2. Composition of vermicomposts

| Batch | Composition (kg) | EFB+POME | Fishmeal | Bone meal | Bunch Ash | Sawdust |
|-------|------------------|----------|----------|-----------|-----------|---------|
| Aa    | 3                | -        | -        | -         | -         | -       |
| Bb    |                  | -        | 3        | -         | -         | -       |
| Cc    |                  | -        | -        | 3         | -         | -       |
| Dd    |                  | -        | -        | -         | 3         | -       |
| Ee    | 0.85             | 0.15     | 0.15     | 0.15      | 1.7       |
| Ff    | 1.3              | 0.1      | 0.1      | 0.1       | 1.4       |
| Gg    | 1.45             | 0.075    | 0.075    | 0.075     | 1.33      |

a: EFB+POME fertilizer  
b: Fishmeal  
c: Bone meal  
d: Bunch Ash  
e: EFB mixed vermicompost with initial theoretical C:N = 25  
f: EFB mixed vermicompost with initial theoretical C:N = 30  
g: EFB mixed vermicompost with initial theoretical C:N = 35

Each batch of vermicompost was placed on top of a 3 kg soil bedding in a 15 L container drilled with 36, 20, 43, and 20 holes at the sides and 78 holes at the bottom. The top of the container is covered with nettings and 9 holes were made in the compost to provide better aeration. 50 earthworms, *Eisenia Fetida* were placed into each batch of vermicompost to facilitate the vermicomposting. The raw materials (EFB+POME fertilizer, fishmeal, bone meal and bunch ash) were also composted separately as control to observe the change in physical appearance and nutrient content. This is helpful to determine whether is it feasible to pre-mix or post-mix the organic additives into the EFB compost. All 7 batches of vermicomposts were placed at the outdoor of the Environmental Research Lab of Universiti Teknologi PETRONAS (UTP) and were covered with a canvas to prevent intrusion of rainwater in the event of heavy downpour which will affect the nutrient concentration and moisture content of composts. The initial appearance of the vermicomposts are shown in Table 3.

2.2.3. Determination of pH and temperature. The pH and temperature of every batch of vermicompost were measured in triplicate using a HANNA Instruments Waterproof Tester in every 3 to 4 days whereby these values were used to plot pH and temperature profile to determine the point of maturation for the composts. The condition of the vermicomposts were observed and recorded. Upon finish recording the readings, the composts were moisturized with POME or leachate, shoveled for mixing and perforated with 9 holes.
2.2.4. **Mass yield.** The final dry mass yield of the vermicomposts was calculated using equation (3)

\[
MY = 100 - \left[ \frac{m_1 (100 - MC_1) - m_2 (100 - MC_2)}{m_1 (100 - MC_1)} \right] \times 100\%
\]  

(3)

whereby \(m_1\) is the weight of initial compost mixture, \(m_2\) is the weight of mature compost, \(MC_1\) is the moisture content of initial compost mixture, \(MC_2\) is the moisture content of mature compost.

2.2.5. **CHNS Elemental Analyzer.** The initial and final Carbon (C) and Nitrogen (N) content of EFB+POME, FM, BM and BA were measured using a CHNS Elemental Analyzer in UTP analytical laboratory. The actual initial and final C:N content of the EFB mixed vermicomposts were then calculated using equation (2).

3. **Result and Discussions**

3.1. **Physical observations**

The physical changes in every batch of vermicompost were recorded. Overall, the changes of the vermicomposts were mild and similar day by day, with a few exceptions whereby drastic change in the compost appearance were noticed. The compost with drastic changes that were worth mentioning are listed down in Table 4.

After 20 days of composting, both the fishmeal and bonemeal compost cannot be proceeded due to the rampant growth of flies and the strong odor was starting to cause environmental problem which concerned the technicians in the laboratory. Therefore, the lab technicians requested the composting of fishmeal and bonemeal to be stopped and to move these 2 batches of composts at an isolated open place. This concluded that fishmeal and bonemeal cannot be composted individually and must be pre-mix into EFB compost for an environmental friendly decomposition process.

3.2 **Temperature and pH profiling**

After composting for 52 days, the temperature and pH profile of the composts are plotted to indicate the approximate time of maturation. The full tabulated temperature and pH profile is tabulated in Table 5 and Table 6 respectively. The graphs of the temperature and pH profiling against time is plotted in Figure 1 and Figure 2.

| Day | Compost Batch |
|-----|---------------|
|     | A  | B  | C  | D  | E  | F  | G  |
| 1   | 25.0 | 25.0 | 27.0 | 28.0 | 34.0 | 34.0 | 32.0 |
| 5   | 29.0 | 40.0 | 42.0 | 28.0 | 31.0 | 31.0 | 31.0 |
| 8   | 28  | 31.5 | 35  | 27.5 | 29  | 29.5 | 28.8 |
| 13  | 26.75 | 28  | 27.25 | 27  | 27  | 27.75 | 28.6 |
| 16  | 27.65 | 20.92 | 29  | 27.35 | 28.95 | 30.35 | 28.75 |
| 20  | 29.13 | 33.8 | 29.9 | 29.63 | 30.3 | 30.25 | 29.38 |
| 24  | 34.08 | -   | -   | 31.33 | 34.05 | 34.33 | 33.05 |
| 27  | 29.33 | -   | -   | 28.85 | 29.63 | 29.55 | 31.03 |
| 30  | 27.4  | -   | -   | 26.83 | 28.08 | 27.95 | 27.75 |
| 34  | 26.05 | -   | -   | 25.6  | 26.55 | 26.45 | 26.03 |
| 37  | 26.8  | -   | -   | 26.43 | 27.13 | 27.08 | 27.3  |
| 41  | 25.4  | -   | -   | 24.83 | 25.7  | 25.38 | 25.33 |
| 45  | 29   | -   | -   | 28.93 | 29.63 | 28.63 | 29.6  |
| 48  | 28.53 | -   | -   | 28.4  | 29.53 | 29   | 29.1  |
| 52  | 29.73 | -   | -   | 28.78 | 28.3  | 28.1  | 28.13 |
Table 4. Initial physical observation of vermicomposts.

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| ![Image](image1.png) | ![Image](image2.png) | ![Image](image3.png) | ![Image](image4.png) | ![Image](image5.png) | ![Image](image6.png) | ![Image](image7.png) |

Table 5. Vermicomposts with drastic appearance changes and reasoning.

| Compost | Observations | Reasoning |
|---------|--------------|-----------|
| Day 5: C | - Large amount of white silky structure covering the compost. | - White silky structure is caused by fungal soil infection (sclerotia) [7]. |
|         | - The soil is severely hardened. | - Soil hardening is due to the fungal response to environmental stress by hardening their mycelia [8]. |
|         | - Very bad odour. | - Bad odour is due to the low pH condition caused by formation of odorous organic acid. [9] |
| Day 5: B | - Formation of large quantity of maggots in the compost. | - The maggots formed are soldier fly larvae which feed on nitrogen – dominant decaying materials [10]. |
| Day 13: E, F, G | - Very bad odour. | - Spores suspending in air landed in the compost and cause the growth of mushrooms. The growth of mushrooms indicate the compost is healthy [11]. |
| Day 20: B | - Sudden sprout of large quantity of mushrooms in all three batches of mixed compost. | - The three batches of mixed compost possess similar fluffy structure and releases earthy smell. |
| Day 52: E, F, G | - The compost is flooded with brown foul odour liquid. | - The brown liquid is the body secretion of soldier fly larvae after they consumed the organic components in the fishmeal [12]. |
|         | - The cellulose and lignin structure is broken down as the decomposition of compost is proceeded [13]. A compost with fine structure also indicates maturation. | - The cellulose and lignin structure is broken down as the decomposition of compost is proceeded [13]. A compost with fine structure also indicates maturation. |
| Day | Compost Batch | | | | | |
|-----|--------------|---|---|---|---|---|
|     | A   | B   | C   | D   | E   | F   | G   |
| 1   | 7.00| 7.00| 6.00| 5.00| 6.50| 5.50| 6.00|
| 5   | 7.00| 5.00| 6.00| 6.50| 6.50| 6.50| 6.50|
| 8   | 7.00| 5.00| 5.70| 6.25| 7.00| 7.00| 6.60|
| 13  | 7.00| 6.50| 6.50| 5.50| 5.88| 6.75| 6.88|
| 16  | 8.26| 3.91| 8.10| 8.42| 5.50| 6.29| 6.34|
| 20  | 8.98| 4.56| 8.41| 6.38| 8.06| 6.51| 8.55|
| 24  | 5.99| -   | -   | 6.73| 6.20| 5.72| 6.05|
| 27  | 6.28| -   | -   | 6.29| 5.78| 5.77| 6.75|
| 30  | 6.35| -   | -   | 6.93| 6.19| 6.62| 6.18|
| 34  | 6.25| -   | -   | 6.34| 6.19| 6.29| 6.20|
| 37  | 6.56| -   | -   | 6.61| 6.37| 6.54| 6.69|
| 41  | 6.84| -   | -   | 6.84| 6.25| 6.36| 6.40|
| 45  | 6.69| -   | -   | 6.70| 6.14| 6.38| 6.58|
| 48  | 6.68| -   | -   | 6.64| 6.87| 6.53| 6.69|
| 52  | 6.71| -   | -   | 6.82| 6.32| 6.41| 6.17|

**Figure 1.** Graph of compost temperature against time

Temperature rise in compost is contributed by the heat generated from microbial breakdown of organic matter. The temperature profile of a compost generally consists of mesophilic phase (44 – 52 °C), thermophilic phase (>70 °C) and psychrophilic phase (-10 – 20 °C) [14]. From Figure 1, it is observed that both fishmeal (B) and bonemeal (C) has a temperature spike in day 5. This indicates both fishmeal and bonemeal contains sufficient nitrogen and moisture for rapid microbial growth, which resulted in large intensity of heat released [15]. However, the temperature only reach around 40 to 45 °C (mesophilic phase). The temperature of other 5 batches of composts fluctuates between 25 to 35 °C, which indicates steady decomposition of non-nitrogen rich organic matters in the compost. All 7 batches of composts did not exhibit the full spectra of temperature change, which could be due to the cool rainy weather that affects the composts and hence, temperature cannot be a reliable indicator of maturation for the compost [16]. This also indicated that the composts should be placed indoor for more accurate temperature monitoring.
The microbial consumption of organic matters in the compost by the microorganisms creates organic acid and alkaline ammonium ions which leads to the fluctuating cycle of pH changes in the compost. From Figure 2, a decrement in fishmeal (B) and bonemeal (C) pH around day 5 is observed, matching their temperature rise shown in Figure 1, indicating that rapid aerobic growth of microorganisms due to large quantity of nitrogen releases a substantial amount of organic acids that reduces the compost pH during that period of time [17]. At around day 15 – 20, the composts showed a sudden rise in pH in around day 15 – 20, which could be due to the increase in alkaline ammonium ion in the form of ammonia generated from biochemical reaction of the nitrogen-containing element [18, 19]. EFB+POME compost (A) has reached the highest pH, which is in line with the findings of Hayawin et al. [2], stating that the addition of partially treated POME into EFB compost will produce a slightly alkaline compost environment. Since compost A has the largest initial POME mass concentration, it is logical to deduce that this batch of compost can achieve the highest pH with the accompaniment of alkaline ammonium ion released from biochemical reaction of nitrogen containing material. After day 25, all the composts started to show stabilizing pH trend, which indicates gradual maturation of composts.

The pH profile of C:N 30 (F) is selected to determine the maturation of compost, as it is generally report that C:N 30 is the optimum C:N ratio of compost. From the Figure 3, the pH of the compost began to stabilize and coalesce with the dotted trendline around day 40 onwards, indicating the maturation of compost occurs at day 40 with an average maturation pH of around 6.3, which is in between healthy pH range of 5.5 – 8 [17].

Figure 2. Graph of compost pH against time

Figure 3. pH profiling of C:N 30 (F) compost.
3.3 Moisture analysis

The initial and final moisture content of the raw material and vermicomposts are tabulated in Table 7. Note that the moisture content of the EFB mixed vermicompost (compost E, F, G) were calculated using equation (1). The final moisture content of sawdust is not of interest since it is not composted alone. Despite stop recording the pH and temperature, samples of fishmeal (B) and bonemeal (C) were also collected on the same collection day of other samples for moisture analysis to calculate its mass yield.

Table 7. Initial and final moisture content of raw material and vermicomposts.

| Material          | Moisture (%) | Initial | Final |
|-------------------|--------------|---------|-------|
| EFB:POME (A)      |              | 49.06   | 72.03 |
| Fish meal (B)     |              | 9.81    | 26.95 |
| Bonemeal (C)      |              | 7.76    | 54.37 |
| Bunch ash (D)     |              | 14.9    | 42.01 |
| Saw dust          |              | 41.69   | -     |
| C:N 25 (E)        |              | 39.15   | 59.32 |
| C:N 30 (F)        |              | 41.80   | 72.44 |
| C:N 35 (G)        |              | 42.94   | 64.71 |

According to Liang, Das and McClendon [20], composts should contain an optimum moisture content range of 50 – 70%. Liang et al [20] mentioned that moisture content lower than 50% halts biological process in compost due to dehydration of microorganisms, while excessively high moisture will cause water logging in the compost, causing an anaerobic condition which will affect composting activity.

Having moisted by POME, EFB:POME has the highest initial moisture content. Saw dust possesses a hydrophilic nature that allows it to absorb water from the atmosphere and thus, contributing to the significant moisture content [21]. Bunch ash also contains small amount of initial moisture despite being the product of incineration due to its hygroscopic nature which allows easy absorption of atmospheric moisture [22]. The initial moisture content of bonemeal and fishmeal, however, are the lowest among all samples since they are obtained from the suppliers in dried state.

After composting for 40 days, every batch of vermicompost experienced an increase in moisture content due to constant moisturization using POME. EFB+POME has a high water absorptivity which leads to large increment in moisture content [23]. In B and C, the growth of large amount of fly larvae produced astonishing amount of secretion as a result of organic matter consumption in the compost which leads to a large increment in the moisture content [12]. Bunch ash, having hygroscopic nature, possess great ability to retain liquid which resulted in large increment of moisture content [22]. The three batches of mixed compost (E, F, G) generally possess high moisture content. Compost E has the lowest moisture content among the three composts, which might be contributed by the lowest amount of moisture absorbing EFB+POME and sawdust in this batch of compost. Compost F has the highest moisture content despite containing lower amount of moisture absorbing EFB+POME and sawdust than Compost G, which is possibly due to the accidental intrusion of exterior moisture source (eg: rain water) during day 15 – 20. Hence, from the result, co-composts E and G has achieved satisfactory moisture content of 50 – 70% by Liang et al [20] while co-compost F has moisture content slightly above recommended range.
3.4 **Mass yield**

The mass yield of each batch of compost is calculated using equation 3 upon completion of composting. The result is tabulated in Table 8.

| Compost          | Final total mass (kg) | m2 (kg) | MC1 (%) | MC2 (%) | Mass Yield (%) |
|------------------|-----------------------|---------|---------|---------|----------------|
| EFB+POME (A)     | 7.85                  | 3.65    | 49.06   | 72.03   | 91.39          |
| Fishmeal (B)     | 5.2                   | 1       | 9.81    | 26.95   | 40.62          |
| Bonemeal (C)     | 7.5                   | 3.3     | 7.76    | 54.37   | 61.22          |
| Bunch Ash (D)    | 7.65                  | 3.45    | 14.9    | 42.01   | 84.33          |
| C:N 25 (E)       | 7.4                   | 3.2     | 39.15   | 59.32   | 89.38          |
| C:N 30 (F)       | 8.45                  | 4.25    | 41.80   | 72.44   | 88.85          |
| C:N 35 (G)       | 7.55                  | 3.35    | 42.94   | 64.71   | 89.93          |

Based on the tabulated result, the mass yield of every vermicompost is less than 100% as a result of organic decomposition of compost. The mass yield of EFB+POME is very high, which is in line with the literatures where EFB has slow decomposition rate due to high C:N ratio. On the other hand, both fishmeal and bonemeal has a low mass yield due to rapid decomposition of large amount of nitrogen element [24]. Mass yield of bunch ash is around 85%, signifying not much decomposition process was happening. As for the EFB mixed compost, they have high mass yield of around 88 to 90%. A large portion of the compost is contributed by EFB:POME and sawdust which extremely difficult to decompose in nature. The decrement in the mass is mainly due to decomposition of fast degrading material such as fishmeal and bonemeal.

3.5 **Carbon and Nitrogen analysis**

The C:N ratio of each compost on day 40 is tabulated in Table 9.

| Sample          | Initial C | Initial N | C:N      | Final C | Final N | C:N      |
|-----------------|-----------|-----------|----------|---------|---------|----------|
| EFB+POME (A)    | 42.423    | 0.709     | 59.877   | 31.894  | 1.083   | 29.450   |
| Fishmeal (B)    | 43.927    | 11.912    | 3.688    | 17.453  | 2.350   | 7.428    |
| Bonemeal (C)    | 29.421    | 3.619     | 8.131    | 15.145  | 1.397   | 10.845   |
| Bunch Ash (D)   | 7.410     | 0.175     | 42.340   | 10.274  | 0.439   | 23.430   |
| C:N 25 (E)      | 42.601    | 1.215     | 35.072   | 24.067  | 1.504   | 16.007   |
| C:N 30 (F)      | 42.934    | 1.019     | 42.141   | 23.324  | 1.540   | 15.150   |
| C:N 35 (G)      | 43.211    | 0.913     | 47.314   | 33.055  | 1.481   | 22.327   |

Comparing with Table 1, there is a large difference in the initial C:N ratio of EFB+POME and bunch ash with the theoretical values as the species of palm oil in both cases could be different, which directly affect the initial C:N ratio of compost E, F and G. Compost with C:N greater than 30 experienced a drop of C:N ratio after the 40 days, while fishmeal and bonemeal experienced an increase in C:N ratio, indicating the compost will balance its own carbon and nitrogen content during decomposition to achieve a natural C:N ratio of roughly 20 to 30. Compost G with initial C:N of 47 produced final compost of C:N 22, which is within the optimum C:N range of 20 to 30, hence suggesting it comprises suitable organic formulations for a healthy compost C:N value with also possibly high essential macronutrient values.
4. Conclusion
Empty Fruit Bunches (EFB) has superior blending properties with different organic wastes to enhance its final nutritional status. This work discovers the final compost quality when EFB+POME in weight ratio of 1:1 is vermicomposted with fishmeal (N source), bonemeal (P source) and bunch ash (K source). Vermicomposting the EFB+POME as based fertilizer topped up with the mentioned organic wastes enhanced its decomposition rate while promising more superior final compost quality as compared to utilizing conventional composting. The EFB co-composts took around 40 days to achieve maturation which is considered fast as compared to commercial compost. The EFB co-compost has a fluffy structure which supports aeration and a high mass yield of around 88 to 90% with moisture content of around 55 – 70%. The final C:N ratio of compost F is 22, suggesting it comprises suitable organic formulations for a healthy compost C:N value with also possibly high essential macronutrient values. Future work will examine the final nutritional quality of the EFB mixed vermicomposts and conduct comparison between proposed fertilizer with commercial organic fertilizer to consolidate the market potential of proposed product.

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