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EFFECTS OF RAW SOURCES ON THE FERTILITY LEVELS OF BIO-FERTILIZERS

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ABSTRACT

An experiment was conducted from 8th February 2021 to 15th March 2021 to determine the properties of bio-fertilizers (composts) using sawdust, cow dung, fish waste and urea at different ratios. The experiment was laid out in a Completely Randomized Design (CRD) with ten treatments in three replications (total thirty) comprising of C1 (sawdust), C2 (sawdust + cow dung = 1:1), C3 (sawdust + cow dung = 2:1), C4 (sawdust + cow dung = 1:2), C5 (sawdust + 2% urea of total weight), C6 (sawdust + 4% urea of total weight), C7 (sawdust + 6% urea of total weight), C8 (sawdust + fish waste = 1:1), C9 (sawdust + fish waste = 2:1) and C10 (sawdust + fish waste = 1:2) by weight. The study revealed that after composting C6, C8 and C9 had the highest pH value (7.90) while C1 had the lowest pH value (7.37). In the case of EC, C8 showed the highest EC in all sampling time (0.87 mS/cm, 0.61 mS/cm, and 0.50 mS/cm in 21st, 28th and 36th days respectively) although it decreased with time. On the other hand, C1 had the lowest EC value (0.05 mS/cm, 0.06 mS/cm, and 0.05 mS/cm in 21st, 28th and 36th days respectively). The total organic matter of C10 decreased (16.52%) at the last stage of composting. The maximum value of bulk density was C1 (0.03 gm/cm^3) and the minimum value was for C5 (0.02 gm/cm^3) of the final compost. The C10 attained the most value (2.12 gm/cm^3) of particle density while the C2 attained the least value (0.87 gm/cm^3) on the last day of composting. The C7 had the highest (90%) water holding capacity and C1 had the lowest (40%) after composting. The results indicate that composting of sawdust and cow dung is a reliable and simple method for the production of organic fertilizer that would improve soil quality.

Key word: Compost, soil amendments, sawdust, cow dung, fish waste, urea.

Introduction

The population of the world is increasing rapidly, which is encouraging people to use chemical fertilizers indiscriminately in agricultural lands all over the world to increase crop production. Chemical fertilizers boost crop yields, but their excessive usage has hardened the soil, reduced fertility, strengthened insecticides, polluted air and water, and emitted greenhouse gases, posing health and environmental risks (Shambhavi *et al.*, 2017). Organic fertilizers are one of the best management techniques for restoring soil condition and productivity (Ali *et al.*, 2017 Composting agricultural land is thought to be a cost-effective, practical, and eco-friendly option (Brochier *et al.*, 2012). Proper composting decreases odor emissions and nitrogen loss, resulting in a somewhat stable organic waste product that can be utilized as a fertilizer (Qasim *et al.*, 2018). In recent years, there has been an increase in demand for the recycling of these materials in agriculture due to the benefits of reducing natural resource consumption, allowing nutrients to be recycled, increasing soil organic matter levels, and, as a result, improving the physical, chemical, and biological characteristics of soil (Westerman and Bicudo, 2005). Cattle manure is one of the best management options due to its high nutritional value (Abou El-Magd *et al.*, 2006; Ogundare *et al.*, 2015). On the other hand, Sawdust is a waste or byproduct of sawmills (Khatun *et al.*, 2020). Every day, a massive amount of wood is generated at Bangladesh's 4,800 sawmills and wood-based businesses. A tiny portion is used as cooking fuel, while the majority is squandered since it has no practical value (Islam and Momin, 2004). Sawdust offers potential in delivering humus once added to soil since it is an extra plant residue and a rich carbonaceous component (Tran, 2005; Ikenyiri *et al.*, 2019). Scientists have recently focused their attention on using this trash as a soil supplement in agriculture due to its high carbon concentration and it is about 50% (Parry *et al.*, 2007; Khatun, *et al.*, 2020). As sawdust generally contains 0.1% to 0.2% nitrogen, soil microorganisms in the soil where it is treated in significant amounts may experience a nitrogen shortage and will seek nitrogen from other sources such as a soil pool and extra fertilizer (i.e. urea) (Ashiono *et al.*, 2017). Fish byproducts are high in protein and may be composted as a nitrogen source. Fish might be a good substrate for lowering the C/N ratio to 20–30, which is good for composting when dealing with high carbon waste (López-Mosquera *et al.*, 2011). The uses of those organic wastes ensure sustainable as well as safe agriculture over the world. The farmers of our country only may accept the options when they achieve desired crop yield, which is one of the crucial outcomes of plant nutrients. As organic by products are the vital sources of nutrients, hence it is a demand to judge the fertility/nutrient levels of bio-fertilizers/composts. Therefore, the study was designed to check the effects of raw sources on the fertility levels of bio-fertilizers in Bangladesh.

Materials and Methods

Study area: The composting process was performed in the campus of Mawlana Bhashani Science and Technology University, Tangail-1902, Bangladesh and Bangladesh Agricultural Development Corporation (BADC), Tangail. The analysis was conducted in the laboratory of the Department of Environmental Science and Resource Management Department, Mawlana Bhashani Science and Technology University.

Sample Collection: Sawdust was collected from Ghosh Para saw meal, Santosh, Tangail Sadar, Tangail. Cow dung was collected from the Bangladesh Agricultural Development Corporation (BADC) farm of Tangail Sadar Upazila. Fish waste was collected from Park Bazar, Tangail Sadar, Tangail. Urea was collected from local shop at Baby Stand Bazar, Tangail Sadar. Places of sample collection are situated nearby Mawlana Bhashani Science and Technology University campus.

Experimental set up: Four different types of experiments were done: Experiment A with sawdust +cow-dung; Experiment B with sawdust +urea; Experiment C with sawdust +fish waste and Experiment D with sawdust only. Experiments A to C had three different treatments. Every treatment had three replications. Experiment D was raw sawdust. It did not have different treatment but had three replications. Table 1 show a total of ten treatments which were done with three replications in thirty cylindrical sized pots in a shed. A total of 30 samples were prepared to complete this whole experiment. Every sample was 600 gm in weight. The experiments were conducted from 8th February 2021 to 15thMarch 2021. In the study, sawdust was used as the common by-products/materials and even solely, hence different combinations were followed for exploring results of the study.

Table 1. Details of the treatments for experiment

Treatment	Details of the treatment	Weight (gm)
C1	Sawdust	600
C2	(sawdust + cow dung = 1:1)	300+300
C3	(sawdust + cow dung = 2:1)	400+200
C4	(sawdust + cow dung = 1:2)	200+400
C5	(sawdust + 2% urea of total weight	588+12
C6	(sawdust + 4% urea of total weight	576+24
C7	(sawdust + 6% urea of total weight	564+36
C8	(sawdust + fish waste = 1:1)	300+300
C9	(sawdust + fish waste = 2:1)	400+200
C10	(sawdust + fish waste = 1:2)	200+400

The composting period was determined to be 36 days based on experience from the preceding research. Compost samples were collected to evaluate various physicochemical parameters like pH, EC (Electrical Conductivity), TOC (Total Organic Carbon), and TOM (Total Organic Matter) after the 21st, 28th and 36th day of composting respectively. Other parameters such as bulk density, particle density and water holding capacity were determined at the end of composting (36th day).

Analytical method: pH was determined by digital pH meter. Total Organic Carbon (TOC) was determined by Tyurin's method. The Total Organic Matter (TOM) in soil was calculated by multiplying the values of total organic carbon within a factor of 1.724 based on the assumption on the organic matter of average soil containing 58% of organic matter (Huq and Alam, 2005). EC was determined by digital EC meter. Bulk Density was measured by core method and particle density was measured by pycnometer method.

Statistical analysis: The samples gathered from individual composting containers were treated as triplicates for each sampling time and their mean with standard error is reported in this paper, which is calculated using Microsoft Excel, 2010. Pearson's correlation among different parameters of compost was determined using SPSS 20.0. The results of Pearson's correlation were then depicted with a heat map using MS Excel, 2010.

Results and Discussion

Changes of pH during composting: The pH value of C3 decreased in comparison with C1 at the end of composting. This decrease in pH value, attributed to an increase in organic acid generation or nitrification might be due to the H+ created during microbial nitrification (Chen *et al.,* 2015). According to Eklind and Kirchmann (2000), the decrease in pH with composting time is due to a reduction in ammoniacal N-volatilization and carbon dioxide emission throughout the composting process. The high amounts of carbon dioxide released during the composting process might cause a decreasing the pH (Huang, 2004). The pH value increased from 7.60, 7.60, 7.63 to 7.83, 7.93 and 7.80 for C5, C6 and C7 respectively at the end of composting. The rise in pH might be caused by ammonia formation during ammonification and the mineralization of organic nitrogen as a result of microbial interaction (Qasim *et al.*, 2019). Torkashv *et al.* (2008) noted that increased urea levels have lowered microbial activity, resulting in an increase in N and a reduction in C. Because of the increased amount of acidic sawdust and higher volatilization of ammonia, the pH of C1 might be lower throughout the composting period. The value of C10 remained constant at 7.63 from the 21st day to the 36th day of composting. When we added a greater amount of fish waste it might be the decreasing of pH due to ammonia. The decline might also be attributed to the breakdown of organic materials and the formation of organic and inorganic acids by microorganisms in compost (Mathur, 1991; Sweeten and Auvermann, 2008).The variation of pH with time during the composting process is presented in Fig. 1.

EC variation during composting: EC of C3 and C4 both decreased from 0.37 mS/cm and 0.47 mS/cm on 21st day to 0.31 mS/cm and 0.30 mS/cm on the 36th day respectively. The EC of C2 slightly decreased from 0.51 mS/cm to 0.50 mS/cm in the composting period. The reduction of water-soluble compounds and the volatilization of ammonia, as well as the formation of mineral salts throughout the process, may be responsible for the ongoing lowering in EC values from the start of the composting process (Watson, 2003; Rashad *et al.*, 2010). At the end of composting C5, C6 and C7 decreased EC value but EC of C1 increased. The rise might be attributed to the release of mineral salts such as phosphates and ammonium ions as organic matter decomposes. With the increase of fish waste ratio, the more decrease in EC value of C10 than C8 and C9 in the last stage of composting. The final EC values of the resulting composts were less than 1.5 mS/cm, indicating that they may be used as soil additions (Watson, 2003). When the EC value of fish compost is 1.2 mS/cm, it will not impair the development of most crops (Rashad *et al.*, 2010).The variation of EC with time during the composting process is presented in Fig. 2.

Changes of TOC during composting: On the 36th day, C1, C2, and C4 showed a similar nature of decreasing of TOC whereas C3 dramatically showed the difference of increasing (1.70% to 1.90%), which is supported by Obasi *et al.* (2013), where the addition of organic carbon/matter sources such as sawdust stimulated microbial activity. On the 36th day, C5, C6 and C7 showed the same nature of increasing TOC except C1. This increasing nature might be due to the decreasing of microbial activity for adding chemical fertilizer (Albert and Anyanwu, 2016). C8 showed the TOC variation for the 28th day but increased for the 36th day. Obasi *et al.* (2013) noted that this might be also for increasing microbial activities due to adding organic amendments. The variation of TOC with time during the composting process is presented in Fig. 3.

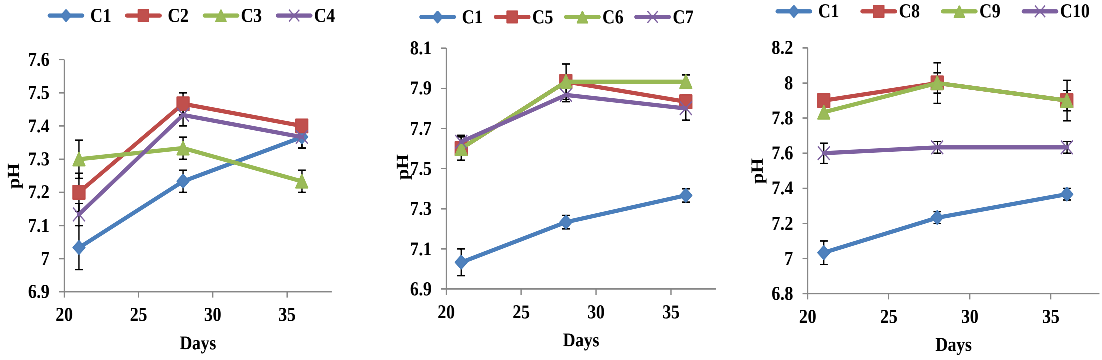

Fig. 1. pH variation during composting

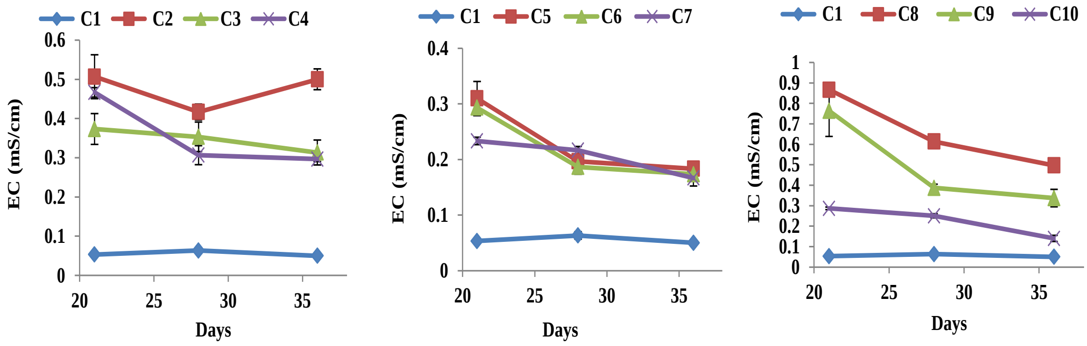

Fig. 2. EC variation during composting

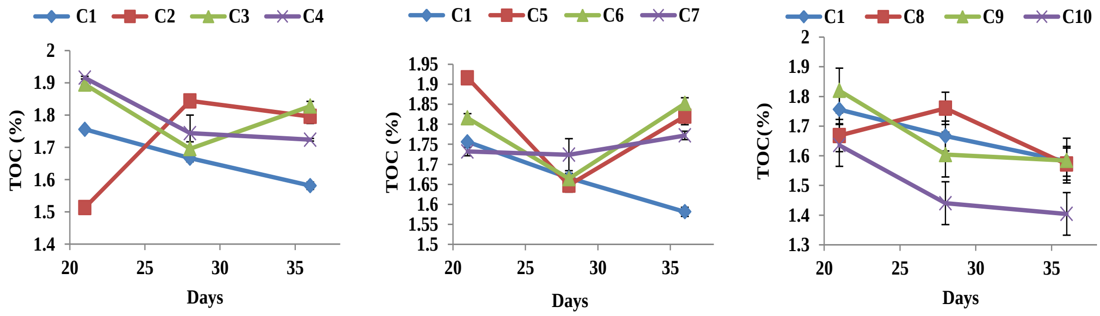

Fig. 3. TOC variation during composting

Changes of TOM during composting: The nature of TOM changes is shown in the first graph for sawdust and cow dung for different treatments. The result of TOM is found similar to TOC. In 21st day of composting, the TOM value of C4 was high (3.30%) compared to C1, C2 and C3. This might be for the increase of organic substances. On the 28th day, C1, C3 and C4 showed the same behavior of decreasing whereas C2 showed the different nature of increasing (2.61% to 3.18%) TOM. On the 36th day, C1, C2 and C4 showed a similar nature of decreasing whereas C3 dramatically showed the difference of increasing (2.92 to 3.15) TOM. The nature of TOM changes is shown in the second graph for sawdust and urea for different treatments. In 21st day of composting, TOM was high for C5 (3.30%) compared to C1 (3.03%), C6 (3.13%) and C7 (2.99%). On the 28th day, all the treatments showed the same nature of decreasing. On the 36th day, all the treatments showed the same nature of increasing except C1. This increasing nature might be due to the decreasing of microbial activity for adding chemical fertilizer (Albert and Anyanwu, 2016). TOM change for sawdust and fish waste for different treatments are shown in third graph. In 21st day of composting C9 had the highest TOM (3.14%) compared to C1 (3.03%), C8 (2.87%) and C10 (2.82%). On the 28th and 36th days, all the treatments showed a similar nature of decreasing TOM except C8. C8 showed the same nature for the 28th day but increased for the 36th day. According to Obasi*et al.* (2013), this might be also for increasing microbial activities due to adding organic amendments. The variation of TOM with time during the composting process is presented in Fig. 4.

Bulk density: Bulk density was found highest for C1 and lowest for C5 (0.02 gm/cm^3). On average, sawdust and cow dung composts (C2, C3, and C4) showed the highest bulk density, and sawdust and urea compost (C5, C6, C7) showed the lowest. Sawdust and fish waste compost (C8, C9, C10) showed the average compared with these two mixtures. The dry bulk density ranges from 100 to 400 kg/m^3, whereas the wet bulk density ranges from 500 to 900 kg/m^3 (Agnew and Leonard, 2003). Some authors agreed that the use of different organic waste materials (chicken manure, cow dung) reduced bulk density in both short and long-term studies (Agbede *et al.*, 2017). In comparison to synthetic fertilizer, Celik *et al.* (2010) found that the addition of compost resulted in the lowest bulk densities. The bulk density of fibrous materials containing high lignin normally increases during composting (Madejón *et al.*, 2002).Bulk density was measured after completing the composting process on the 36th day which is given in Fig. 5.

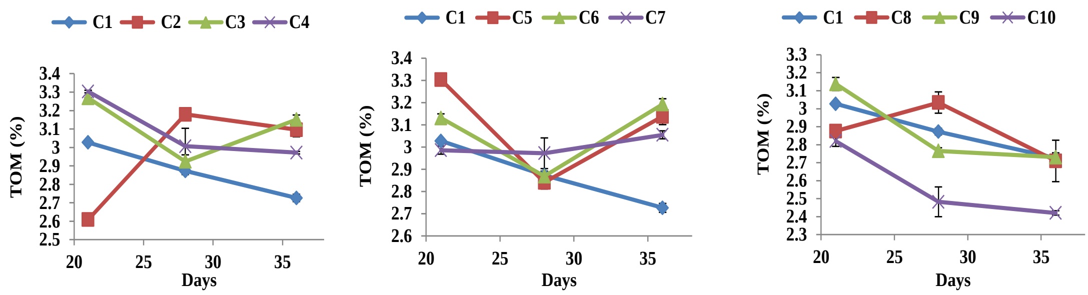

Fig. 4. TOM variation during composting

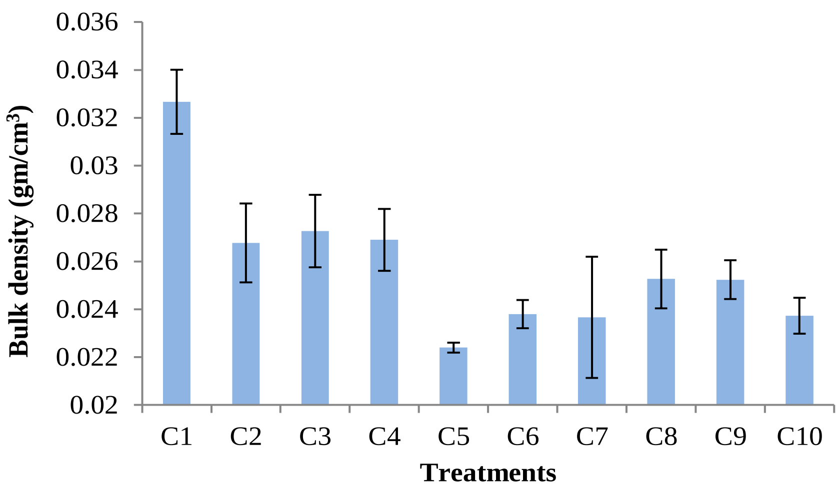

Fig. 5. Bulk density of final compost

Particle density: Particle density was found the highest 2.12 gm/cm^3 for C10 and the lowest 0.87 gm/cm^3 for C2. Ginkel *et al.*, (1999) and Mohee and Mudhoo (2005) both found a significant fluctuation in particle density in the composting process over time. The change in ash concentration and volatile substances throughout the composting process influence particle density (Ginkel *et al.*, 1999). The current research finds significantly low particle density values, which might be linked to fibrous interference in waste material that was not fully decomposed (Ginkel *et al.*, 1999; Jain *et al.*, 2018). Particle density was measured after completing the composting process on the 36th day which is presented in Fig. 6.

Water holding capacity: Water holding capacity for C1 showed the lowest value (40%), and C7 showed the highest value (90%). Many features of organic matter may have a role in increasing water holding capacity which is noted by some authors (Rayne and Aula, 2020). Similar results were found in biochar application to the soil (Ni *et al.*, 2020). Soil treated with chicken or farmyard manure held more water than unamended soil (Ahmed *et al.*, 2010). In this study, sawdust with urea compost had higher water holding capacity than others which is similar to Schjønning *et al.* (1994). Water holding capacity was measured after completing the composting process on the 36th day which is presented in Fig. 7.

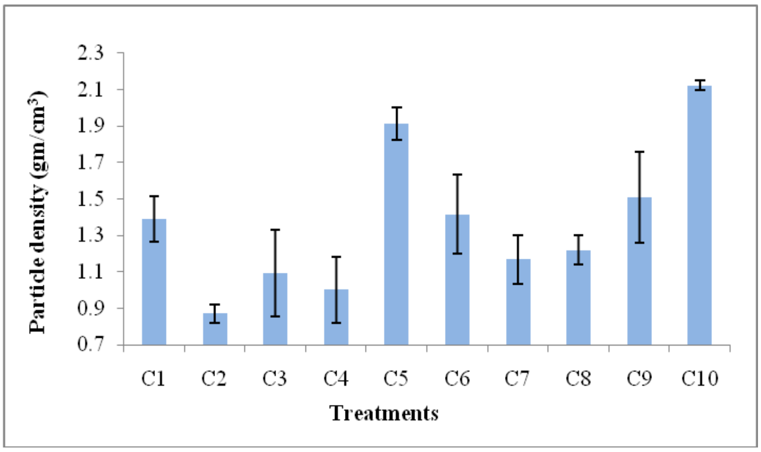

Fig. 6. Particle density of final compost

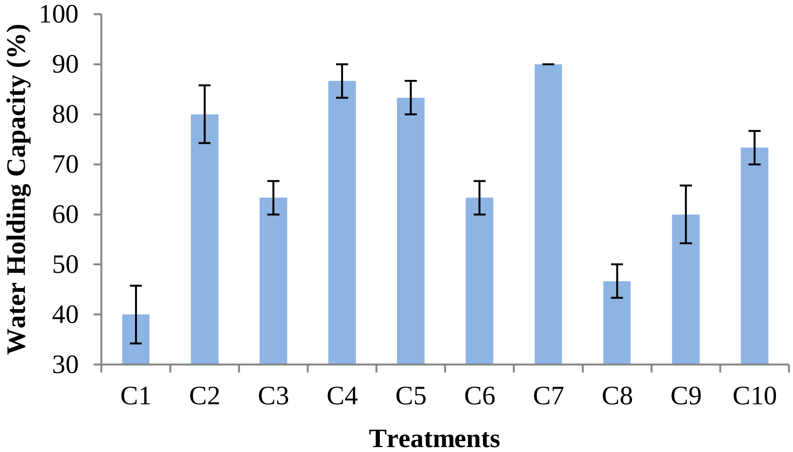

Fig. 7.Water holding capacity of final compost

Conclusion

Organic fertilizers might be used instead of mineral fertilizers, helping to conserve resources and recycle organic matter. Our results indicate that a mixture of sawdust and fish waste at a 1:2 ratio has suitable conditions to produce bio fertilizer but fish waste scales, bones decompose relatively late and due to its high cost it is best not to use them on a large scale as composting. The total organic matter decreased at C10>C9>C4>C1>C8>C5>C3and increased at C6>C7>C2 respectively. So, mixed with organic fertilizer sawdust and cow dung at a 1:2 ratios would be an efficient soil amendment that would improve soil quality.

This may be helpful to evaluate maximum replenishment of degraded soil by using this fertilizer which was made from locally available raw materials. More study is required to observe the effects of the composts produced on plant growth and soil physical and chemical properties.

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