

<https://doi.org/10.46344/JBINO.2021.v10i03.14>

PREPARATION AND CHARACTERIZATION OF VERMICOMPOST OBTAINED FROM DIFFERENT PLANT LEAF LITTERS, CROP RESIDUAL AND ANIMAL WASTES IN TERMS OF NUTRIENT CONTENTS WESTERN

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ABSTRACT

The activity was done at Bako Agricultural Research Centre (BARC) on station 2020–2021. The experiment was considered to prepare and characterize vermicompost obtained from residual of crops, plant leaf litter and farmyard manure in the area in terms of chemical composition to identify the quality compost from them. Eleven types of feedstock materials mixture were used as a treatment which was converted into vermicompost subsequently two months to give a uniform material. The Laboratory analysis for its chemical composition. The PH of all type of vermicompost were in appropriate range for plant development. The percentage of carbon to nitrogen ratio and organic carbon vermicompost have good. The vermicompost gained from the combination of croton macrostachyus, Faba bean and farmyard manure has higher value of 2.44% total nitrogen. Some vermicompost were very poor in other primary and secondary plant nutrient elements. The vermicompost produced from the combination of *Cordia Africana* and farmyard manure recorded a higher value in total phosphorus, total potassium and total magnesium and *Cordia Africana*, finger millet and farmyard manure the highest score value in calcium content. The result of these study was showed that regardless of providing other important nutrients needed for plant growth, 4.66 tons of this vermicompost can substitute the suggested amount of urea (92 kg N), supplying simultaneously (65.23 kg P2O5), an amount which surpasses the recommended amount of phosphorus for some crop. Thus, by feature of the availability of raw materials, easiness of its manufacture and well availability of the nutrient contained in it to the plant, utilizing the vermicompost of croton macrostachyus and farmyard manure has a principal importance in increasing crop yield and improving soil productiveness.

INTRODUCTION

Generation off the extensive amount of leaf litter produced by trees rising in the forests, along the streets, in the backyard, sideways, in the garden as well as in farm and crop residual has always been a problem. Inappropriate management of leaf wastes such as, burning, dumping in public places etc. has deteriorate the health and environment. Leaf litters and crop residual burning are which causes several health problems, especially respiratory like asthma and heart diseases In India, (Sannigrahi, 2009). and also, in rural area use leaf litter as biomass fuel for cooking. By using solid biomass for cooking many women and children die due to indoor air pollution in India (Sannigrahi, 2009) in addition to this leaf litter and crop residual wastes when applied directly added into soil or farming fields reason of soil and environment related problems including phytotoxicity (Hsujh, losl et al.,1999).

(Tripathi and Bhardwaj 2004) state that the modification of a negative waste into advantageous materials an important aspect of resource recycling and environmental and Negative wastes represent a valuable organic resource, when it is recycled and transformed into nutrient rich fertilizer (Calabi-FloodyM et al., 2018). The best alternative to make proper use of the available unutilized organic recyclable wastes to convert them into compost within a short period. Leaf litters and crop residual are a potential energy resource if properly converted to organic matter(vermicompost). (Mallet et al., 2005). says conversion of leaf litter and crop

residue in to compost is an easy way by using mesophilic earth worm activity.

Vermicomposting is the use of mesophilic earthworms to produce an organic fertilizer from organic waste (Ndegwa, et al, 2001). Vermicompost restore & improve soil fertility as well as significantly increase crop production and the most effective means to alleviate and manage environmental pollution problems (Waleed SA et al, 20160). Vermicomposting of organic waste and their application in the fields could decrease the number of chemical fertilizers and eventually replace it and its richer by important micronutrient and beneficial soil microbe such as nitrogen fixing, phosphate solubilizing bacteria and actinomycetes and it's an excellent growth promoter and protector for crop plant than conventional compost (CerdaA, Artola A, Fonyx etal 2018). Bajsa O, Nairet al.,2003) state that vermicomposting gives a advanced-excellent end product than conventional composting due to joint action of enzymatic and microbial activities that occur during the process .in addition Vermicomposting is an important practice of sustainable remediation and microbiologically active organic material formed from the interactions among earthworms and different type of microorganisms (Domínguez, 2004).Through vermicompost process, environmental hazard of leaf material converted into a safer and more stable product suitable for application to soil (Lazcano et al., 2008), and reduces the transportation costs because of the significant reduction in the water content of the raw organic matter .

In the world Vermicompost is prepared from different plant leaf litters and crop residue such as sawdust, paddy straw and wheat straw (Indrajeet and Singh 2010), Sugarcane leaf (Alagesan and Dheebea,2010), Ashoka tree leaf litter, Teak tree leaves litter and Neem tree leaf litter (Jayanthiet.al., 2010), Tendu leaf litter (Mushan and Rao,2012), Mango and Guava leaf (Vasanthiet.al., 2013), Rubber leaf litter (Nath and Chaudhuri,2014;), Teak leaf litter and Prakash 2016).

In Ethiopia Vermicomposting recently approved biotechnology in which the exertion of on farm verification and demonstrating its consumption was made by Haramaya University & Ambo plant protection research center. However, there was a very inadequate effort of characterizing vermicompost and identifying it by the nutrient and other quality parameters in terms of soil fertility improvement as well as enhancement of crop productivity due to lack of experience. Vermicompost of coffee husk, inset waste, khat waste and vegetable waste using the epigeic earthworm *Eisenia foetida* and found to be as a good option for improving solid waste management in Ethiopia and production of excellent - biofertilizers for soil fertility improvement purpose Gezahegn et al. (2012)

Western part of Oromia region receives enough annual rainfall, that permit the substantial amounts of decomposable materials needed to prepare compost from leaf litter. However, due to lack of consciousness and technical knowledge, these materials are usually misused without proper use despite soil fertility in the region is declining rapidly from time to time. In

order to solve this problem, we will prepare and study the compost obtained from locally available major plant leaf litters such as large-leaved Cordia (*Cordia Africana*), makanisa (bisana) *croton macrostachyus* and crop straw such as finger millet straw, Faba bean and farmyard manure. Therefore, the objectives of these activities are to prepare and characterize vermicompost obtained from different plant litters, crop residual and farmyard manure based on nutrient content the quality of vermicompost measured by means of chemical composition.

Materials and Methods

Description of the study area

The study was conducted at Bako Agricultural Research Centre (BARC) in 2020/2021. Bako Agricultural Research Centre (BARC) located in the Western part of Ethiopia at a distance of 250 km away from Addis Ababa. It lies at latitude of 9° 6' 00''N and longitude 37° 9' 00''E and at an altitude of 1650 m above sea level. Warm humid climate with annual mean minimum and maximum temperature of 14.50C and 29.7 °C respectively. The area of Bako receives an annual rainfall of 1337 mm from May to October with maximum precipitation in the month of June to August (BARC Metrological station, 2020).

Experimental materials and treatment

The materials were used in this experiment are plant leaflitters these leaf litters were collected from the forest which exist around the center, farmyard manure from animal farms of the center and the earthworms which we use in the work was red non burrowing type of species known as (*Esinea Fatida*). This worm for the

activities was taken from the center it was established since 2016 by a soil fertility improvement research team. The treatments consist of eleven feed stock materials which undergo partial fermentation for 15 days with the combination ratio of plant leaf litter to farmyard manure 1: 1 on weight basis.

During Preparation for vermicompost Collected leaf wastes were chopped into small pieces. The chopped waste was mixed with farmyard manure in 1: 1 ratio and also Farmyard manure was taken as Control for the study

Treatment combination

- 1 *Croton Macrostachyus* + farmyard manure.
- 2 *Cordia Africana* + farmyard manure.
- 3 Finger millet+ farmyard manure.
- 4 Faba bean + farmyard manure.
- 5 *Croton Macrostachyus* + *Cordia Africana* + farmyard manure.
- 6 *Cordia Africana* + finger millet + farmyard manure.
- 7 *Croton Macrostachyus* + Faba bean + farmyard manure.
- 8 Finger millet + Faba bean + *croton Macrostachyus* + farmyard manure.
- 9 Finger millet + Faba bean + *Cordia Africana* + farmyard manure.
- 10 Finger millet + Faba bean + *Cordia Africana* + *croton Macrostachyus* + farmyard manure.
- 11 Farmyard manure.

The vermicomposting process was ongoing by emancipating worms into the partly decayed medium in circumstances where

the three most important ecological factors (temperature, adequate moisture and ventilation) were maintained (Glenn, 2009). The material mixture was safely converted in to vermicompost after sixty days to give a uniform humus like loamy material in which no food scraps and residue materials are recognizable. It is light and black or dark brown in color. The compost composed by manual harvesting which involved hand sorting, or picking the worms directly from the compost by hand. The vermicompost were dehydrated, piled, and stowed while their representative samples were taken and prepared for laboratory test and the analysis done based on laboratory procedure.

Laboratory analysis

The organized vermicompost samples were evaluated in JIJE Analytical Testing Service and at Bako agricultural research center in soil Laboratory of the center for their nutrient content composition and some chemical properties price considering in characterizing the materials to an extent.

Major Parameters and its Test Methods

The PH of the vermicompost was tested by FAO-Potentiometric Water extract method (Sahilemedehin and Taye, 2000). Organic carbon (OC) determined by FAO -Loss on ignition method at 450°C (Cohen,1993), Nitrogen content (N) was measured by means of FAO - Kjeldahl method (ISO 11261, 1995). Total Potassium (TK) and Phosphorous (P) determined by FAO - Aqua regia digestion extract – Flame photometer (FAO, 2002). Total Calcium (Ca) and Magnesium (Mg) was estimated

by FAO - Aqua regia Digestion extract – EDTA Titration method (Sahilemedehin and Taye, 2000)

Data analysis

The experimentation was a laboratory analytical procedure on the different materials where values documented are means of triplicate values recorded and interpreted following previous standards. not an open field type which is usually subjected to effects of different treatment variation as slope, fertility and other gradients as any agronomic experiments do, which calls for statistical analysis. This is rather a greenhouse type experiment conducted with uniform and controlled internal and ambient environmental conditions simply to measure the nutrient contained in the vermicompost like any other organic fertilizer such as pit compost and FYM. The laboratory analytical values obtained are means of triplicates, which were used for explanation of the result of the experiment.

Result and Discussion

Chemical property and nutrient level of the vermicompost Total nitrogen, PH and Organic matter According to the result of laboratory analysis, the vermicompost obtained from *Croton Macrostachyus* + Faba bean + farmyard manure had higher value of 2.44 % total nitrogen content. The compost from the combination of Finger millet + Faba bean + *Cordia Africana* + farmyard manure holds second position with the value of 2.43. The PH value which falls in the alkaline range of PH scale, the PH values of all type of vermicompost are

found in appropriate range for plant growth. Considering the organic carbon, carbon to nitrogen ratio and total nitrogen content vermicompost has outsmarted than the other compost significantly. The amendment of acidity was possibly due to nitrogenous waste excreted by the earthworms and the Characterization of Vermicompost for major plant nutrient contents Verm wash released in the method which increased the moisture content thus neutralizing the PH of the vermicompost.

Table 1. Laboratory analytical Results of the vermicompost

| No | Feed material combination | %OC | PH | %T. N | C: NRatio | %T. P | %T. K | %T. Ca | % Mg |
|----|--|-------|------|-------|-----------|-------|-------|--------|------|
| 1 | Croton Macrostachyus +farmyard manure. | 32 | 8.3 | 1.57 | 21.1 | 1.23 | 2.43 | 5.33 | 2.2 |
| 2 | Cordia Africana + farmyard manure. | 32.1 | 8.2 | 1.99 | 16.32 | 1.4 | 3.95 | 7.92 | 4.8 |
| 3 | Finger millet+ farmyard manure. | 35.2 | 8.6 | 2.1 | 17.77 | 0.72 | 3.3 | 3.1 | 1.86 |
| 4 | Faba bean + farmyard manure. | 35.4 | 8.5 | 1.47 | 26.83 | 0.7 | 1.9 | 3.34 | 3.9 |
| 5 | CrotonMacrostachyus+CordiaAfricana+farmyard manure. | 34.43 | 8.2 | 1.83 | 20.77 | 0.69 | 1.76 | 5.28 | 3.79 |
| 6 | Cordia Africana + finger millet + farmyard manure. | 33.2 | 8.76 | 2.27 | 16.23 | 0.81 | 2.8 | 8.4 | 6.9 |
| 7 | Croton Macrostachyus + Faba bean + farmyard manure. | 35 | 8.89 | 2.44 | 15.1 | 0.92 | 2.33 | 6.27 | 3.34 |
| 8 | Finger millet +Faba bean + croton Macrostachyus + farmyard manure. | 37.3 | 8.22 | 1.99 | 19.4 | 0.74 | 1.93 | 3.09 | 3.2 |
| 9 | Finger millet + Faba bean + Cordia Africana + farmyard manure. | 36.03 | 8.66 | 2.43 | 15.3 | 0.85 | 2.54 | 5.3 | 3.19 |
| 10 | Finger millet + Faba bean + Cordia Africana +crotonMacrostachyus+farmyardmanure. | 35.2 | 8.14 | 1.96 | 18.91 | 0.87 | 2.23 | 3.19 | 5.72 |
| 11 | Farmyard manure. | 41.8 | 9.3 | 2.2 | 21.41 | 0.74 | 1.7 | 5.31 | 1.91 |

The values recorded are means of triplicates

The table shows vermicompost contain higher percentage of organic carbon and total nitrogen compared to the other conventional compost.

The earthworms play a significant role in the recycling of Nitrogen in different agro ecosystems evident in vermicomposting which converts household and agricultural waste into compost within short time, reduces the C:N ratio (Nagavallema et al. 2004)

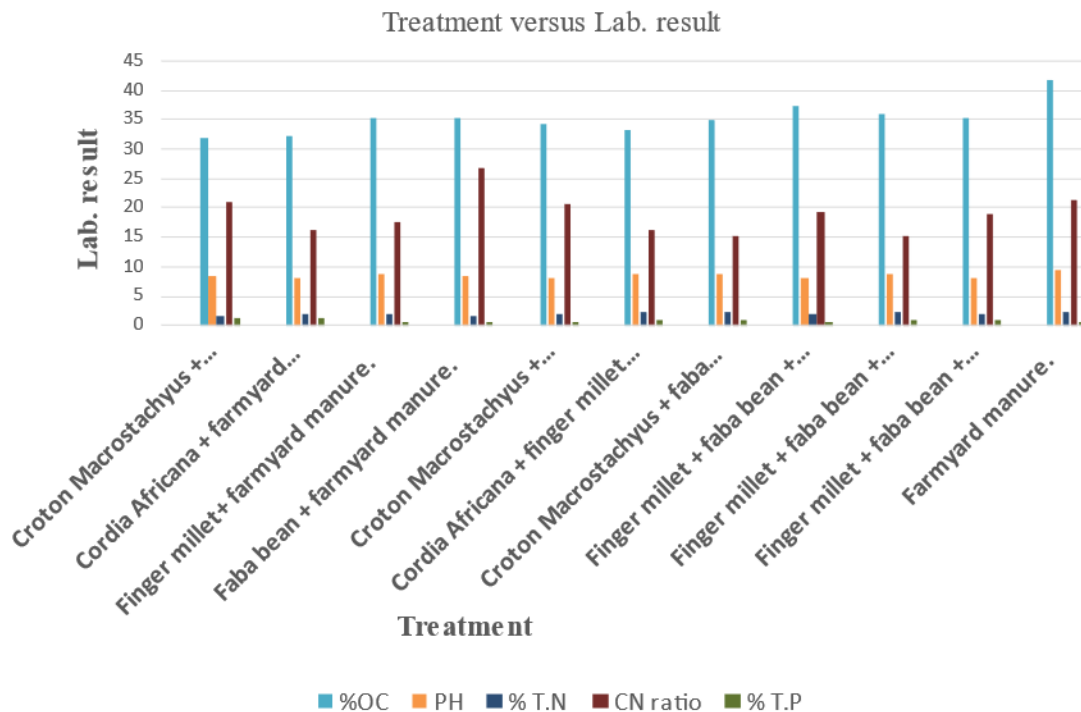


Fig 1. pH, organic matter and primary nutrient(Nitrogen and Phosphorous) content of the vermicompost

The chart shows the nutrient content of the vermicompost in each and every treatment. The percent of organic carbon was highest in treatment eleven and the lowest was recorded in treatment one. The total phosphorus, total potassium, total calcium, and total magnesium content with regard to other plant growth restraining nutrients the vermicompost formed from *Cordia Africana* and farmyard manure recorded a higher value in total phosphorus, total potassium and total magnesium while the vermicompost produced from *Cordia Africana*, finger millet and farmyard manure has recorded higher value in total Calcium. The higher total phosphorus content in the vermicompost is attributed to the mineralization and mobilization of

phosphorous contained in feedstock due to earthworm activity as earthworms play an important role in the release of phosphates on organic matter. The increase in potassium and magnesium is increased in a similar way by the earthworm activity on the feed material. The result of this study is in line with the finding of (2011) Amir and Fouzia who reported that vermicompost have rich sources of nutrient content, a higher base Cation Exchange capacity and more exchangeable sodium, magnesium and potassium than pit compost and garden soil. The analytical result of the experiment collaborates the result of Pius and Thompson (2000) who also reported that and showed vermicomposting result in a significant increase in total and available

P, exchangeable K, exchangeable Ca and total Mg, emphasizing that the higher concentrations of plant nutrients in end

product of vermicomposting indicate a potential for using agriculture wastes in sustainable crop production

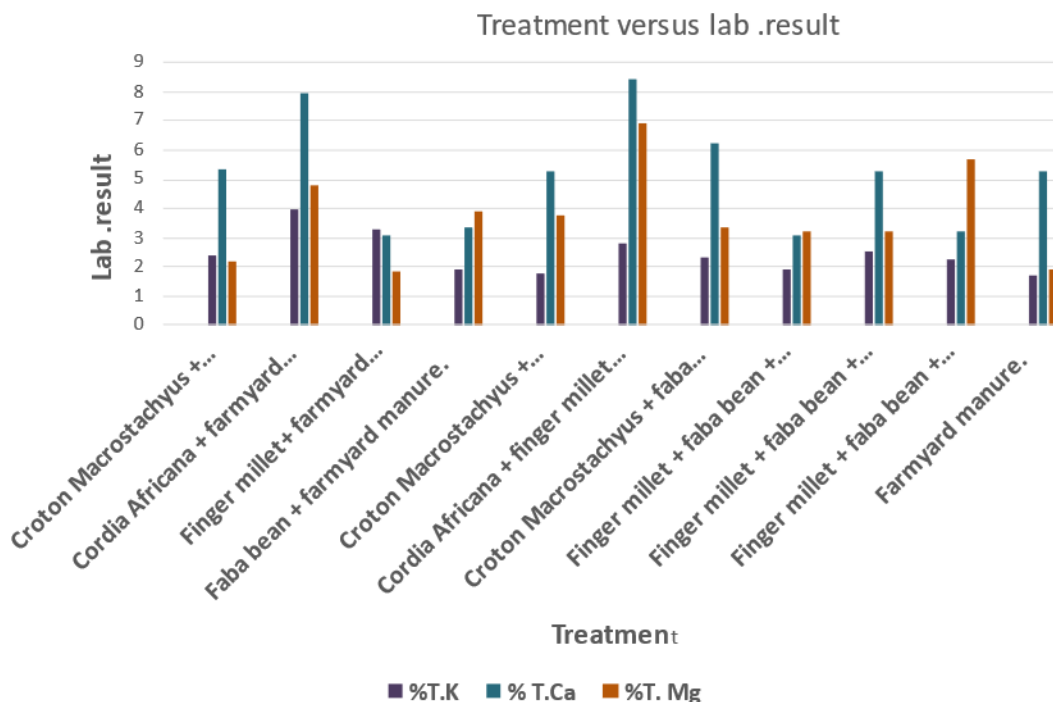


Fig 2. total potassium, total calcium, and total magnesium

From the second chart the total calcium was highest in treatment T6 and the lowest was recorded in the T8. The nitrogen content of the vermicompost obtained from *Croton Macrostachyus*, Faba bean and farmyard manure. The compost obtained from the combination of Finger millet, Faba bean, *Cordia Africana* and farmyard manure Were much better than the other combinations. With respect to other major plant nutrients like phosphorus, potassium and magnesium, the vermicompost obtained from *Cordia Africana* + farmyard manure has out ranked than other types of compost. The manuring value of the vermicompost can

be demonstrated by taking maize crops in the experimental area and other parts of western Oromia as an example. The recommended rate of fertilizer for this crop which is being used nowadays is 200kg urea and 100kg NPS. According to the result 4.66 tons of vermicompost prepared from *Cordia Africana* + farmyard manure can replace the recommended amount of urea (65.23 kg P205), an amount which exceeds the recommended dose of phosphorus for the crop.

Conclusion and Recommendation

According to the results of the study, the integrated effect of all the nutrients

present in vermicompost could help to avoid plant nutrient imbalance when applied to the soil in general. Among the different combinations, vermicompost obtained from *Cordia Africana* + farmyard manure can be of paramount importance when it comes to nutrient composition in enhancing crop productivity, improving soil health and fertility. The obtainability of raw materials, simplicity of its production and better availability of the nutrients contained in it to the plant could be proposed and recommended to farmers in the study area.

Acknowledgements

This research tremendously benefited from the technical support of many person. We are also grateful to JJE Analytical Testing service Laboratory for handling the compost analysis task. The Soil Fertility Improvement Research case team members of Bako Agricultural Research Center also deserve appreciation for their commitment to put the brief of this experiment to affect.

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