Biological Forum – An International Journal 15(2): 350-357(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Production and Composition of Nutrient Enriched Vermicompost Prepared from different Organic Materials and Minerals

Bhargava A.[1], Sharma S.K.[2] and Trivedi S.K.[3]*
[1]*Ph.D. Scholar, Department of Soil Science, RVSKVV, Gwalior (Madhya Pradesh), India.*
[2]*Director Research Services, RVSKVV, Gwalior (Madhya Pradesh), India.*
[3]*Head, Department of Soil Science, RVSKVV, Gwalior (Madhya Pradesh), India.*

(Corresponding author: Bhargava A.)*
(Received: 11 December 2022; Revised: 29 January 2023; Accepted: 04 February 2023; Published: 11 February 2023)
(Published by Research Trend)

ABSTRACT: The continuous use of chemical fertilizers resulted in the decline in organic matter content of the agricultural soil leading to depletion of beneficial microorganisms which in turn reduced the soil productivity. Vermicompost is an organic fertilizer rich in nutrients, beneficial microorganisms, and plant growth harmones, which can not only promote crop growth, but also help improve the physical, chemical and biological characteristics of the soil. However, its low nutrient content makes it less popular with farmers and limits its applicability. This study, apparently the first of its kind, aimed to enrich the nutrient content of vermicompost by supplementing it with organic materials - Neem cake, Sesame cake, Binola cake, Groundnut cake, Mustard cake, Linseed cake, Wood ash, Banana peel, Poultry manure, Legume waste, Dry Neem Leaves with cow manure, and organic nutritional (Mineral mixtures) supplements (Lime stone, Rock phosphate, Dolomite, Gypsum, Potash Feldsphar Bone meal). The analysis of prepared enriched vermicompost was done using standard chemical methods. Results showed an enhanced Total Organic Carbon (TOC) - 33.0 %, Total Kjeldahl Nitrogen (TKN) 2.70%, Total Phosphorus (TP) 3.36%, Total Potassiume (TK) - 2.2%, Total Sulfur (1.32%) and micronutrients Zn (ppm)- 89, Cu (ppm) – 21, Fe (ppm) -400, Mn (ppm)-130, Ca (ppm) – 0.27, Mg (ppm) – 0.42 in vermicompost. Organic materials with cow manure and nutritional supplements have been shown to only improve the nutritional content of final product, but also increase the overall activity of the earthworm. The stability and maturity of the vermicomposts expressed in C/N (<20) indicated that the vermicompost obtained were suitable for agriculture applications. It was concluded that the adding of cow manure with organic nutritional supplements in vermicompost resulted in the production of mature, nutrient-rich vermicompost suitable for sustainable agriculture production.

Keywords: Rock Phosphate, Enriched vermicompost, Mineral mixtures, oil cake.

INTRODUCTION

Long-term use of inorganic fertilizers without organic conditioners will cause pollution and environmental damage, especially to the physical, chemical and biological properties of the soil. Organic fertilizers not only provide organic matter and nutrients, but also increase microbial activity, biodiversity and microbial population size in the soil, affecting soil structure, nutrient turnover and many other parameters soil physicochemicals (Albiach *et al*., 2000). In most parts of India, the organic matter content of cultivated soils is generally insufficient. Such low organic matter content reduces soil fertility and productivity. Organic matter affects crop growth and yield directly by supplying nutrients, or indirectly by altering soil physical properties such as aggregate stability and porosity. Organic matter can improve the root zones of plants, thereby stimulating plant growth (Darwish *et al*., 1995). Organic amendments are commonly used to increase soil fertility (Graham, Haynes and Meyer 2002). Vermicompost has recently been used to increase soil organic matter content, thereby improving soil fertility. Vermicompost is a natural ecological fertilizer produced by degrading organic matter through the interaction between microorganisms and earthworms. 2004). This includes nutrients easily absorbed by plants, such as magnesium, calcium, phosphorus, potassium, and nitrates. Vermicompost is a perfect soil conditioner or amendment due to microbial activity, water holding capacity, drainage, aeration and high porosity (Orozco *et al.,* 1996). Vermicompost can improve soil productivity in continuous crops (Zhang *et al.,* 2010). It acts as a soil conditioner, improving soil fertility by increasing nutrient content, cation exchange capacity and soil organic matter, thereby improving soil structure (Srivastava *et al.,* 2011). Depletion of soil organic matter is one of the main drivers of loss of ecosystem resilience and degradation of ecosystem services (Feller *et al.,* 2012). Therefore, many studies have suggested vermicomposting as an alternative to maintain economically viable agricultural production while minimizing environmental pollution. Additionally, organic fertilization has been shown to suppress plant diseases, especially those caused by soilborne pathogens, increase microbial biomass and activity, soil organic matter content, and improve soil resistance soil erosion (Thiele-Bruhn *et al.,* 2012). Soil organic matter plays a key role in the sustainability of agricultural production due to its many desirable properties, such as beneficial effects on soil quality parameters, cation exchange capacity and water retention capacity (Liu *et al*., 2006). Vermicompost increased plant nutrient availability (Jat and Ahlawat 2006; Mamo *et al.,* 1998) and improved enzyme activities (protease, amylase, cellulase and pectinase) compared to other organic fertilizers. Vermicompost has been reported to improve soil physical properties by improving air and water permeability, and it also increases total porosity and aggregate stability by reducing osmotic resistance and bulk density (Aksakal *et al.,* 2016). Vermicompost improves soil fertility conditions, increasing the availability of nutrients to plants, as well as their water retention capacity (Radillo *et al.,* 2013). Some previous studies have also reported positive effects of vermicompost treatment on crop productivity (Atiyeh *et al.,* 2002; Joshi; Vig and Singh 2013).

Yatoo *et al.* (2022). Studied that, it was investigated to enrich the nutrient content of vermicompost by supplementing the macrophyte biomass with cow manure and organic nutrient supplements (egg shell, bone meal, banana peel, and tea waste). Results showed an enhanced TKN (2.87%), TP (0.86%), TK (3.74%) and other nutrients in vermicompost amended with cow manure and nutrient supplements. Highest biomass gain (710-782 mg), growth rate (11.83-13.04 mg), and reproduction rate (3.34-3.75 cocoons per worm) was also observed in T_2 and T_3, indicating that amending bulking agent and nutrient supplements not only enhance the nutrient content of the final product but also improve overall earthworm activity. The stability and maturity of vermicompost, as indicated by C/N (< 20) and GI (> 80), indicates that vermicompost obtained is suitable for agricultural applications. It is concluded that amendment of cow manure and organic nutrient supplements results in producing mature and nutrient enriched vermicompost suitable for sustainable agricultural production.

In general, organic manures like FYM, compost, and vermicompost contain an average 0.5 to 1.5% N, 0.2 to 0.8% P_2O_5 and 0.5 to 1.2% K_2O, which is not sufficient to meet the crop demand in low doses. For supplying N at 100 kg ha^{-1}, the organic manure should be applied at 07 to 20 t ha^{-1}. These demerits of manures can be overcome to a certain extent through the preparation of enriched Vermicompost by adding natural or biological sources of nitrogen, phosphorus, potassium, sulfur and micronutrients either alone or in combination. Moreover, waste with different nutrient rich substances can open new direction of technological up gradation for improving the quality and nutrient status of vermicompost. Modification of vermicompost either by microbial enrichment or fortifying with nutrient rich rock minerals and agricultural waste may help in enriching the nutrient content. Keeping these facts in view the study was conducted to prepare crop Specific (cerels, pulses and oilseed) enriched vermicompost.

The major objective of the study was to -

- To prepare enriched vermicompost for cereal crop with higher N, P, K and Zn content.
- To prepare enriched vermicompost for pulse crop with higher P, K and S content.
- To prepare enriched vermicompost for oil seed crops with higher N, P, K and S content.
- To determine the chemical composition of prepared vermicompost.

MATERIAL AND METHODS

a. Location and Place of working: Enriched vermicompost was prepared at the animal husbandary farm, RVSKVV Gwalior (M.P.) and laboratory experiment were be carried out in the Department of Soil Science and Agriculture Chemistry College of Agriculture, RVSKVV Gwalior (Madhya Pradesh).

b. Experimental setup and vermicomposting: Vermicompost was prepared by using (*Esenia fetida)* earthworm species using with different organic materials and minerals, for the enrichment of the compost for N, P, K, S, Zn, Ca and Mg. Cemented vermicompost pits were used for compost preparation These pits were already available in Dairy Farm ,RVSKVV Gwalior. The flow chart given in Fig. 1 was used for the preparation of vermicomposts.

c. Experiment Details

No. of Treatment - 8

No. of Replication- 3

Experiment Design - RBD

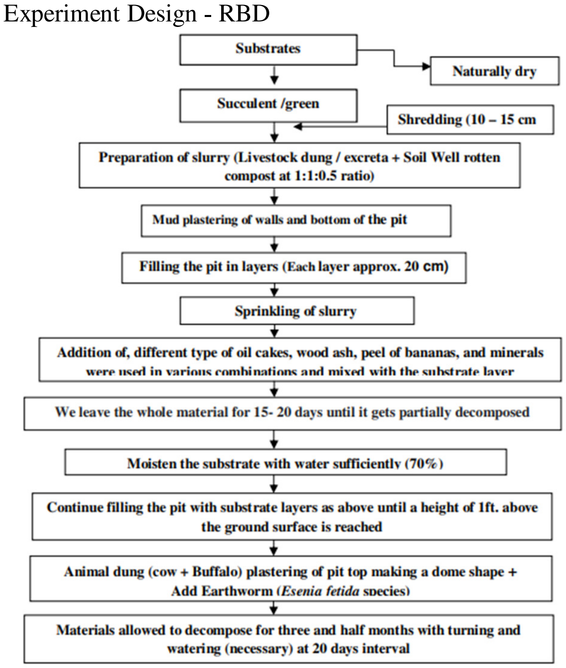

Fig. 1. Protocol used for the preparation of Enriched vermicompost.

Treatment details

T_1: Enrichment of VC through Mustard cake + Rock phosphate + Potash feldsphar + limestone + Poultry manure

T_2: Enrichment of VC through Groundnut cake + Bone meal + Wood ash + Gypsum + Poultry manure
T_3: Enrichment of VC through Neem cake + Wood ash + Gypsum + Poultry manure
T_4: Enrichment of VC through Seasam cake + Legume waste + Potash feldsphar + Limestone + Poultry manure + Banana peel + Wood ash
T_5: Enrichment of VC through Lineseed cake + Gypsum + Bone meal + Poultry manure + Dolomite
T_6: Enrichment of VC through Binola cake + Potash feldsphar + Rock phosphate + Legume waste + Dolomite + Banana peel.
T_7: Enrichment of VC through Mustard cake + Binola cake + Neem cake + Groundnut cake + sesame cake + Linseed cake.
T_{15}: Control (Conventional Vermicompost)

d. Physicochemical Analysis of the Initial Substrate and the Final Vermicompost: The physicochemical analysis of the initial substrate and the final vermicompost of different vermibeds was carried out as follows.

Substrate to water ratio 1:10 (w/v) for pH and EC. Mix 5 g of sample with 50 ml of distilled water and place in a shaker for 45 min for proper mixing. The mixture was then filtered through Whatman filter paper and the pH and EC were determined using a digital pH meter (Sytronics 4698) and a conductivity meter (Systronics 2551). Total Kjeldahl (TKN) was measured by the standard Kelplus-Distyl Em method of digestion and distillation using a Kelplus-Distyl Em (Tandon, 2005). Total organic carbon (TOC) was estimated using the loss on ignition method as described by Tandon (2005). A mixture of HNO_3 and $HCLO_4$ (4:1, v/v) was used to estimate total potassium (K) using a flame photometer (Garg and Kaushik 2005) and total phosphorus (P) using the molybdovanadate method (Tanden, 2005). Cu, Zn, Fe and Mn concentrations were determined by digesting each sample with a ternary solution (HNO_3-$HClO_4$-HF) and filtering through Whatman no. 42 filter paper. The extracts were analyzed for micronutrients by atomic absorption spectrometry (Varian, Spec-trAA-10) (Jordao *et al.*, 2007). Calculate the C/N ratio by dividing the TOC by the total nitrogen content. All reagents and chemicals used in analytical work are AR grade. Tables 1 and 2 list the physico-chemical properties of the initial substrate and the final vermicompost.

e. Statistical analysis: SPSS-27.0 software was used for statistical analysis. The data obtained were subjected to ANOVA (ANOVA in the RBD design) of Fisher (1958) and Panse and Sukhatme (1978), means of significance separated by a critical difference (CD) of 0.05% (CDP = 0 .05%) level of importance.

Table 1:Physicochemical characteristics of initial raw materials used in vermicomposting experiments.

Nutrient	Raw material	Content (%)
Nitrogen	Neem cake	5.2
	Seasame cake	6.2
	Groundnut cake	7.3
	Mustard cake	5.3
	Linseed cake	4.9
	Binola cake	6.4
	Bone meal	3.5
	Poultry manure	3.03
	Cow Dung	0.5
Phosphorus	Bone meal	16-18
	Rock phosphate	20-40
	Banana peel	0.3
	Legume waste	0.087
	Dry neem leaves	0.025
Potassiume	Potash feldsphar	10-11
	Wood ash	5.9
	Banana peel	4.6
	Legume waste	1.38
Sulphur	Gypsum	18.6
Calcium	Bone meal	18-20
	Limestone	54
	Dolomite	30
	Gypsum	23
	Banana peel	0.8
	Dry neem leaves	0.14
Magnesium	Dolomite	18

RESULTS AND DISCUSSION

Analyzed pH, Electrical Conductivity (EC), Total Organic Matter (TOC), Total Nitrogen (TN), Total Phosphorus (TP), Total Potassium (TK), Total Sulfur (TS), Zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), calcium (Ca) and manganese (Mn), the data are presented in Tables 2 and 3.

pH. From the data, it is clear that after 60 days of successful vermicomposting, the pH of the final vermicomposting was in the neutral range (7.1 – 7.5). The highest pH of 7.5 was found in T_4 and T_{15} and the lowest (7.1) was found in T_1 and T_7. Treatment T_{15} was found to be statistically superior to T_1 and T_7, and the other treatments were statistically comparable to each other. The release of organic acids, ammonia, and CO_2, along with the combined activities of microorganisms and earthworms, cause the pH to shift toward neutral or acidic pH throughout the vermicomposting process

(Zhang *et al.,* 2015; Ramnarain *et al.,* 2019; Yuvaraj *et al.,* 2019; Karmegam *et al.,* 2021).

Electrical Conductivity. Conductivity (EC) is one of the most important parameters indicating the acceptability of the final product for agricultural use. During this study, EC values were well below <4 dSm^{-1} required for vermicompost used for agricultural purposes (CPHEEO 2016). Table 2 shows that EC values range from 0.41 dSm^{-1} to 0.47 dSm^{-1}. The highest measured EC occurred at T_{15} (0.47 dSm^{-1}), followed by T_6 (0.46 dSm^{-1}), T_2, T_5, T_7 (0.44 dSm^{-1}), T_4 (0 .43 dSm^{-1}), T_1 (0.42 dSm^{-1}) and T_3 (0.41 dSm^{-1}) are the lowest. Treatments T_6 and T_7 were statistically equivalent but significantly superior to the remaining treatments. Differences in EC values were not significant among other study treatments. During the decomposition of organic substrates, ammonium, phosphate, potassium, nitrate and calcium ions are released, leading to an increase in EC (Gong *et al.,* 2019; Yuvaraj *et al.,* 2019; Paul, 2020).

Total Nitrogen. The data about the percent of total nitrogen (TN%) content in vermicompost under different treatments are presented in Table 2. The highest TN% was obtained in the treatment T_7 (2.70%) followed by T_4 (2.60%), and T_2 (2.50%), these three treatments were found statistically at par with each other but, were significantly superior to T_1 (1.90%), T_3 (2.00%), T_5 (2.10%), T_6 (2.00%), and T_{15} (0.94%). Treatment T_{15} was found significantly inferior to the rest of the treatments.

This result is consistent with some previous workers who reported increased levels of total nitrogen after adding cow manure and other nutritional supplements, such as 3.12% in sludge from the paper industry with cow manure and green manures (Karmegam *et al.,* 2019), 2.90% of the garden litter contained cow dung and used fungi substrates (Gong *et al.,* 2019), 2, 52% of coconut litter contained cow dung et al, 2021). This suggests that modification of cow manure and other nutritional supplements is essential for the production of nutrient-rich vermicompost (Karmegam *et al.,* 2019; Yuvaraj *et al.,* 2021).

Total Phosphorus. The percentage of total P_2O_5 content was highest in T_4 (3.36%), which may be due to the high phosphorus content in bone meal. Bone meal contains high amounts of phosphorus and is considered a good source of phosphorus. It was followed by T_3 (3.50%) and T_6 (3.20%), and all three treatments were statistically equivalent and significantly better than the others. The lowest Total phosphorus (0.78%) was found in T15 and this treatment was statistically lower than all other treatments in the study. Study results showed that adding cow dung and other nutritional supplements increased the TP content of vermicompost due to improved growth and activity of earthworms and micro -organisms. Gong *et al.* (2019) also reported that total phosphorus levels were higher when garden waste was supplemented with cow dung and mushroom litter due to accelerated litter degradation by microorganisms and fungi and earthworms. Other researchers have also indicated that phosphatase activity, mobilization of organic matter and mineralization of microorganisms and earthworms are the main causes of progressive changes in TP (Balachandar *et al.,* 2020; Karmegam *et al*., 2019; Yadav and Garg 2019).

Total potassium. TK (total potassium) in vermicompost was associated with mineralization of organic waste, total loss of organic matter, and increased activity of earthworms and microorganisms (Devi and Khwairakpam 2020; Singh and Kalamdhad 2016). The highest percentage of total K20 content was highest in T_4 (2.2%), which could be attributed to the potassium content of banana peels, bone meal and other nutritional supplements, indicating that the addition of nutritional supplements improved the nutritional status of the final produc. vermicompost. This was followed by T_1 (1.98%) and T_6 (1.94%), all three treatments were found to be statistically comparable to each other and significantly better than each other. The lowest percentage of PT occurred in T_{15} (0.64%), which was found to be statistically lower than all other treatments in the study. TK content was also higher when press sludge and paper mill sludge were mixed with other nutritional supplements such as cow dung and green manures, at 3.34% and 2.78%, respectively (Balachander *et al.,* 2020; Karmegam *et al.,* 2019), showing that the addition of nutritional supplements plays an important role in improving TK.

Total Sulfur. Total Sulfur content in the different treatments ranged from 0.85%-1.32%. It was the highest in treatment T_7 (1.32%), followed by T_3 (1.30%), T_2 (1.28%), T_5 (1.25) all these treatments were statistically at par with each other, While, the treatment T_1 (0.85%), T_4 (0.88%), T_6 (0.86), T_{15} (0.85%) were significantly lower in S content as compared to T_7, T_3, T_2 and T_5 but were found at par with each other. The lowest S content was found 0.85% in the treatments T_1 and T_{15}.

On a weight basis, vermicomposts have a higher availability of N and a supply of various other plant nutrients than conventional composts, for example adding vermicomposts to soil significantly increases phosphorus (P), potassium (K), sulfur (S) and magnesium (Mg) (Atiyeh *et al*., 2000b; Atiyeh *et al*., 2000c).

C:N ratio. The C:N ratio was found significantly higher in the case of treatment T_{15} (23.0) this treatment was significantly Superior to the rest of the treatments. While the lowest C: N ratio was found in T_7 (9.2) which was found at par with T_1 (11.2) while the rest of the treatments were having significantly higher C:N as compared to T_7 Treatment T_4, T_5, T_6 were at par with each other.

Khwairakpam and Bhargava (2009); Bhat *et al.* (2016); Sangwan *et al.* (2010); Prakash and Karmegam (2010) reported 12.96, 14.18, 16.31 and 17.89 N/N ratios of vermicompost respectively for the pressed sludge + manure combination However, Bhat *et al.* (2014) reported pressed sludge + cow manure (1:3). The C/N ratio of vermicompost is very low at 4.80. (2014). This could be attributed to higher TKN content. A decrease in the C/N ratio of indicates a C/N ratio of less than 20 (Atiyeh *et al.,* 2000; Ravindran *et al.,* 2015). Therefore, in this study, with the exception of T_{15}, the C/N ratio of the vermicompost was well below the norm in all treatments, indicating a higher degree of stabilization of the worms in the pressed mud. Total organic carbon - Respiration and assimilation activities of earthworms and microbes are associated with reductions in TOC during vermicomposting (Karmegam *et al.,* 2019; Ananthavalli *et al.,* 2019; Biruntha *et al.,* 2020; Balachander *et al.,* 2021; Lay *et al.,* 2021). High nutrient substrate adequacy means higher microbial and earthworm activity, resulting in greater carbon release and assimilation, resulting in lower overall TOC. TOC results were similar to Devi and Khwairakpam (2021) (35%); Gusain and Suthar (2020b) (42%), who studied vermicomposting of plant substrates. Plant-based substrates contain slowly degrading lignocellulosic material, and to overcome the slow degradation of cellulose-rich waste mixtures during vermicomposting, few authors recommend adding cow dung or microbial inoculants (Negi and Suthar 2013; Gong *et al.,* 2019).

Total organic carbon (TOC). Percent total organic carbon (TOC%) was determined and data are presented in Table 2. TOC% ranged from 21.0 -33.60% and the differences across the treatments were significant. The highest TOC (33.00%) was found in the treatment T_5 followed by T_4 (32.40%), T_3 (32.0%), T_2 (31.80%), T_6 (30.40%), T_7 (24.60) all these treatments were statistically at par with each other but were found significantly superior to T_1 and T_{15}. The variation in TOC% indicates that the addition of bulking material and other nutritional supplements has a substantial impact on vermicomposting.

Respiration and assimilation activities of earthworms and microbes are associated with reductions in TOC during vermicomposting (Karmegam *et al.,* 2019; Ananthavalli *et al.,* 2019; Biruntha *et al.,* 2020; Balachander *et al.,* 2021; Lay *et al.,* 2021). High nutrient substrate adequacy means higher microbial and earthworm activity, resulting in greater carbon release and assimilation, resulting in lower overall TOC. TOC results were similar to Devi and Khwairakpam (2021) (35%); Gusain and Suthar (2020b) (42%), who studied vermicomposting of plant substrates. Plant-based substrates contain slowly degrading lignocellulosic material, and to overcome the slow degradation of cellulose-rich waste mixtures during vermicomposting, few authors recommend adding cow dung or microbial inoculants (Negi and Suthar 2013; Gong *et al.,* 2019).

Ca, Mg & Other micronutrients. Plants need micronutrients, such as macronutrients, for overall growth and yield. Therefore, the presence of sufficient amounts of essential micronutrients in vermicompost guarantees its suitability for agronomic use, allowing plants to grow and develop more efficiently. Due to the inclusion of various supplements, one of the main purposes is also to enrich the micronutrient content of the final vermicompost product.

Total Zinc content in the different treatments ranged from 65 ppm - 89 ppm. It was the highest in treatment T_4 (89 ppm), followed by T_5 (86ppm), T_3 (85ppm), T_2 (80ppm), T_1 (75ppm), all these treatments were statistically at par with each other, While, the treatment T_7 (68ppm), T_{15} (65ppm) were significantly inferior in Zn content as compared to rest of the treatments but were found at par with each other. Micronutrient content (Mn, Zn, Fe, and Cu) was higher in enriched vermicompost as compared to Conventional Compost which was also observed in previous studies (Rajesh *et al.,* 2003).

Total Cu content in the different treatments ranged from 14 ppm – 21ppm. It was the highest in treatment T_3 and T_5 (21 ppm), closely followed by T_6 (20ppm), T_4 (19ppm), T_7 (18ppm) all these treatments were statistically at par with each other, while, the treatment T_1 (16ppm), T_2 (14ppm) and T_{15} (15ppm) were significantly inferior in Cu content as compared to the rest of treatments but were found at par with each other. Higher level of copper content in vermicompost might be due to the presence of copper containg oxidizing enzymes (Daman *et al.,* 2016).

Total Fe content in the different treatments ranged from 218 ppm- 400 ppm. It was the highest in treatment T_4 (400ppm) followed by T_2 (380ppm), T_1 (360ppm), T_5 (356ppm), T_7 (258 ppm), and the lowest in T_{15} (218 ppm). All the treatments under study were statistically superior to the treatment T_1. Micronutrient content (Mn, Zn, Fe, and Cu) was higher in enriched compost as compared to CC which was also observed in previous studies (Rajesh *et al.,* 2003).

Total Mn content in the different treatments ranged from 100ppm- 130ppm. It was the highest in treatment T_2 (130ppm) followed by T_4 (129ppm), T_6 (128ppm), T_5 (126 ppm), T_1 (125 ppm), T_7 (120ppm), T_{15} (115ppm) and lowest in T_{13} (100 ppm). All the treatments under study were statistically superior to treatment T_{15}. Increase of manganese content in vermicompost is due to mineralization of this element by the earthworm activity (Daman *et al.,* 2016)

Total Ca content in the different treatments ranged from 0.21ppm- 0.27ppm. It was the highest in treatment T_1 and T_6 (0.27ppm) followed by T_4 (0.26ppm), T_2 (0.25ppm), T_5 (0.24 ppm), T_3 (0.23 ppm), and lowest in T_{15} (0.21ppm). Treatment T_{15} was found significantly inferior to all the treatments under study except treatment T_3 in Ca content. Vermicompost contains most nutrients in plant-available forms such as 'nitrates' (N), 'phosphates' (P), 'soluble' potassium (K), & magnesium (Mg) and 'exchangeable' phosphorus (P) & calcium' (Ca) (Edward and Burrows 1988); *Edward et al*., 2004) (70 & 73). Vermicomposts have large particulate surface areas that provides many micro-sites for microbial activities and for the strong retention of nutrients (Arancon *et al.,* 2004; Arancon, 2006).

Total Mg content in the different treatments ranged from 0.31ppm- 0.42 ppm. It was the highest in treatment T_4 (0.42ppm) and T_1 (0.41ppm) followed by T_2 (0.40ppm), T_3 (0.39 ppm), T_6 (0.38 ppm), T_5 (0.35 ppm), T_7 (0.33ppm) and lowest in T_{15} (0.31ppm). Treatment T_7 and T_{15} were found significantly inferior to all the treatments under study except but between these two treatments difference in Mg content was non-significant. Mineralization of organic waste, reduction in biomass volume (concentrated metal levels) and addition of bulking agents are variables leading to improved micronutrients in the final product (Paul *et al.*, 2020; Rai *et al.*, 2021).

At mature enriched vermicompost content TOC (6.10%), N (33.02%), P (66.39%), K (9.10%), S (35%), Ca (88.06%), Fe (26.06%), Cu (23.48%), Mn (30.78%), Zn (19.79%), azotobacter (15.55%), rhizobium (4.65%) and PSB (40.54%) respectively which higher than normal vermicompost. Total P content increased when cow dung with rock phosphate and phosphate solubilizing bacteria was used as one of the bedding materials. It was concluded that the animal excreta and agriculture waste used as bedding material has the greatest influence on the physical, chemical and biological of matured vermicompost. Since vermicompost have a high nutritive value and a low C:N ratio, they are suitable for use in the field.

In conclusion, the results of this study including cow manure and other organic nutritional supplements showed higher macronutrient content in the following treatments T_7, T_4, T_3 and lower micronutrient content in T_4, T_3, T_2, T_6 also higher. This suggests that adding organic nutrient supplements can not only improve the nutrient status of vermicompost, but also make other parameters such as C/N ratio, pH, EC, etc. necessary for an ideal agronomic fertilizer to use.

Table 2: Major and Secondary nutrient content in prepared Enriched Vermicompost.

Treatment	pH	Ec (dsm^{-1})	TOC (%)	Total N (%)	Total P (%)	Total K (%)	Total S (%)	C:N Ratio
T_1	7.1	0.42	21.0	1.90	2.16	1.98	0.85	11.2
T_2	7.3	0.44	31.80	2.50	2.30	0.65	1.28	12.7
T_3	7.3	0.41	32.00	2.00	3.35	0.69	1.30	16.1
T_4	7.5	0.43	32.60	2.60	3.36	2.2	0.88	12.6
T_5	7.4	0.44	33.00	2.10	2.30	0.61	1.25	15.8
T_6	7.2	0.46	30.40	2.00	3.20	1.94	0.86	15.4
T_7	7.1	0.44	24.60	2.70	2.37	0.96	1.32	9.2
T_{15}	7.5	0.47	21.60	0.94	0.78	0.64	0.85	23.0
SEm±	0.11	0.01	1.06	0.12	0.11	0.018	0.027	1.1
$C.D_{5\%}$	0.33	0.041	3.21	0.37	0.35	0.05	0.08	3.2

Table 3: Micro nutrient content in prepared Enriched Vermicompost.

Treatment	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Ca (ppm)	Mg (ppm)
T_1	75	16	360	125	0.27	0.41
T_2	80	14	380	130	0.25	0.4
T_3	85	21	321	100	0.23	0.39
T_4	89	19	400	129	0.26	0.42
T_5	86	21	356	126	0.24	0.35
T_6	78	20	351	128	0.27	0.38
T_7	68	18	258	120	0.24	0.33
T_{15}	65	15	218	115	0.21	0.31
SEm±	2.05	1.24	1.15	1.22	0.011	0.014
$C.D_{5\%}$	6.22	3.77	3.47	3.71	0.03	0.04

CONCLUSIONS

The present results suggest that organic matter combined with cow dung and nutritional supplements can be used to produce concentrated vermicompost with multiple environmental benefits. T_7, T_4, T_3 had the highest content of trace elements such as total N, P, K, etc., indicating that the appropriate proportion of organic matter in the blowing agent and nutritional supplements can help improve the overall quality of vermicompost. Vermicompost enrichment also reduces the recommended dose of vermicompost. All treatments promoted earthworm growth and reproduction. Overall, the study concluded that vermicomposting is a viable method of managing organic matter, and the addition of cow dung and organic nutrient supplements is highly recommended to speed up the vermicomposting process and produce nutrient-rich crops suitable for sustainable agricultural production. It can also meet the nutritional needs of crops.

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How to cite this article: Bhargava A., Sharma S.K. and Trivedi S.K. (2023). Production and Composition of Nutrient Enriched Vermicompost Prepared from Different Organic Materials and Minerals. *Biological Forum – An International Journal, 15*(2): 350-357.