https://doi.org/10.48047/AFJBS.6.15.2024.4375-4388

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Poultry Manure Vermicompost by *Eisenia foetida* and its Impact on Vegetable Crops

Falguni Chaudhari and Jagruti Barot*

Department of Biosciences, Veer Narmad South Gujarat University, Surat 395007, Gujarat, India

Correspondence: * jkbarot@vnsgu.ac.in Mobile no:09662062380

Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.4375-4388

Abstract: The present study evaluated the physicochemical characteristics of poultry manure vermicompost (PMV) using *Eisenia foetida* in different proportions: Control (50% soil + 50% cow dung), T1 (50% PM + 50% soil), and T2 (50% PM + 25% soil + 25% leaves). The effect of these fertilizers on the growth of tomato, brinjal, and chilli plants was assessed at field level. The results indicated that *E. foetida* enhanced the quality of PMV by increasing the levels of total nitrogen, total phosphorus, total potassium, and pH, and decreasing the organic carbon content. The earthworm biomass was highest in T2, followed by T1. The plant growth parameters included plant height, number of branches, leaves, flowers, and fruits. Tomato plants showed maximum growth in T2, while chilli and brinjal plants showed significant growth in T1. The fruit quality was evaluated by measuring some biochemical parameters (protein, sugar, lipid, and vitamin C). Tomato fruits had the highest protein and vitamin C content in T1, and the highest lipid and sugar content in T2. Brinjal fruits had the highest protein, sugar, and vitamin C content in T2, and the highest lipid content in Control. Chilli fruits had the highest protein and sugar content in T1, and the highest lipid and vitamin C content in T2. Therefore, T2 was more effective as an organic fertilizer for tomato plants, and T1 was more effective for chilli and brinjal plants, compared to Control. The study suggested that PMV can be a good alternative to synthetic fertilizers

Keywords: *Eisenia foetida;* Organic fertilizer; plant growth, poultry manure; quality of fruits; vermicompost

Introduction: Vermicompost is a suitable, hygienic and cost-effective technique practiced for organic waste management. Vermicomposting is a rich in nutrient and microbiologically active organic amendment that result from the interactions between earthworm and microorganisms during the breakdown of organic materials (Ramnarain et al., 2019; Yadav et al., 2022). Vermicompost contains most nutrients in plant available forms such as nitrates, phosphates and exchangeable calcium and soluble potassium. The beneficial effects of vermicompost on the growth, productivity and chemical characteristics of several crop plants and their products were investigated in green house as well as under field experiments. There are some reports revealing that vermicompost post application can enhance both quantity and quality of plants (Arancon et al., 2004; Atiyeh et al., 2002; Chaoui et al., 2003; Gutiérrez-Miceli et al., 2007). *Eisenia foetida* earthworm species is widely used for vermicomposting by many researchers (Orozco 1996; Garg 2006).

Urban organic waste, a potential resource of plant-nutrients is either thrown away haphazardly or burnt or buried causing pollution of soil, water and air in developing countries like India. Since a few decades, municipal sewage sludge has been increasingly used in numerous countries around the world as fertilizers on farm lands because of their high content of organic matter and essential nutrients that favour crop growth (Spinosa and Vesilind 2001). Poultry industry is one the largest and fastest growing livestock production systems in the world. In India, there are about 3430 million populations of poultry with a waste generation of 3.30 million tons per year. In recent times, attention has been directed towards organic manure because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health. Poultry manure, sometimes called chicken manure, is an excellent soil amendment that provides nutrients for growing crops and also improves soil quality when applied wisely, because it has high organic matter content combined with available nutrients for plant growth (Verbeek et al., 1993; Adeleye et al., 2010).

The use of manure application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure, the nutrient status of soil and enhances crop yield. Real time challenges are “replacement of synthetic fertilizers” and “effective poultry waste management”. Keeping this in mind, the proposed study was therefore carried out with the aim of vermicomposting of poultry manure by *Eisenia foetida* earthworm and its effect on plant growth.

Materials and Methods

Sample collection sites: The poultry manure was collected from an Atul poultry farm at Dolvan, Tapi (20°54´56´´N; 73°19´22´´E) India. Earthworms *Eisenia foetida,* soil and mango leaves *(Mangifera indica*) were collected from a cow shed located at Bedkuvadur, Tapi, Gujrat, India (21°14´57´´N; 73°23´59´´E). Earthworms *Eisenia foetida* were collected using hand sorting method (Edwards et al., 2004).

Experimental setup: Total 3 plastic rectangle containers (about 60 cm diameters, 45 cm height) were used for the experiment. All three (C, T1 and T2) containers had small holes drilled in the bottom to drain the extra water. Container T1 contained poultry manure (2.5kg) and soil (2.5kg) in equal proportion. Container T2 contained poultry manure (2.5kg), soil (1.5kg) and leaves (1 kg). While Container C was considered as control contained only soil (2.5 kg) and cow dung (2.5 kg). To these, about 100 earthworms (species *Eisenia fetida*) were introduced separately. The moisture was maintained by sprinkling water at regular intervals for a period of 60 day.

Physicochemical analysis of control and formulated vermicompost T1 and T2: Control (C) and vermicompost samples (T1 and T2) were analyzed before the experimental procedures and after 60 days experimental set up for vermicompost. Some selected physicochemical parameters were measured such as pH, Organic carbon (OC), Total Nitrogen (TN), Total Phosphorus (TPh), Total potassium (TP). The pH of samples was measured using pH meter (microprocessor-based pH mater model -1010). OC was determined by walkely-black method (Gelman et al., 2012). TN was measured by micro Kjeldahl method. TPh was determined by using Olsen' sodium bicarbonate extraction method. TP was determined flame photometric method.

Selection of vegetable plants: The selected vegetable plants were listed in Table 1 to check the efficiency of formulated vermicomposts T1 and T2 as compared to control C.

Table 1 The selected vegetable plants for experimental setup

Sr.no.	Crops	Variety
1	Tomato (*Lycopersicon esculentum*)	Vaishali
2	Brinjal(*Solanum melongena*)	Maharaja pink (Gulabi)
3	Chilli (*Capsicum annuum*)	Surajmukhi

Experimental setup of vegetable crops (Pot study): Three different vegetable plants (Tomato, Brinjal and Chilli) were taken for the experiment and total three treatments were

given [Control (50% Soil + 50% cow manure), Test 1 (50% Poultry Manure + 50% Soil) and Test 2 (50% Poultry Manure + 25% Soil + 25% Leaves)]. Pots were prepared before growing plants according to above mentioned treatments. Five seeds were sown in each pot. Irrigation and weeding were performed as and when it was required. Various growth parameters like plant height, number of branches, number of flowers, and number of fruits were recorded at regular intervals (monthly).

Biochemical analysis for fruits of Tomato, Brinjal and Chilli: After five months of pot/field study, biochemical analysis of the fruits was carried out to check the quality of fruits. Ascorbic acid estimation was determined by volumetric method. Protein estimation was determined by Lowery's method. Lipid estimation was determined by the Bartle's method. Carbohydrate estimation was determined by the Nelson- somogyi's method.

Results and Discussion

Vermicomposting after 60 day: After 60 days of interval control C and formulated vermicomposts T1 and T2 were ready to evaluate their potentiality on the growth of selected plants.

The physicochemical characteristics of soil and formulated vermicompost: It is obvious from the results that the formulated vermicomposts T1 and T2 had comparatively higher quantities of total N, P, K, and pH than the control. On the other hand, lower quantities of OC than the control (soil). Maximum reduction of OC was observed in T2 and minimum reduction in C. The reduction of carbon in the worm-worked substrates was higher than in the worm un-worked units. OC has been found to be low in the final product. Among all the treatments, T2 showed the higher content of total nitrogen. The gradually increased content of N, P, K, was observed in all the treatments followed by control (Table 2).

Table 2 Physicochemical characteristics of Control (C) and formulated vermicompost (T1, T2)

Parameters	Control (C)	Test-1	Test-2
pH	5.95	7.74	7.76
Nitrogen (%)	2.88	2.80	3.98
Phosphorus (%)	0.17	0.79	0.75
Potassium (%)	0.30	0.88	0.55
Organic carbon (%)	3.618	1.00	0.67

The quantity of TN on the control was 2.88%. The TN content on formulated vermicompost was T1 (2.80%) and T2 (3.98%). Increased content of TN may be attributed to the release of nitrogenous products of earthworm metabolism through the casts (excreta) and urine. The highest TP content was recorded in T1 followed by C and T2. The quantity of TP on the control was 0.17%. The TP content on formulated vermicompost was T1 (0.79%) and T2 (0.75%). In this study, final formulated vermicopost showed a higher total potassium level and showed the maximum content of TK in T1 (0.88%) and minimum in C (0.30). These findings were very strongly supported by previous researchers (Natarajan and Devi 2014; Yuvaraj et al., 2019; Laouar et al., 2020).

Earthworm biomass (in context of number): To check the suitability of formulated vermicomposts, number of earthworms was counted at regular intervals. About 100 earthworms were added to the Control, T1 and T2 at the initial phase of the study. After 60 days of interval, in T1, earthworms' number increased upto 237 while in T2, this number increased about 814. The increased biomass is significantly high as compared to control *i.e.* about 178. It clearly shows the great suitability of poultry manure as a part of vermicompost to earthworms *Eisenia foetida*. Table 3 summaries this Earthworm biomass (in context of number).

Table 3 Earthworm biomass (in context of number) in different treatment

Treatments	No. of earthworms (0 day)	No. of earthworms (60 day)
Control (S+CD)	100	178
T1 (PM+S)	100	237
T2 (PM+ S + L)	100	814

Effect of treatment on growth and yield parameters of plants & nutrient value of Tomato, Brinjal and Chilli: In order to analyze the efficiency of formulated vermicompost T1 and T2, pot study was carried out after 30 days from the germination of seed of selected plants. Some of the parameters including plant height, number of leaves per plant, number of branch, number of flowers, number of fruits and fruit weight was recorded. This survey was conducted every month till 150 days.

In tomato T1 and T2, flowers were observed on 43th day while in control it was observed on 52th day. Fruit were observed in 52 days in T2 in tomato, while in T1 it was observed in 55 days and in control it was observed in 62 days. Fruit ripening days were found

to be similar in all tests. Among treatments study, parameters of Control was recorded plant height (73 cm), Number of Leaves (35), Number of branch (7), Number of flowers (27), Number of fruits (21). In T1, plant height (74), Number of Leaves (35), Number of branch (7), Number of flowers (21), Number of fruits (14) were recorded. While, in T2 plant height (78), Number of Leaves (38), Number of branch (8), Number of flowers (39), Number of fruits (31) were recorded. Maximum plant growth in tomato was recorded in T2 and minimum plant growth in tomato was recorded in T1 (Figure 1).

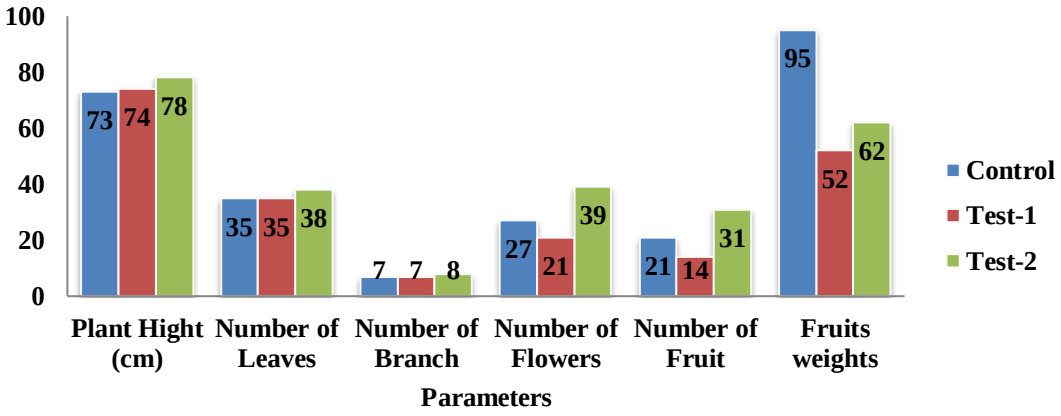

Figure 1: Effect of treatments on growth and yield parameters of Tomato

In case of biochemical analysis of tomato fruit, Figure 2 represent that in Control Protein (1.6 mg/g), Lipid (2.11 mg/g), Sugar (1.47 mg/g) and Vitamin C (16.58 mg/g) were measured. In T1, for biochemical analysis of tomato fruit, Protein (5.5 mg/g), Lipid (1.72 mg/g), Sugar (1.71 mg/g) and Vitamin C (16.78 mg/g) were recorded. While in tomato from T2 treatment, Protein (3.04 mg/g), Lipid (2.52 mg/g), Sugar (1.81 mg/g) and Vitamin C (16.77 mg/g) were recorded. Protein and vitamin C was recorded maximum in T1 treatment and minimum in Control (soil). Lipid and Sugar was recorded maximum in T2.

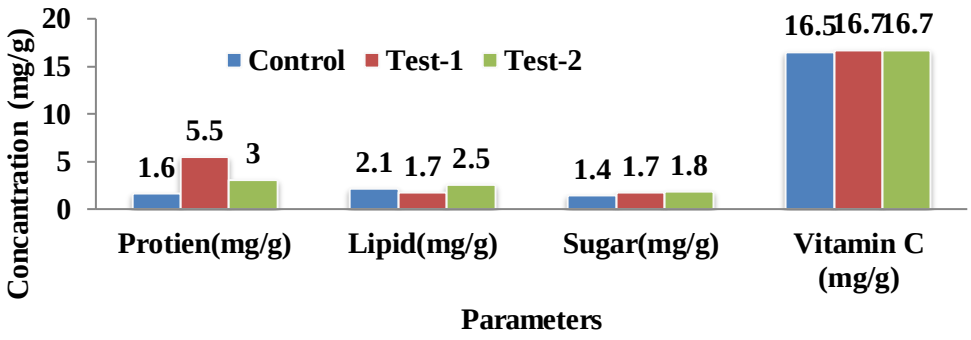

Figure 2: Nutrient values of Tomato fruits

The growth parameters of tomato plants and biochemical analysis of tomato fruit clearly indicates the significant efficiency of formulated poultry manure vermicompost T1 and T2 during this study. A similar result was obtained by Wang et al., (2017). Their formulated vermicompost led to greater improvements in tomato fruit yield (74%), vitamin C (47%), and soluble sugar (71%). Adekiya (2017) also worked in order to obtain maximum economical value of plant nutrient in poultry manure and increase in tomato yield. Abduli et al., (2013) investigated that Vitamin C and total sugar content in tomatoes increase with using their formulated vermicompost. Usman (2015) indicated that growth and yield of tomato was lowest in control treatment which showed that the organic manures used in the study especially poultry manure positively influenced the performance and yield of tomato.

In brinjal, flowers were observed on 61th day in T1 while in T2 flowering was observed on 75th day which is comparatively earlier as in the case of flowering in control treatment (69th day). Brinjal fruits were observed on 72th day in T1 in brinjal, while in T2 it was observed on 87th day. In control, it was observed on 82th day. Among treatments in this study, growth parameters in Control was recorded as plant height (35 cm), Number of Leaves (47), Number of branch (8), Number of flowers (8), Number of fruits (3) in Test-1 plant height (75), Number of Leaves (77), Number of branch (16), Number of flowers (13), Number of fruits (6). While, in T2, plant height (45), Number of Leaves (54), Number of branch (14), Number of flowers (10), Number of fruits (4) were recorded. Maximum plant growth in brinjal was recorded in T1 and minimum plant growth in brinjal was recorded in Control (Figure 3).

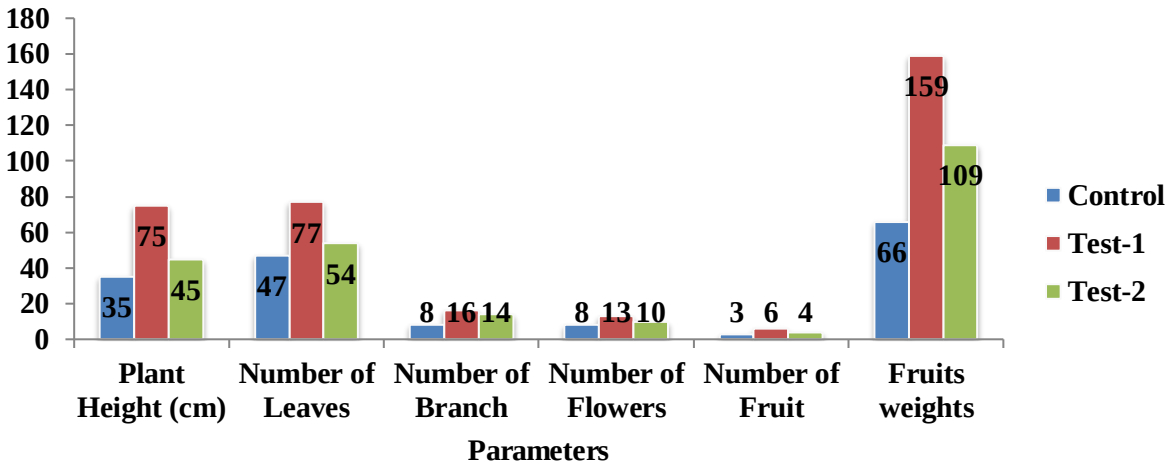

Figure 3: Effect of treatments on growth and yield parameters of Brinjal

In case of biochemical analysis of brinjal fruit, Figure 4 represents that in control, Protein (1.57 mg/g), Lipid (7.89 mg/g), Sugar (3.53 mg/g) and Vitamin C (5.32 mg/g) were recorded. In brinjal fruit from T1, Protein (1.87 mg/g), Lipid (6.47 mg/g), Sugar (2.16 mg/g)

and Vitamin C (5.32 mg/g) were recorded. While, in T2, the brinjal contained Protein (3.73 mg/g), Lipid (5.1 mg/g), Sugar (3.54 mg/g) and Vitamin C (5.37 mg/g). Protein, Sugar and vitamin C were recorded maximum in T2 treatment. Lipid was recorded maximum in Control.

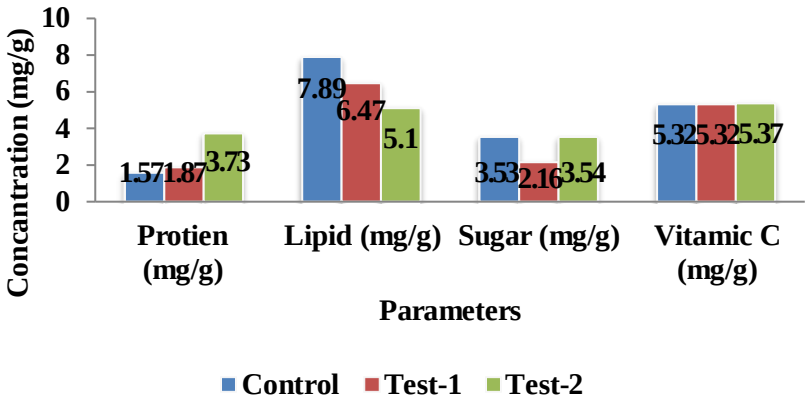

Figure 4: Nutrient value of Brinjal fruits

The growth parameters of brinjal plants and biochemical analysis of brinjal fruit evidently indicates the considerable efficiency of formulated poultry manure vermicompost T1 and T2 during this study. A similar result was obtained by Mufti et al., (2017). They observed higher values for days to first fruit picking (53.40), plant height (126.51), number of branches plant (7.06), number of fruits plant (16.50), Fruit length (13.41cm), average fruit weight (65.65g), fruit yield plant (1.08kg), fruit yield hectare (395.42q), duration of fruiting (92.16) was recorded in treatment T_9 (50% RFD+ 50% PM). Khadka et al., (2022) experimented with 10 different treatments. Among all the treatments, it is noticed that the growth, yield and yield attributing parameters like plant height, numbers of leaves per plant, number of branches per plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, fruit yield per plant, fruit yield per plot, total yield, and quality parameters like total soluble solids, sugar content, reducing sugar and vitamin c content in fruit were found maximum in treatment T8 (20% cowdung+ 20% Mustard oil cake+ 20% Poultry manure+ 40% chemical fertilizer) and the minimum being recorded in T1(Cowdung). Kumar et al., (2020) conducted the study effect to standardize the best treatment combination of organic and inorganic source for better growth and yield of brinjal. They concluded that the treatment T7 25% RDF + 100% @ Poultry manure is proved as a best combination of different organic and inorganic fertilizer for the improvement of brinjal cultivation through organically; where treatment T7 25% RDF + 100% @ Poultry manure significantly enhances the growth, flowering, fruit yield and quality traits of brinjal.

In Chilli, flowers were observed on 104th day in T1 while in T2, it was observed on 125th day which is quite delayed flowering as compared to that of the control (92 day). Chilli fruits were observed on 115th day in T1, while in T2 it was observed on 136th day. In chilli plants of Control group, fruiting was observed on 110th day. Among treatments during this study, growth parameters of chilli plants in Control was recorded as plant height (64 cm), Number of Leaves (135), Number of branch (20), Number of flowers (36), Number of fruits (25) In T1, plant height (80 cm), Number of Leaves (147), Number of branch (26), Number of flowers (76), Number of fruits (66) were recorded. While, in T2, plant height (65), Number of Leaves (103), Number of branch (19), Number of flowers (15), Number of fruits (8) were recorded. Maximum plant growth in chilli was recorded in T1 and minimum plant growth in chilli was recorded in T2 (Figure 5).

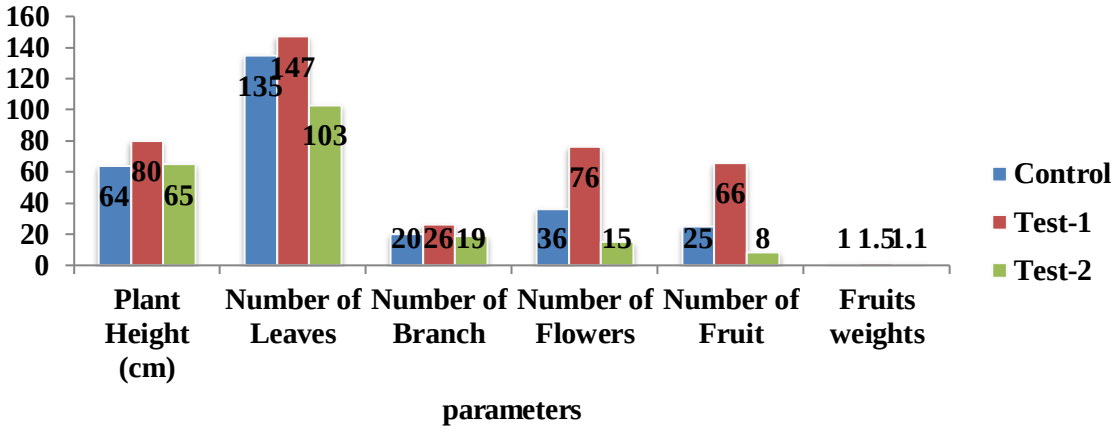

Figure 5: Effect of treatments on growth and yield parameters of Chilli

In case of biochemical analysis of chilli fruit, Figure 6 represent that chilli from Control contained Protein (1.85 mg/g), Lipid (5.47 mg/g), Sugar (1.5 mg/g) and Vitamin C (3.99 mg/g). Protein (2 mg/g), Lipid (5.52 mg/g), Sugar (1.51 mg/g) and Vitamin C (4.79 mg/g) were recorded in Chilli from T1. While, in T2, chilli contained Protein (1.66 mg/g), Lipid (6.36 mg/g), Sugar (0.53 mg/g) and Vitamin C (5.06 mg/g). Protein and Sugar was recorded maximum in T1 treatment. Lipid and Vitamin C was recorded maximum in T2.

A similar result was obtained by Sorenge et al., (2017). They studied the effect of organic manures on different plant varieties of Chilli (*Capsicum annum*) under subabul (*Leucaena leucocephela*) based Horti-silviculture system. As per their experiments, the overall best variety and treatment noticed was Chilli G- 4 and F_4 (100% poultry manure). Altaf et al., (2019) also concluded that the poultry manure can be a good alternative of synthetic fertilizers by their series of experiments.

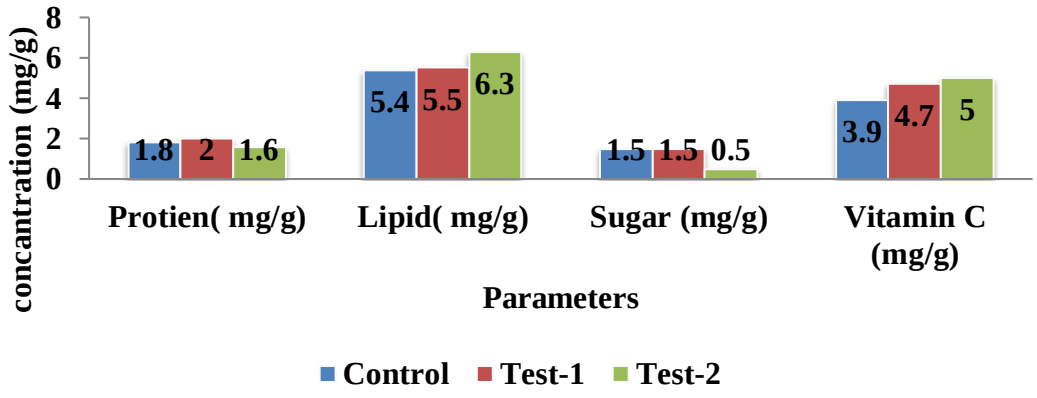

Figure: 6 Nutrient value of chilli fruits

A field experiment was conducted during Rabi season 2016-2017 in the Department of Horticulture, SHUATS, Allahbad, (UP) in Randomized Block Design with three replication and 11 treatments. The experiment consisted of three Bulky organic manures (FYM, Vermicompost and Poultry manure) and three chemical fertilizers (Nitrogen, Phosphorus and Potassium). The result revealed that maximum plant height (44.55 cm), Number of leaves plant^{-1} (35.97), Leaf area plant^{-1} (56.27 cm^2), Number of flowers plant^{-1} (4.37), average fruit set (140.47 g/fruit) and fruit yield plot^{-1} (4.23 kg) were produced by treatment T_6 (50%RDN + 50% vermicompost ha^{-1}). Treatment T_6 showed higher nutrient availability in the soil with organic carbon (0.47%) and the residual nutrient status of nitrogen (106.08kg/ha), Phosphorus (23.83 kg/ha) and Potassium (381.33 kg/ha) (Jamir et al., 2017). Bilal et al., (2019) also concluded that addition of vermicompost @ 3 tons ha-1 significantly improved vegetative as well as the reproductive growth of Pusa Jawala in the prevailing agro-climatic conditions of Peshawar valley.

Conclusion: In conclusion, the study assessed the physicochemical characteristics of poultry manure vermicompost (PMV) using *E. foetida* in different proportions and evaluated their impact on the growth of tomato, brinjal, and chilli plants in a field setting. The results demonstrated that *E. foetida* positively influenced the quality of PMV by increasing total nitrogen, total phosphorus, total potassium, and pH levels, while decreasing organic carbon content. The highest earthworm biomass was observed in T2 (50% PM + 25% soil + 25% leaves), followed by T1 (50% PM + 50% soil). Plant growth parameters varied among the treatments, with tomato plants exhibiting maximum growth in T2, and chilli and brinjal plants showing significant growth in T1. Biochemical analysis of fruit quality revealed that T1 was most effective for tomato plants, while T2 was more effective for chilli and brinjal plants, compared to the control (50% soil + 50% cow dung). Overall, the study suggests that PMV, particularly in the T1 and T2 formulations, can serve as a viable organic alternative to

synthetic fertilizers for promoting the growth and enhancing the quality of various vegetable crops.

Acknowledgments: Author is thankful to UGC-SAP-DRS-II for financial support at department level.

REFERENCES

Abduli, M., Amiri, L., Madadian, E., Gitipour, S. and S. Sedighian. (2013). Efficiency of vermicompost on quantitative and qualitative growth of tomato plants. *Int.J. Environ. Res.***7**, 467-472.

Adekiya, A. and T. Agbede. (2017). Effect of methods and time of poultry manure application on soil and leaf nutrient concentrations, growth and fruit yield of tomato (*Lycopersicon esculentum Mill*). *J. Saudi Soc. Agric. Sci.* **16**, 383-388.

Adeleye, E., Ayeni, L. and S. Ojeniyi. (2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on alfisol in southwestern Nigeria. *J. Am. sci*. **6**, 871-878.

Altaf, M. A., Shahid, R., Ren, M. X., Naz, S., Altaf, M. M., Khan, L. U., Lal, M. K., Tiwari, R. K. and A. Shakoor. (2022). Melatonin mitigates cadmium toxicity by promoting root architecture and mineral homeostasis of tomato genotypes. *J. Soil Sci. Plant Nut.* **22,** 1112-1128.

Arancon, N., Edwards, C., Bierman, P., Welch, C. and J. Metzger. (2004). Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. *Bioresour. Technol.* **93,** 145-153.

Atiyeh, R., Lee, S., Edwards, C., Arancon, N. and J. Metzger. (2002). The influence of humic acids derived from earthworm-processed organic wastes on plant growth. *Bioresour. Technol.* **84**, 7-14.

Bilal, H., Aman, F., Ullah, I., Awan, A. A., Ullah, S., Khan, S., Aamir, M., Khan, M. A. and B. Rome. (2019). Response of chilli varieties to various sources of organic fertilizers. *ARPN- J. Agric. Biol. Sci.* **13**, 15-26.

Chaoui, H. I., Zibilske, L. M. and T. Ohno. (2003). Effects of earthworm casts and compost on soil microbial activity and plant nutrient availability. *Soil Biol. Biochem.* **35**, 295-302.

Edwards, C. A., Dominguez, J. and N. Q. Aranconl. (2004). 18. The influence of vermicomposts on plant growth and pest incidence. *Soil Zoology for Sustainable Development in the 21st Century; Hanna, HSH, Mikhail, WZA.*

Garg, P., Gupta, A. and S. Satya. (2006). Vermicomposting of different types of waste using *Eisenia foetida*: A comparative study. *Bioresour. Technol.* **97**, 391-395.

Gelman, F., Binstock, R. and L. Halicz. (2012). Application of the Walkley–Black titration for the organic carbon quantification in organic rich sedimentary rocks. *Fuel* **96**, 608-610.

Gutiérrez-Miceli, F. A., Santiago-Borraz, J., Molina, J. A. M., Nafate, C. C., Abud-Archila, M., Llaven, M. A. O., Rincón-Rosales, R. and L. Dendooven. (2007). Vermicompost as a soil supplement to improve growth, yield and fruit quality of tomato (*Lycopersicum esculentum*). *Bioresour. Technol.* **98**, 2781-2786.

Jamir, T., Rajwade, V. B., Prasad, V. and C. Lyngdoh. (2017) Effect of organic manures and chemical fertilizers on growth and yield of sweet pepper (*Capsicum annuum L.*) hybrid Indam Bharath in shade net condition. *Int. J. Curr. Microbiol. Appl. Sci.* **6**, 1010-1019.

Khadka, H., Kumar, J., Silas, V. J., Yadav, A., Giri, H., Aashish, K. and M. K.Yadav. (2022) Effects of organic manures and chemical fertilizers on the yield and quality parameters of Brinjal (*Pusa purple long*) under the agro-climatic conditions of Kanpur.

Kumar, P. S., Prasad, V. and D. Singh. (2020). Effect to standardize the best treatment combination of organic and inorganic source for better growth and yield of Brinjal (*Solanum melongena L.*). *Int. J. Chem. Stud.* **8**, 3193-3195.

Laouar, F., Halilat, M., Oustani, M., Benbrahim, F., Aidoud, A. and H. Guessoum. (2020). Evolution of the physical and physico-chemical parameters of compost resulting from a mixture of oasis waste and poultry manure. *J. Fundam. Appl. Sci.* **12**, 1436-1451.

Mufti, S., Chattoo, M., Wani, K. P., Bhat, R., Mushtaq, F., Afroza, B., Nabi, A. and U. H. Masoodi. (2017). Carry over effect of organic manures and inorganic fertilizers on growth, yield and quality of residual crop fenugreek in brinjal-fenugreek cropping sequence. *J. Pharmacog. Phytochem.* **6**, 1883-1886.

Natarajan, N. and K. Devi. (2014). The use of earthworm *Eudrilus eugeniae* in the

breakdown and management of poultry waste. *Growth* **3**, 40-43.

Orozco, F., Cegarra, J., Trujillo, L. and A. Roig. (1996). Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: effects on C and N contents and the availability of nutrients. *Biol.Fert.Soils.* **22**, 162-166.

Ramnarain, Y. I., Ansari, A. A. and L. Ori. (2019). Vermicomposting of different organic materials using the epigeic earthworm *Eisenia foetida*. *Int. J. Recycl.Org. Waste Agric*. **8**, 23-36.

Soreng, M. K. and N. S. Kerketta. (2017). Effect of organic manures on different plant varieties of chilli (*Capsicum annum*) under subabul (*Leucaena leucocephala*) based Horti silviculture system. *J. Med. Plants Stud.* 5, 273-276.

Spinosa, L. and P. A.Vesilind: *Sludge into biosolids*; IWA publishing (2001)

Usman, M. (2015). Cow dung, goat and poultry manure and their effects on the average yields and growth parameters of tomato crop. *J. Biol. Agric. Healthcare.* **5**, 7-10.

Verbeek, A., Van Ryssen, J. and S. Van Malsen. (1993). Mineral composition of poultry manure in South Africa with reference to the Farm Feed Act. *S. Afr. J. Anim. Sci.* **23**, 54-57.

Wang, X. X., Zhao, F., Zhang, G., Zhang, Y. and L. Yang. (2017). Vermicompost improves tomato yield and quality and the biochemical properties of soils with different tomato planting history in a greenhouse study. *Front. Plant Sci.* **8**, 1978.

Yadav, K. D., Sharma, D. and R. Prasad. (2022). Challenges and opportunities for disposal of floral waste in developing countries by using composting method. In *Advanced Organic Waste Management*, 55-77.

Yuvaraj, A., Thangaraj, R. and R. Maheswaran. (2019). Decomposition of poultry litter through vermicomposting using earthworm *Drawida sulcata* and its effect on plant growth. *Int. J. Environ. Sci. Technol.* **16**, 7241-7254.