Does starter medium improve epigeic earth worms growth and vermicompost qualities?

T. S. Abd El-Ghany * A. A. El-Sheshtawy, and K. M. Ghanem

Department of Environment and Bio-agriculture, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

* Corresponding author E-mail: tamer_said2013@azhar.edu.eg (T. Abd El-Ghany)

ABSTRACT:

Vermicomposting is a composting technique that utilizes humus-feeding epigeic earthworms to break down complex organic material into manure with added value (vermicompost), which is rich in beneficial microorganisms and contains nutrients that are accessible to plants. The present study aimed to determine the manure quality of different vermicompost produced from 100% horse dung (T1), 75% horse dung + 25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung + 25% mushroom compost (T4), and 50% horse dung + 50% mushroom (T5) using earthworms. The obtained results revealed that T5 vermicompost showed higher physio-chemical traits as it gave the highest organic carbon, organic matter, and ash content with the lowest C/N ratio. A stimulation in the nutrients level has been shown in the T5 vermicompost with stimulation in the growth regulators of gibberellin, indoleacetic acid, cytokinin, and abscisic acid. Microbial populations were much more abundant in all vermicompost samples produced with a significant peak in T5 compost. The maximum earthworm' number 2041.7 and weight 2448.3 g of earthworms were noticed by T5 compost. In conclusion, using 50% horse dung and 50% mushroom as raw materials for vermitechnology produced vermicompost with high-quality characteristics.

Keywords: Vermicompost; *Eisenia fetida*, *Perionyx excavates;* horse dung; compost mushroom and compost.

INTRODUCTION

Vermicomposting is a helpful process that assists in the conversion of organic wastes (agro-waste, household waste, and animal manure) into highly nutritious fertilizers (vermicompost) for plants and soil using earthworms (Gajalakshmi and Abassi 2004). Worm cast and decomposed organic materials are the major components of vermicompost (Ismail 2005 and Devi and Prakash 2015). Vermicompost is a product that has a good structure, moisture-holding ability, porosity, drainage, and aeration (Ismail 2005 and Edwards *et al*., 2011). It is a sustainable alternative to chemical fertilizers that is high in macro and micronutrients, growth promoters, and beneficial soil microorganisms (Sinha *et al*., 2011 and Singh and Chauhan, 2015), so it is used safely and widely in organic agriculture (Ansari and Jaikishun, 2011 and Chauhan and Singh, 2013).

Organic substances differ in terms of components, nutritional content, and palatability all of which can affect earthworm development and performance (Suthar 2007). These variables may have an impact on the amount and quality of vermicompost generated. Yan *et al*., (2013) stated that in vermicomposting processes, the initial organic waste material impacts the vermicompost content of nutrients, as well as found that nutrients concentration in the initial organic waste correlated positively with vermicompost nutrients.

Vermicompost is a highly nutritious organic fertilizer and a potent growth stimulator compared with synthesis fertilizers that have degraded soil qualities and reduced natural fertility over time. Numerous studies have found that vermicompost has a higher nutritional content (Lourduraj and Yadav 2005; Gurav and Pathade 2011 and Abdelmonem *et al*., 2016). Using cow dung as a feeding substance exhibited the highest raise in earthworm quantity and vermicompost produced (Sarker and Kashem, 2020).

Vegetable production regularly uses vermicompost as a bioenhancer. Vermicomposting experiments provide farmers with environmentally friendly fertilizer and support the shift of the agriculture industry to a greener one. The use of such technologies would help control the industry's rising costs, which have increased farmers' responsibilities related to chemical pesticides and fertilizers in recent years.As a result, the production cost has significantly increased. Vermicompost as an organic fertilizer that can replace synthetic fertilizers in crop production, save expenses, and generate organic production that is more valuable on the market, which could be a feasible solution. Organic agriculture, which is produced using only natural pesticides and fertilizers and is thought to be healthier for consumers and better for the environment, is becoming more and more popular as global living standards increase (Kaplan, 2016).

Horse dung is a very precious and underutilized resource generated in enormous quantities, as a horse weighing 1.000 pounds will often create 50 pounds of manure and 10 pounds of urine per day (Rynk, *et al.*, 1992). Horse manure is a good source of minerals where typically a ton of horse dung have 11 pounds of N, 2 pounds of P, and 8 pounds of K. Horse manure may be a useful resource in the crop production if properly managed (Auvermann *et al.*, 1999). It may enhance soil quality and serve as a source of nutrients for crop growth. The organic content of horse manure can increase the soil's features and water-holding ability.

Fruits and vegetables (horticultural crops) act a pivotal function in the human's life diet and these substantial commodities request significant increase because of the increasing world population. Fruit and vegetable wastes are produced in huge quantities during their production, handling, processing, and consumption. The horticulture waste is a significant source of bioactive materials that have the potential to be useful, such as organic acids, phenolics, pigments, antioxidants, dietary fibres, minerals, sugar derivatives, and other compounds like organic acids and phenolics (Sagar, *et al.*, 2018; Edwiges *et al.*, 2018), with about 85 - 90 % water content (Li *et al.*, 2020). Fruits and vegetables wastes have 80–97 % volatile solid: total solid ratio and 14.7–36.4 C/N ratio (Thi *et al.*, (2015). According to Plazzotta *et al.*, (2017). These wastes offer a high potential for recycling, reuse, and vermicomposting and should be handled carefully. Several reports were performed to investigate the different operation systems and conditions for horticultural wastes vermicomposting (Suthar (2009); Garg and Gupta (2011); Fernández Gómez *et al.*, (2010).

The agriculture industry relies heavily on expensive imported agro-chemical inputs like chemical fertilizers and insecticides (Kaplan, 2016). Vermicompost is one organic input that can be substituted for than synthetic fertilizers to help organic agricultural systems growth. Therefore, the goal of this research is to create and modify technologies to manufacture high-quality vermicompost utilizing organic waste that are readily and available locally using earthworms.

MATERIALS AND METHODS

Experimental location

This experiment was conducted at Vermicompost Production Unit of Environment and Bio-Agriculture Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt during the period from 28th December 2020 to 28th March 2021, and repeated from 9th June to 9th September 2021.

Raw materials and feeding

The warms of *Eisenia fetida and Perionyx excavatus* were obtained from the Union Agricultural Development Company. Healthy, juvenile earthworms (3-7 in cm length) were released in the foam box at the rate of 150 g for 90 days. The horse dung was obtained from a horse breeder at Abu Hummus - Beheira and used after 10 days of collection for avoiding the death of worms. Compost and compost mushroom were obtained from Al-Fayrouz Company, Bilbies, Sharkia Governorate. Chemical characteristics of compost, horse dung, and compost mushroom are showed in Table (1).

Vegetables and fruit waste collection and preparation

The vegetables and fruit waste (tomatoes - eggplant - cabbage leaves, lettuce - watermelon) were obtained from vegetable and fruit sellers, Naser City, Cairo, Egypt and cut into pieces (3-5 cm). The wastes were watered to keep the moisture about 65–70% (Gusain and Suthar, 2020b).

Experimental treatments and layout

This study was performed in foam box (Figure 1), (50 cm length × 30 cm width × 15 cm height) filled with 3 Kg of started media, in five treatments as follows: T1: 100% horse dung, T2: 75% horse dung + 25% compost, T3: 50% horse dung + 50% compost, T4: 75% horse dung + 25% mushroom compost, and T5: 50% horse dung + 50% mushroom compost. All the treatments were processed at the basis of w: w. Each box supplemented with 300 g of vegetable and fruit wastes each 15 days. The arrangement of the experiment was Complete Randomized Design in six replicates.

Data recorded

Vermicompost temperature, EC, and pH

Temperature, EC and pH were assessed weekly in each vermicompost unit during vermicomposting process. Electrical conductivity (EC) and pH in vermicompost paste extracts was determined as described by (Ryan *et al.*, 1996) in a 1:2.5 vermicompost suspension.

Physiochemical properties

Organic and carbon matter:

Organic matter content was determined in vermicompost materials by glowing (burning) vermicompost samples at 550 ºC to constant weight, as recommended by Page *et al.*, (1982). Organic carbon content was calculated according to Walkley and Black method (Black *et al.*, 1965) by multiplying the organic matter dry weight by 0.58, as reported by Jackson (1973).

Ammoniacal and nitrate nitrogen:

Soluble nitrogen i.e., NH_4^+ and NO_3^- were determined in vermicompost according to the methods outlined by Page *et al.*, (1982).

Nutrients estimation

A 0.2g sample of dried vermicompost was mixed with 5 mL of concentrated sulfuric acid and the mixture was heated for 10 min, then 1 ml of hydrogen peroxide was added to the mixture and heated till reaching to the clear solution (Piper, 1947). The digested solution was quantitively transferred to a 100 ml using deionized water and used for nutrient estimation as follows: Total nitrogen (%) was estimated using Micro Kjeldahl method as described by Page *et al.*, (1982), phosphorous (%) was estimated calorimetrically using spectrophotometer according to Ryan *et al.*, (1996), potassium (%) was determined using a Flame photometer according to Jackson (1965), calcium (%) and magnesium (ppm) were determined using Atomic Absorption according to (Cottenie *et al.*, (1982) and Ryan *et al.*, (1996)) respectively, while, iron and zinc (ppm) elements were determined as described by Jones Jr., (1981) using Atomic Absorption. Available nitrogen was extracted in the vermicompost samples using 2.0 M KCl and analyzed by direct MgO-Devarda Alloy procedure and steam distillation system (Black *et al.*, 1965). Available phosphorous was extracted with 0.5 N Na HCO_3 at pH 8.5 and determined calorimetrically according to Olsen and Sommers, (1982).

Hormone determination

A sample of 10 g was mixed with methanol 70 % and stirred at 4°C overnight. The Whatman filter was used for filtered extraction and then the methanol evaporated under a vacuum. The aqueous phase was adjusted to pH 8.5 by phosphate buffer (0.1 M) and then partitioned 3 times with ethyl acetate. After ethyl acetate phase removal, the pH was adjusted to 2.5 using 1 N HCl. The solution was partitioned with diethyl ether 3 times and then passed through anhydrous sodium sulfate. After that, the diethyl ether was evaporated, and the residue was dissolved in 2.0 mL of methanol and stored at 4°C in vials. The chromatographic analysis was performed on an Agilent Model 1260 (Durley *et al.*, 1982).

Microbiological analysis

Total bacteria and actinomycetes were estimated for each box, according to Holt, (1994) and Abd El-Malek (1971) procedure. Total fungi were examined according to the dilution method described by Taylor, (1962), and plate count procedure of Jahnson *et al.*, (1959). The medium Martin (Martine, 1950) was used for fungi determination.

Earthworms' population and vermicompost production

After 90 days, the total population of earthworm and vermicompost production were determined. The earthworm population in each box was assessed by hand-sorting procedure as described by Zicsi (1962). Vermicompost productivity was calculated using the following formula:

Vermicompost productivity (%) = (harvested vermicompost (kg) / total mass of feed (kg)) × 100.

Statistical analysis:

The layout of the experiment was a randomized complete block design (RCBD). Data collected were statistically analyzed using one-way analysis using MSTAT-C (Nissen, 1989) for data set. Duncan multiple range test was used according to Steel and Torrie (1960) to compare the means at the $p \leq 0.05$ probability level. Results were presented as average mean ± SE.

RESULTS AND DISCUSSION

Physiochemical properties

In the initial mixtures, pH ranged from 8.25–8.52 (Figure 2), and declined to 7.82–7.52 at the final stage (Figure 2 and Table 2). The pH of the mixture fell within the required range for microbial growth and N preservation in the substrate. Early vermicomposting operations caused the pH in all treatments to decrease. The organic acids produced, as well as microbiologic acid breakdown and nitrification-ammonification processes, may be responsible for the pH fluctuations in vermibeds. (Nakasaki *et al.*, 2005; Gusain *et al.*, 2018). The same findings were reported by Nakasaki *et al.*, (2005) who claimed that the organic acids created during waste mineralization processes may be the cause of the decrease in vermicompost pH during vermicomposting procedures activities. Wani *et al.*, (2013) found that using organic wastes such as garden waste and kitchen waste led to a decrease in the pH values of vermicompost resulting from *Eisenia fetida*. Das and Deka (2021) noticed a decrease in the pH level in the vermicompost. In the final stage of vermicomposting, the changes in the pH are owing to the creation of H^+ and NO_3- ions (Nakasaki *et al.*, 2005; Meng *et al.*, 2017).

At the initial stage, the EC of vermicompost mixtures ranged from 2.14–2.86 dS m^{-1} and increased to 3.12-3.55 dS m^{-1} at the final stage. During vermicomposting, the EC of treatments increased by 24.3, 9.79, 10.53, 52.33, and 64.35% for T1, T2, T3, T4, and T5, respectively. EC is a measurement of the total amount of soluble salts created during the decomposition of waste, as well as a fertilizer indicator parameter (Awasthi *et al.*, 2014). EC showed a consistent rise during the vermicomposting phase, which was likely caused by the mineralization of organic wastes into soluble salts. The variations in organic matter mineralization rates and ammoniacal nitrogen conversion rates into other pertinent forms of nitrogen could be to blame for the variations in waste substances EC values. The highest EC and ash values were obtained by T5 (3.55 dS m^{-1} and 67.62%, respectively) but T1 treatment exhibited the lowest values (3.12 dS m^{-1} and 47.31%). The increase in ash content corroborated the results of Boruah *et al.*, (2019) and Karmegam *et al.*, (2020) who stated that the final product of vermicomposting process presented a significant elevation in ash content. The growing in EC value followed by a growing in the organic carbon and organic matter values as shown in Table 2, the same treatment (T5) gained the highest organic carbon (310 g kg^{-1}) and organic matter (533.20 g kg^{-1}). On the other hand, the lowest EC (3.12 dS m^{-1}) is obtained by T1 followed by lower and significant organic carbon (297.67 g kg^{-1}) and organic matter (511.99 g kg^{-1}) as compared with the rest of treatments except T2. In the same direction, Paczka *et al.*, (2020) indicated that the release of several mineral ions, including phosphates, ammonium, potassium, and others, may be the cause of the increase in the EC of vermicompost.

Regarding ash content, T5 recorded a significant rise as compared with the other treatments, followed by a significant increase in the nitrous nitrogen (45.33 ppm) and ammonium nitrogen (55.67 ppm) as compared with the other treatments. In contrast, the lowest values in this respect given by T1 (47.31%, 34.67 ppm, and 32.33 ppm for ash, nitrous nitrogen, and ammonium nitrogen, respectively). There were substantial variances between the C/N ratios of the various vermicompost types, with T5 significantly showing the lowest C/N ratio, T1 having the greatest C/N ratio (22: 1), followed by T3 (20.68:1), however there were no significant differences between them. The degree of mineralization and stabilisation of the waste mass is determined by the C/N ratio, which is the most popular vermicomposting maturity indicator (Paczka et al., (2020). Depending on how far the vermicomposting process has progressed, carbon is lost via the mineralization of instable organic compounds and in the form of CO_2 due to the respiration of microorganisms, while nitrogen content simultaneously rises as a result of the physiological functions of agriculture earthworms. Abd El-Sattar (2014) reported that reducing the C/N ratio reflects a satisfactory degree of organic wastes maturity. The moisture ranged between 64.67 and 75.0 % showing lower moisture content in T1 than in the other treatments. The results of this study are consistent with the study of Raphael and Velmourougane (2011) and Gusain and Suthar (2020b) who reported that physicochemical characteristics were increased in vermicompost.

The nutrient content

The N, P, and K content present in different vermicompost types is represented in Table 3**.** The results revealed significant increase in the N, P, K, Ca, and Mg content in T5 vermicompost, as it gave the highest values (15.23, 4.83, 13.60, 35.3, and 11.9 g kg^{-1} for N, P, K, Ca, and Mg, respectively) as compared with the other vermicompost types. While the lowest N, P, K, and Mg content was detected by T1 (13.40, 3.30, 12.08, and 10.43 g kg^{-1} for N, P, and K, respectively) and T3 (14.73, 3.93, 12.90, 33.73, and 10.7g kg^{-1} for N, P, K, Ca, and Mg, respectively). The increase in nitrogen content in the vermicompost contributed to the activity of the earthworms in recycling nitrogen, and their metabolic and excretory products, as well as mucus, body fluid, enzymes, and decomposing worm tissues. As well as significant amounts of metabolized N species (NH_4^+-N, NO_2-N, NH_3, etc.) released during the decomposition of organic matter, and these species afterwards changed into residual forms in the aerobic environment. Similar results were stated by Parthasarathi and Ranganathan (2000) who noticed a rise in the amount of nitrogen (N) in the final vermicompost product in the form of worm-produced growth-stimulating hormones and enzymes. Similar findings were also reported by Yadav and Garg, 2011; Devi and Khwairakpam, 2020a,b.

P content is influenced by the rate of P retention by chelating oxalic, lactic, citric, succinic, acetic, and formic acids in waste mixtures; its subsequent release is reliant on the oxidation of humic acid in waste materials by microbes (Wei et al., 2018). The Earthworms' consumption of leaf litter increased the amount of accessible P, which may be related to the worms' decomposition of the leaf material. Orozco *et al***.**, (1996). Hussain *et al*., (2018) reported that the augmentation of phosphorus-solubilizing microorganisms in the feedstock enhances phosphatase secretion, which in turn accelerates the degradation of phosphoric esters into inorganic phosphorus. The mineralization of the organic matter and biomass loss contributed to K concentration in the vermibeds (Gusain and Suthar, 2020a). The mineralization of organic K in vermicompost is a complex procedure and is impacted by several factors like the mobility of K in the substrate, feedstock type, leaching to undermost layers, and earthworm assimilation rate (Orozeo *et al*., 1996). An increase in K levels during vermicomposting caused by the presence of microbes in earthworm guts, which contributed to this process. Premuzic *et al*., (1998) claimed that dissolving the insoluble K into soluble form is a result of acidity created by microorganisms. On the other hand, (Garg *et al*.**,** 2006) stated that the increment in K availability may be attributed to the physical disintegration of the feedstock by the earthworms and the release of endogenic/exogenic enzymes by the microorganisms. Generally, the nutrient concentration significantly increased over the vermicomposting process through microbial activity, earthworm mucus, and their excretory products and body fluids.

In this study, the elevation in Ca level in the vermicompost products may be a result of Ca emission via earthworm faecal substances and by solubilization of organic Ca through acts of organic acids formed over the final phases disintegration (Wei *et al*., 2018). The degradation of humic acids and other organic acids during vermicomposting releases Ca in the substrate (Wei *et al*., 2018). During earthworm ingestion the plant tissue bounded Ca is transferred into soluble forms via initial enzymatic solubilization, also, fungi and actinomycetes invaders to worm cast help in releasing Ca (Domínguez, 2004). The increase in calcium level in the vermicompost is due to the presence of calciferous glands in the earthworm that are involved in the production of calcium carbonate, which might favor the calcium availability in the vermicompost. Sivakumar and Subbhuraam (2005) reported that the increased calcium level is due to the gut process associated with calcium metabolism, primarily for enhanced calcium content in worm cast.

Higher levels of Fe and Zn were noticed in T5 vermicompost, as it significantly gave 181.3 and 253.3 ppm for Fe and Zn, respectively against 1414.6 and 218.2 ppm which were given by T1 for Fe and Zn, respectively (Table 3). Enzymes and co-factors in the earthworm gut may be a reason of the increase in Fe content in the vermicompost. Zn is an essential for the transformation of carbohydrates, and it regulates the consumption of sugar. Soil pH is the most critical factor controlling Zn availability. The present findings are in accordance with Sainz, (1998), Ravindran and Mnkeni (2016) who revealed that there is a significant increase in the Zn concentration after vermicompost processing.

Growth regulators

The results in Table 4 shows the growth regulators analysis for different vermicompost types. The T1 vermicompost had the highest values of gibberellin, IAA, and cytokinin as it recorded 29.0, 21.0, and 30.0 ppm, respectively, with the lowest value of abscisic acid (0.95 ppm). The results for T1 vermicompost occupied the lowest value of gibberellin (21.0 ppm), IAA (18.0), cytokinin (25.0 ppm), and the highest abscisic acid value (3.10 ppm). Ravindran *et al*., (2016) investigated converting tannery waste into a proper finished product via composting and vermicomposting, and they found that the highest phytohormones (mg kg^{-1}) were found in vermicompost as IA, and gibberellic acid. The findings exhibited that the greatest concentration of phytohormones in vermicompost was a result of the microbes and earthworms' mutual action. An increase in the hormone's concentration (auxins, cytokinin, and gibberellins) in the vermicompost is produced by sewage sludge. (Tomati *et al.*,1988). Garg *et al.*, (2018) reported that vermicompost contains plant growth-affecting compounds including plant growth regulators and others. The release of biological factors like gibberellin, cytokinin, and auxins as a result of the microbial activity of the microbes contained in the casting has also been linked to the beneficial effect of worm casting. Arraktham *et al.*, (2016) reported that earlier research had shown that producing IAA is related to the *Pseudomonas*, *Bacillus*, *Arthrobacter*, and *Enterobacter* bacteria groups isolated from vermicompost, which have the capability to produce IAA.

Microbial biodiversity

The results presented in Table 5 summarizes the microbial biodiversity assayed from various vermicompost types produced via earthworms. There was a significant difference in microbial populations of different vermicompost types. The higher populations count of bacteria, actinomycete, and fungi were found by T5 vermicompost, (97, 82, and 88.67 1 × 10^6 C.F.U/ g) with significant increase by 53.96, 54.71, and 111.2% compared with T1 vermicompost. Others vermicompost (T2, T3, and T4) had a moderate microbial population. The raw material of vermicomposting influences the microbial population in the final vermicompost. Earthworms alter the substrate's chemical environment by buffering pH and releasing hydrosoluble carbon through the decomposition of lignocellulose, which also promotes the fast growth of microbial communities in waste settings. Due to lignocellulosic components, which serve as a simple source of carbon for microbial development, substrate rich in plant biomass supported the largest rise in microbial population. the high content of N, p, and K nutrients could stimulate the growth of microorganisms in the vermibeds (Sharma and Garg, 2018). The previous studies of Arraktham *et al.*, (2016) demonstrated the presence of 343 distinct kinds of microorganisms including bacteria, fungi, and actinomycetes in the earthworm *Pheretima* sp., and most of these bacteria are in the genus *Pseudomonas* and *Azotobacter* and are capable of producing phosphate solubilizers, nitrogen-fixing bacteria, and plant growth promoters.

The most diversified species of bacteria, which are found in composted waste, are thought to facilitate the enzymatic decomposition of complex organic compounds (Grgic *et al.*, 2019). In vermicomposting systems, bacteria from the genera *Pseudomonas*, *Bacillus*, and Macrobacterium predominate, and they contribute to the disintegration of organic molecules through intricate enzyme-substrate pathways (Jayakumar and Natarajan, 2013). Particularly, actinomycetes break down certain more refractory components including cellulose, lignin, protein, carbohydrates, etc. and give finished compost/vermicompost a wonderful earthy fragrance.

Earthworm growth and reproduction performances

Earthworms' performance after 90 days of vermicomposting process are presented in Table 6. The average number of earthworms in different vermicompost type was in the ranges of 1740-2041.67 with range weight of 1279-2448 g (Table 6). The highest number of earthworms was recorded in T5 vermicompost as it presented an increase by 17.33% compared with T1 vermicompost in earthworms' number with an increase in the earthworm's weight by 91.42% than T1. The high N content, active ingredients content of triterpenes, flavonoids, alkaloids, steroids, and glycosides) (Singh *et al.*, 2013; Agbafor *et al.*, 2015), and vitamins (riboflavin, pyridoxine, ascorbate, thiamine, niacin) in fruit and vegetable wastes (Edwiges et al. 2018) could have possibly stimulated the weight of earthworms gained in the fruit and vegetable waste-based composting system.

The vermicompost productivity for different types of vermicompost is presented in Table 6. The results showed that the T5 had significantly higher value of 51.06 %. On the contrary, T1 recorded the lowest value of 26.65 % compared with the treatments. Sinha *et al.*, (2010) and Edwards *et.al*, (2011) stated that per day, 500 g of earthworms can process 500 g of organic material and produce 250 g of vermicompost (40–50 % conversion rate).

CONCLUSION

Composting by *Eisenia fetida* and *Perionyx excavatus* is an appropriate process to convert mushroom compost and fruit and vegetable wastes into rich manure in nutrients and microorganisms. The mixture of horse dung at 50% with 50% mushroom compost in vermibeds exhibited better output of compost with physical and chemical traits, growth regulators content, and microbial populations. Earthworm growth was also higher in vermicompost produced from the mixture of horse dung at 50% with 50% mushroom compost.

REFERENCES

Abd El-Malek, Y. 1971: Free-living nitrogen-fixing bacteria in Egyptian soils and their possible contribution to soil fertility. Plant Soil, 35: 423–442.

Abd El-Sattar, A.M. 2014: Effect of microbial inoculants and earthworm on microbiological and chemical characteristic of organic fertilizers produced from agricultural residues. M.SC. Thesis, Faculty of Agriculture Ain Sham university.

Abdelmonem, M.E., Kuttyammoo, M., Hassanein, K., Zayed, A.E. 2016: Vermicomposting: Analysis of soil nutrients enrichment with indigenous species from Jazan province of Saudi Arabia. Int. J. Adv. Res. Biol. Sci., 3(10): 131–137.

Agbafor, K.N., Engwa, A.G., Obiudu, I.K. 2015: Analysis of chemical composition of leaves and roots of *Ageratum conyzoides*. Int. J. Curr. Res. Acad. Rev., 3(11): 60–65.

Ansari, A.A., Jaikishun, S. 2011: Vermicomposting of sugarcane bagasse and rice straw and its impact on the cultivation of *Phaseolus vulgaris* L. in Guyana, South America. J. Agric. Tech., 7(2): 225–234.

Arraktham, S., Tancho, A., Niamsup, P., Rattanawaree, P. 2016: The potential of bacteria isolated from earthworm intestines, vermicompost and liquid vermicompost to produce indole-3-acetic acid (IAA). J. Agric. Technol., 12(2): 229–239.

Auvermann, B.W., McDonald, L.A., Devin, R., Sweeten, J.M. 1999: Composting horse manure, publication B-6084, Texas Agricultural Extension, College Station, USA.

Awasthi, M.K., Pandey, A.K., Khan, J., Bundela, P.S., Wong, J.W., Selvam, A. 2014: Evaluation of thermophilic fungal consortium for organic municipal solid waste composting. Bioresour. Technol., 163: 214–221.

Black, C.A., Evans, D.D., Ensminger, L.E. 1965: Methods of soil analysis. American Society of Agronomy; Madison, WI, USA.

Boruah, T., Barman, A., Kalita, P., Lahkar, J., Deka, H. 2019: Vermicomposting of citronella bagasse and paper mill sludge mixture employing *Eisenia fetida*. Bioresour. Technol., 297: 122147.

Chauhan, H.K., Singh, K. 2013: Effect of tertiary combinations of animal dung with agrowastes on the growth and development of earthworm *Eisenia fetida* during organic waste management. Int. J. Recycl. Org. Waste Agric., 2: 11.

Cottenie, A., Verloo, M., Kiekens, L., Velghe, G., Camerlynck, R. 1982: Chemical analysis of plants and soils. Laboratory of Analytical and Agrochemistry. State University, Ghent Belgium, pp: 63.

Das, D., Deka, H. 2021: Vermicomposting of harvested waste biomass of potato crop employing *Eisenia fetida*: Changes in nutrient profile and assessment of the maturity of the end products. Environ. Sci. Pollut. Res., 28: 35717–35727.

Devi, C., Khwairakpam, M., 2020a: Bioconversion of *Lantana camara* by vermicomposting with two different earthworm species in monoculture. Bioresour. Technol., 296: 12308.

Devi, C., Khwairakpam, M. 2020b: Feasibility of vermicomposting for the management of terrestrial weed *Ageratum conyzoides* using earthworm species *Eisenia fetida*. Environ. Technol. Innov., 18: 100696.

Devi, J., Prakash, M. 2015: Microbial population dynamics during vermicomposting of three different substrates amended with cowdung. Int. J. Curr. Microbiol. Appl. Sci., 4(2): 1086–1092.

Domínguez, J., 2004: State-of-the-art and new perspectives on vermicomposting research. Earthworm Ecol. (Second Ed). 401–424.

Durley, R.C., Kannagara, T., Simpson, G. 1982: Leaf analysis for abscisic, phaseic and indolylacetic acids by high-performance liquid chromatography. J. Chromatogr, 236, 181–188.

Edwards, C.A., Subler, S., Arancon, N. 2011: Quality criteria for vermicomposts. In: Edwards, C.A., Arancon, N.Q., Sherman, R.L. (Eds.) Vermiculture technology: earthworms, organic waste and environmental management. CRC Press, Boca Raton, pp: 287–301.

Edwiges, T., Frare, L., Mayer, B., Lins, L., Triolo, J.M., Flotats, X., Costa, M.S.S.D. 2018: Influence of chemical composition on biochemical methane potential of fruit and vegetable waste. Waste Manag., 71: 618–625.

Fernández-Gómez, M.J., Romero, E., Nogales, R. 2010: Feasibility of vermicomposting for vegetable greenhouse waste recycling. Bioresour. Technol., 101: 9654–9660.

Gajalakshmi, S., Abassi, S.A. 2004: Earthworms and vermicomposting. Indian J. Biotechnol., 3(4): 486–494.

Garg, P., Kaushik, G., Nagar, J.K., Singhal, P. 2018: Role of earthworms in managing soil contamination. In: Hussain C.M. (Eds.) Handbook of environmental materials management. Springer, Cham., 1859–1877.

Garg, V.K., Gupta, R. 2011: Optimization of cow dung spiked pre-consumer processing vegetable waste for vermicomposting using

Eisenia fetida. Ecotoxicol. Environ. Saf., 74(1): 19–24.

Garg, V.K., Yadav, Y.K., Sheoran, A., Chand, S., Kausik, P. 2006: Livestock excreta management through vermicomposting using epigeic earthworm *Eisenia fetida*. Environmentalist, 26: 269–276.

Grgic, D.K., Domanovac, M.V., Domanovac, T., Šabic, M., Cvetnic, M., Bulatovic, V.O. 2019: Influence of *Bacillus subtilis* and *Pseudomonas aeruginosa* BSW and Clinoptilolite addition on the biowaste composting process. Arabian J. Sci. Eng., 44: 5399–5409

Gurav, M.V., Pathade, G.R. 2011: Production of vermicompost from temple waste (Nirmalya): A case study. Univ. J. Environ. Res. Technol., 1(2): 182–192.

Gusain, R., Pandey, B., Suthar, S. 2018: Composting as a sustainable option for managing biomass of aquatic weed Pistia: a biological hazard to aquatic system. J. Cleaner. Prod., 177: 803–812.

Gusain, R., Suthar, S. 2020a: Vermicomposting of duckweed (*Spirodela polyrhiza*) by employing *Eisenia fetida*: Changes in nutrient contents, microbial enzyme activities and earthworm biodynamics. Bioresour. Technol., 311: 123585.

Gusain, R., Suthar, S. 2020b: Vermicomposting of invasive weed *Ageratum conyzoids*: Assessment of nutrient mineralization, enzymatic activities, and microbial properties. J. Bioresour. Technol., 312: 123537.

Holt, J.G. 1994: Bergey's manual of determinative bacteriology. 9th Edition, Lippincott Williams and Wilkins, Baltimore, Maryland, USA.

Hussain, N., Das, S., Goswami, L., Das, P., Sahariah, B., Bhattacharya, S.S. 2018: Intensification of vermitechnology for kitchen vegetable waste and paddy straw employing earthworm consortium: Assessment of maturity time, microbial community structure, and economic benefit. J. Clean. Prod., 182: 414–426.

Ismail, S.A. 2005: The earthworm book. Other India Press, Mapusa, pp 101.

Jackson, M.L. 1973: Soil chemical analysis. prentic-hall of india private limited, New Delhi, pp. 1-498.

Jackson, M.L. 1965: Soil chemical analysis advanced course. Dept. of Soil Science, University of Wisconsin, Madison, USA.

Jayakumar, P., Natarajan, S. 2013: Molecular and functional characterization of bacteria isolated from straw and goat manure-based vermicompost. Appl. Soil Ecol., 70: 33–47.

Johnson, L.E., Crul, E.A., Bond, E.A., Fribourg, H.A. 1959: Method for studying soil microflora plant disease relationships. Minneapolis. Burgess Publishing Co. USA. pp: 1–178.

Jones Jr., J.B. 1981: Analytical techniques for trace of element determinations on plant tissues. J. Plant Natur., 3(1–4): 77–92.

Kaplan, M. 2016: The National Master Plan for Agricultural Development in Suriname. Final Report. Kaplan Planners Ltd. Regional and Environmental Planning 2016, 255p. https ://www.share 4dev.info/kb/documents/5426.pdf.

Karmegam, K., Vijayan, P., Prakash, M., Paul, A.J. 2020: Vermicomposting of paper industry sludge with cow dung and green manure plants using *Eisenia fetida*: A viable option for cleaner and enriched vermicompost production. J. Clean. Product., 228: 718–728.

Li, W., Bhat, S.A., Li, J., Cui, G., Wei, Y., Yamada, T. 2020: Effect of excess activated sludge on vermicomposting of fruit and vegetable waste by using novel vermireactor. Bioresour. Technol., 302: 122816.

Lourduraj, A.C., Yadav, B.K. 2005: Effect of vermicompost application on soil and plant growth. In: Verms and vermitechnology. Kumar, A., (Ed.). SB Nangia, APH Publishing Corp., New Delhi, 81–96.

Martine, J.P. 1950: Use of acid, rose bengal, and streptomycin in the plate method for estimating soil fungi. Soil Sci., 69(3): 215–232.

Meng, L., Li, W., Zhang, S., Wu, C. 2017: Feasibility of co-composting of sewage sludge spent mushroom substrate and wheat straw. Bioresour. Technol., 226: 239–245.

Nakasaki, K., Nag, K., Karita, S. 2005: Microbial succession associated with organic matter decomposition during thermophilic composting of organic wastes. Waste Manag., 23: 48–56.

Nissen, O. 1989: MSTAT-C, a microcomputer program for the design, management and analysis of agronomic research experiments. Michigan State University, East Lansing, Michigan, USA.

Olsen, S.R., Sommers, L.E. 1982: Phosphorus. In: Page A.L., Miller, R.H., Keeney, D.R. (Eds.), Methods of soil analysis. Part 2: Chemical and microbiological properties 2nd ed. American Society of Agronomy, Inc. Soil Science Society of America, Inc. Madison, Wisconsin USA., pp: 403–430.

Orozco, F.H., Cegarra J., Trujillo, L.M., Roig, A. 1996: Vermicomposting of cofee pulp using the earthworm *Eisenia fetida*: efects on C and N contents and the availability of nutrients. Biol. Fertil. Soils, 22: 162–166.

Paczka, G., Mazur-Paczka, A., Garczynska, M., Kostecka, J., Butt, K.R. 2020: Effects of vermireactor modifications on the welfare of earthworms *Eisenia fetida* (Sav.) and properties of vermicomposts. Agriculture, 10(10): 481.

Page, A.L., Miller, R.H., Keeney, D.R. 1982: Methods of soil analysis. Part 2: Chemical and microbiological properties. 2nd ed. American Society of Agronomy, Inc. Soil Science Society of America, Inc. Madison, Wisconsin USA.

Parthasarathi, K., Ranganathan, L.S. 2000: Aging effect on enzyme activities in pressmud vermicasts of *Lampito mauritti* (Kinberg) and *Eudrilus eugeniae* (Kinberg). Biol. Fertil. Soils, 30: 347–350.

Piper, C.S. 1947: Soil and Plant Analysis. Adelaide, UK:The University of Adelaide, 368 p.

Plazzotta, S., Manzocco, L., Nicoli, M.C. 2017: Fruit and vegetable waste management and the challenge of fresh-cut salad. Trends Food Sci. Technol., 63(2017): 51–59.

Premuzic, Z., Bargiela, M., Garcia, A., Rendina, A., Iorio, A. 1998: Calcium, iron, potassium, phosphorus and vitamin C content of organic and hydroponic tomatoes. J. Hortic. Sci., 33: 255–257.

Raphael, K., Velmourougane, K. 2011: Chemical and microbiological changes during vermicomposting of coffee pulp using exotic (*Eudrilus eugeniae*) and native earthworm (*Perionyx ceylanesis*) species. Biodegradation, 22(3): 497–507.

Ravindran, B., Mnkeni, P.N.S. 2016: Bio-optimization of the carbon-to-nitrogen ratio for efficient vermicomposting of chicken manure and waste paper using *Eisenia fetida*. Environ. Sci. Pollut. Res., 23: 16965–16976.

Ravindran, B., Wong, J.W.C., Selvam, A., Sekaran, G. 2016: Influence of microbial diversity and plant growth hormones in compost and vermicompost from fermented tannery waste. Bioresour. Technol., 217: 200–204.

Ryan, J., Garabet, S., Harmsen, K., Rashid, A. 1996: A soil and plant analysis manual adapted for the West Asia and North Africa region. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. 140 pp.

Rynk, R., Van de Kamp, M., Willson, G.B., Singley, M.E., Richard, T.L., Kolega, J.J., Gouin, F.R., Laliberty Jr., L., Kay, D., Murphy, D.W., Hoitink, H.A.J., Brinton, W.F. 1992: On-farm composting handbook (NRAES 54). Natural Resource, Agricultural, and Engineering Service. Plant and Life Sciences Publishing, Ithaca, New York.

Sagar, N.A., Pareek, S., Sharma, S., Yahia, E.M., Lobo, M.G. 2018: Fruit and vegetable waste: Bioactive compounds, their extraction, and possible utilization. Compr. Rev. Food Sci. food Saf., 17(3): 512–531.

Sainz, M.J., Taboada-Castro, M.T., Vilariño, A. 1998: Growth, mineral nutrition and mycorrhizal colonization of red clover and cucumber plants grown in a soil amended with composted urban wastes. Plant Soil, 205: 85–92.

Sarker, M.M.H., Kashem, M.A. 2020: Earthworm species and their feeding substances have great role on the quantity and quality of produced vermicompost. Organic Agric., 10(4): 437–448.

Sharma, K., Garg, V.K. 2018: Comparative analysis of vermicompost quality produced from rice straw and paper waste employing earthworm Eisenia fetida (Sav.) Contents lists available at Science Direct, journal homepage: Bioresource Technology 250: 708-715.

Singh, K., Chauhan, H.K. 2015: Potancy of vermiwash with neem plant parts on the infestation of *Earias vittella* (Fabricius) and productivity of okra (*Abelmoschus esculentus*) (L.) Moench. Asian J. Res. Pharm. Sci., 5(1): 36–40.

Singh, S.B., Devi, W.R., Marina, A., Devi, W.I., Swapana, N., Singh, C.B. 2013: Ethnobotany, phytochemistry and pharmacology of *Ageratum conyzoides* Linn (Asteraceae). J. Medicin. Plant Res., 7(8): 371–385.

Sinha, R.K., Agarwal, S., Chauhan, K., Chandran, V., Soni, B.K. 2010: Vermiculture technology: Reviving the dreams of Sir Charles Darwin for scientific use of earthworms in sustainable development programs. Technol. Invest., 1(3): 155–172.

Sinha, R.K., Valani, D., Soni, B., Chandran, V. 2011: Earthworm vermicompost: a sustainable alternative to chemical fertilizers for organic farming. Agriculture issues and policies. Nova Science Publishers Inc, New York, p 71.

Sivakumar, S., Subbhuraam, C.V. 2005: Toxicity of chromium (III) and chromium (VI) to the earthworm *Eisenia fetida*. Ecotoxicol. Environ. Saf., 62(1): 93–98.

Steel, R.G.D., Torrie, J.H. 1960: Principles and procedures of statistics. (With special reference to the biological sciences). McGraw Hill, New York, 187–287.

Suthar, S. 2007: Production of vermifertilizer from guar gum industrial waste by using composting earthworm *Perionyx sansibaricus* (Perrier). Environmentalist, 27(3): 329–335.

Suthar, S. 2009: Vermicomposting of vegetable-market solid waste using *Eisenia fetida*: impact of bulking material on earthworm growth and decomposition rate. Ecol. Eng., 35(5): 914–920.

Taylor, J. 1962: The estimation of numbers of bacteria by tenfold dilution series. J. Appl. Microbiol., 25(1): 54–61.

Thi, N.B.D., Kumar, G., Lin, C.Y. 2015: An overview of food waste management in developing countries: Current status and future perspective. J. Environ. Manag., 157: 220–229.

Tomati, U., Grappelli, A., Galli, E. 1988: The hormone like effect of earth- worm casts on plant growth. Biol. Fertil. Soils, 5: 288–294.

Wani, K.A., Mamta Rao, R.J. 2013: Bioconversion of garden waste, kitchen waste and cow dung into value-added products using earthworm *Eisenia fetida*. Saudi J. Biol. Sci., 20(2): 149–154.

Wei, Y., Zhao, Y., Shi, M., Cao, Z., Lu, Q., Yang, T., Fan, Y., Wei, Z. 2018: Effect of organic acids production and bacterial community on the possible mechanism of phosphorus solubilization during composting with enriched phosphate-solubilizing bacteria inoculation. Bioresour. Technol., 247: 190–199.

Yadav, A., Garg, V.K. 2011: Vermicomposting – an effective tool for management of invasive weed Parthenium hysterophorus. Bioresor. Technol., 102: 5891–5895.

Yan, Y.W., Abd Aziz, N.A., Shamsuddin, Z., Mustafa, M., Abd Aziz, S., Teng, S.K. 2013: Comparison of plant nutrient contents in vermicompost from selected plant residues. Afri. J. Biotechnol., 12(17): 2207–2214.

Zicsi, A. 1962: Determination of number and size of sampling unit for estimating Lumbricid populations of arable soils. In: Murphy, P.W. (Ed.) Progress in soil zoology. Butterworths, London, pp: 68–71.

Table 1: Chemical analysis of compost, horse dung, and compost mushroom as raw materials used in vermicomposting.

Chemical characteristics	Compost	Horse dung	Compost mushroom
pH*	8.25	8.52	8.41
EC** (dSm^{-1})	3.26	3.12	3.14
Organic carbon (g kg $^{-1}$)	291.86	297.67	302.32
Organic matter (g kg $^{-1}$)	502	512	520
Ash (%)	49.99	32.19	45.44
Total N (g kg $^{-1}$)	14.63	13.4	14.9
Total phosphorous (g kg $^{-1}$)	3.6	3.3	4.3
Total potassium (g kg $^{-1}$)	12.63	12.08	13.60
Nitrous nitrogen (ppm)	34	34.67	38.67
Ammonium nitrogen (ppm)	31	32	44
C/N ratio	19.95: 1	22.21: 1	20.29: 1
Moisture (%)	64	65	72
Weed seeds	0.00	0.00	0.00

*1:2.5 w/v raw material water suspension, ** EC: Electrical conductivity (1:10).

Table 2: Physiochemical analysis of vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) using earthworms.

Treatments	pH*	EC** (dSm^{-1})	Organic carbon (g kg $^{-1}$)	Organic matter (g kg $^{-1}$)	Ash (%)	Nitrous nitrogen (ppm)	Ammonium nitrogen (ppm)	C/N ratio	Moisture (%)	Weed seeds
T1	7.82^{a}	3.12^{c}	297.67^{c}	511.99^{c}	47.31^{c}	34.67^{c}	32.33^{c}	22.22:1^{a}	65.00^{b}	0.00
T2	7.78^{b}	3.14^{c}	302.00b^{c}	519.44^{bc}	60.30^{b}	34.67^{c}	33.00^{c}	20.64:1^{b}	64.67^{b}	0.00
T3	7.76^{b}	3.15^{c}	304.67^{b}	524.03^{b}	66.77^{a}	31.00^{d}	29.00^{c}	20.68:1^{a}	71.00^{a}	0.00
T4	7.60^{c}	3.26^{b}	305.67^{ab}	525.75^{ab}	67.22^{a}	38.67^{b}	44.00^{b}	20.52:1^{b}	73.67^{a}	0.00
T5	7.52^{d}	3.55^{a}	310.00^{a}	533.20^{a}	67.62^{a}	45.33^{a}	55.67^{a}	20.36:1^{b}	75.00^{a}	0.00

*1:2.5 w/v vermicompost water suspension, ** EC: Electrical conductivity (1:10). Means in each column followed by the same letter are not significantly different at the 5% level

Table 3: Macro and micronutrients in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) using earthworms.

Treatments	Macronutrients (g kg $^{-1}$)					Micronutrients (ppm)	
	N	P	K	Ca	Mg	Fe	Zn
T1	13.40^{c}	3.30^{e}	12.08^{e}	34.57^{bc}	10.43^{d}	141.6^{d}	218.2^{e}
T2	14.63^{b}	3.60^{d}	12.63^{d}	33.73^{d}	10.70^{c}	147.2^{c}	225.4^{d}
T3	14.73^{b}	3.93^{c}	12.90^{c}	34.30^{c}	10.80^{c}	151.2^{c}	231.6^{c}
T4	14.90^{b}	4.33^{b}	13.23^{b}	34.93^{ab}	11.20^{b}	174.5^{b}	242.9^{b}
T5	15.23^{a}	4.83^{a}	13.60^{a}	35.30^{a}	11.90^{a}	181.3^{a}	253.3^{a}

*Means in each column followed by the same letter are not significantly different at the 5% level.

Table 4: Growth regulators in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) using earthworms.

Treatments	Gibberellin	Indoleacetic Acid	Cytokinin	Abscisic Acid
	(ppm)			
T1	21.00^{c}	18.00^{b}	25.00^{c}	3.10^{a}
T2	24.00^{b}	19.00^{ab}	27.67^{b}	2.83^{b}
T3	25.00^{b}	19.33^{ab}	28.33^{ab}	1.50^{c}
T4	28.00^{a}	21.00^{a}	28.33^{ab}	1.40^{c}
T5	29.00^{a}	21.00^{a}	30.00^{a}	0.95^{d}

*Means in each column followed by the same letter are not significantly different at the 5% level.

Table 5: Microbial biodiversity in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) using earthworms.

Treatments	Total count (1 × 10^{6} C.F.U/ g)		
	Bacteria	Actinomycete	Fungi
T1	63.00^{e}	53.00^{a}	42.00^{e}
T2	71.33^{d}	63.00^{d}	50.33^{d}
T3	77.00^{c}	67.33^{c}	61.67^{c}
T4	82.00^{b}	70.67^{b}	70.33^{b}
T5	97.00^{a}	82.00^{a}	88.67^{a}

*Means in each column followed by the same letter are not significantly different at the 5% level.

Table 6: Earthworms number, weight, and productivity in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5).

Treatments	Earthworms number (3 months)	Earthworms weight (g)	Productivity of vermicompost (%)
T1	1740.00^{d}	1279.00^{d}	26.65^{d}
T2	1759.33^{d}	1710.00^{c}	35.63^{c}
T3	1869.00^{c}	1750.00^{c}	36.46^{c}
T4	1978.33^{b}	2355.00^{b}	49.06^{b}
T5	2041.67^{a}	2448.33^{a}	51.01^{a}

*Means in each column followed by the same letter are not significantly different at the 5% level.

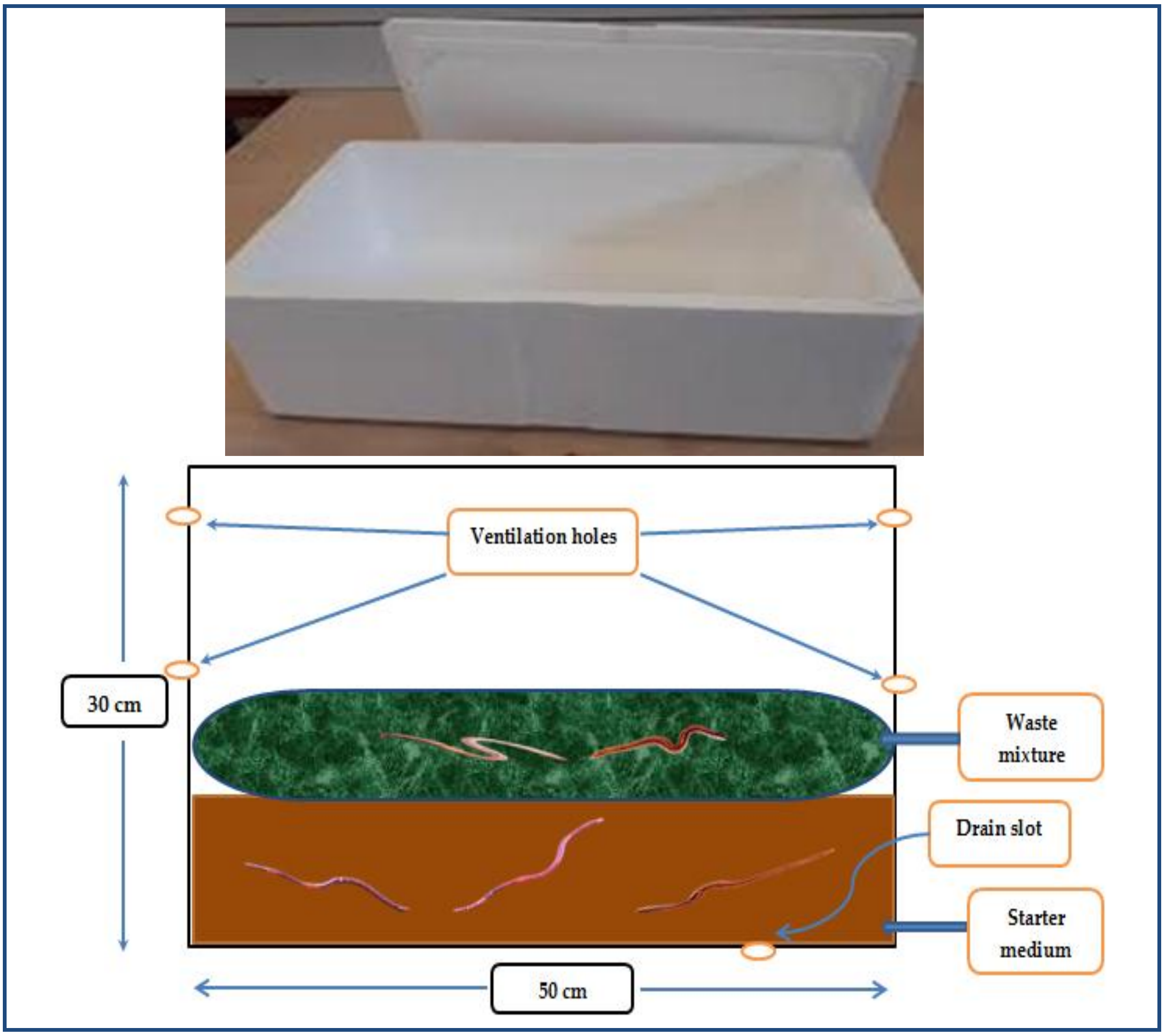

Figure 1: Foam box in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) during vermicomposting process.

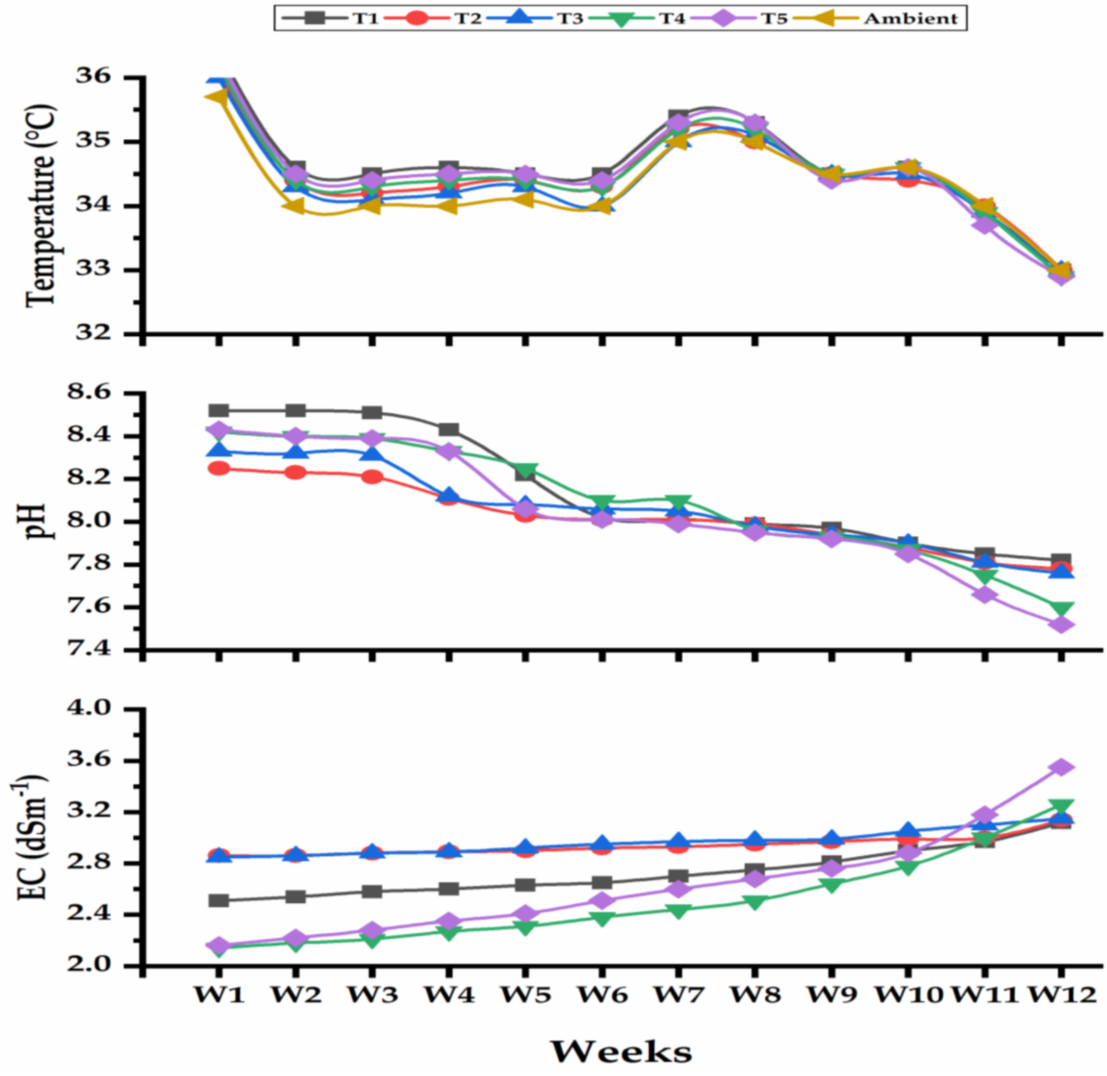

Figure 2: Weekly temperature, pH, and Electrical conductivity (EC) in vermicompost mixtures of 100% horse dung (T1), 75% horse dung +25% compost (T2), 50% horse dung + 50% compost (T3), 75% horse dung +25% compost mushroom (T4), and 50% horse dung +50% compost mushroom (T5) during vermicomposting process.

هل تُحسن بيئة النمو الأولية من نمو ديدان الأرض وجودة السماد الدودي الناتج؟

تامر سعيد عبدالعزيز عبدالغنى[*] , عبدالناصر ابورواش الششتاوى, خالد محمد غانم

قسم البيئة والزراعة الحيوية, كلية الزراعة بالقاهرة, جامعة الأزهر, مصر

[*] البريد الإلكتروني للباحث الرئيسيtamer__said2013@azhar.edu.eg

الملخص العربي

السماد الدودي هو المنتج النهائي لهضم دودة الأرض والتحلل الهوائي للمواد العضوية (إعادة النفايات) وحيث تستخدم في هذة التقنية أنواعا من ديدان الأرض تعرف بديدان الكمبوست, وتُعرف هذه التقنية باسم التسميد الدودي بينما يُعرف المنتج باسم السماد الدودي, وتتم هذه العملية عبر تغذية ديدان الكمبوست علي خليط غير متجانس من نفايات الخضار أو الفاكهة، ومواد الفراش، وروث الحيوانات ومخلفات المشروم المتحلله ويمتاز السماد الدودي بإرتفاع محتواه من الميكروبات النافعة وإحتواءه علي العديد من العناصر الغذائية التي يحتاجها النبات فضلا عن الهرمونات والإنزيمات التي لها تأثير ايجابي علي التربة والنبات . هدفت هذه الدراسة إلى تحديد جودة انواع السماد الدودي المختلفة المنتجه من روث الخيل 100٪ (المعاملة الأولى), 75٪ روث الحصان + 25٪ سماد (المعاملة الثانية), 50٪ روث الحصان + 50٪ سماد (المعاملة الثالثة), 75٪ روث الحصان + 25٪ سماد الفطر (المعاملة الرابعة) و 50٪ روث الحصان + 50٪ فطر (المعاملة الخامسة) بإستخدام ديدان الأرض. أظهرت النتائج أن السماد الدودى المنتج من المعاملة الخامسة له خصائص فيزيائية وكيميائية عالية حيث أعطت أعلى نسبة كربون عضوي ومواد عضوية ومحتوى رماد مع أقل نسبة كربون للنيتروجين , وزيادة في محتوى العناصر الغذائية وبعض منظمات النمو. كما تم الحصول علي تنوع ميكروبى جيد فى جميع المعاملات مع زيادة واضحة فى المعاملة الخامسة, كما لوحظ زيادة كبيرة في أعداد ديدان الأرض (2041.7) ووزن السماد الدودى (2448.3 جم) من ديدان الأرض بواسطة سماد المعاملة الخامسة. ونهاية فإن إستخدام 50٪ من روث الخيل و 50٪ سماد عيش الغراب كمواد خام لتقنية الفيرمى كمبوست أنتج سماد دودى بخصائص وجودة عالية , فضلا عن معدل أعلي في تكاثر الديدان .

الكلمات الاسترشادية: سماد ديدان الأرض ، *Eisenia fetida* ، *Perionyx excavatus* , روث الخيول ، كمبوست فطر عيش الغراب.