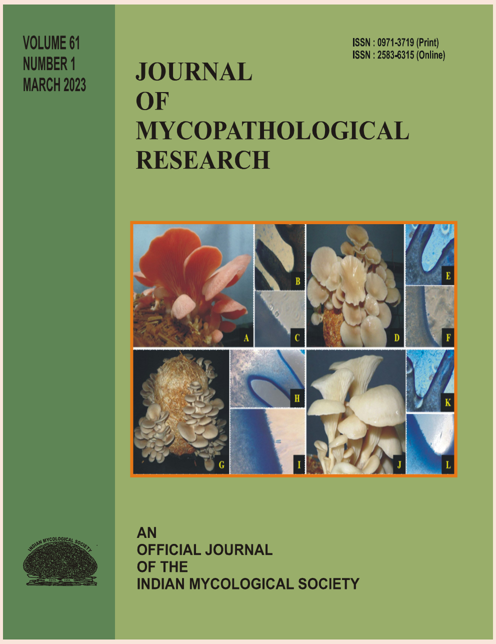
Physico-chemical evaluation of vermicompost formulated by the wastes of mango pulp and fish waste with different biofertilizers

MURUGAN ,V.C., SENTHILKUMAR, D



J. Mycopathol. Res. 61(1) : *63-68, 2023;*
ISSN 0971-3719

J. Mycopathol. Res. **61(1)** : 63-68, 2023; ISSN : 0971-3719 (Print), 2583-6315 (Online)
doi.10.57023/JMycR.61.1.2023.063

Physico-chemical evaluation of vermicompost formulated by the wastes of mango pulp and fish waste with different biofertilizers

MURUGAN ,V.C.*, SENTHILKUMAR, D

Department of Zoology, Kandaswami Kandars College, Velur, NamakkalTamil Nadu-638182

Received : 22.11.2022 Accepted :24.01.2022 Published : 27.03.2023

Millions of tons of organic wastes are generated in India. More than 1/2th of these wastes contain the solid waste of fruit industry and fish waste. Immaturity of these wastes has been widely recognized as one of the major problems facing their composting process and their subsequent application to land use. Hence, the need to evaluate their physico-chemical properties for safe agricultural practices is necessary. The objective of this research work was to evaluate the physico-chemical indices of mango pulp and fish waste with biofertilizers formulated vermicompost. The research was designed in five set ups comprising of mango pulp and fish wastes for a period of 80 days. The parameters measured were pH, EC, OC, N, P, K, S, Zn and Fe by standard methods. The results revealed that the samples ranged from acidity to alkalinity in pH, had high conductivity, total organic carbon, nitrogen phosphorus, potassium, sulfur, zinc and ferrous iron. The physical and chemical properties of agricultural wastes and prepared compost were used in soil management in a good way to improve and maintain soil quality, soil fertility, and conserve the environment. Hence, this prepared compost can be allowed to attain maturity and have acceptable range of physico-chemical parameter values before being applied as manure.

Key Words: *Azospirillum*, biofertilizers, fish waste, mango pulp, *Phosphobacterium*, physico-chemicals,*Rhizobium*, vermicompost

INTRODUCTION

Fishing generates large quantities of waste daily in fish markets and fish processing industries (Canneries, fresh and frozen fish processing plants, etc.). Composting made from fish wastes could provide an effective source of nutrient-rich fertilizer. It is a cost effective for large fish processing plants.

Because of high nutrient content in fish waste, they can be used for local gardening and agricultural crop production (Subbu Lakshmi, 2015).

In the mango processing industry, only 50% of the mango becomes juice and the rest is seed, skin, or fruit pulp which is removed during the process (Nguyen Ngoc and Schnitzer, 2008). Usage of fruits produces two types of waste a solid waste of peel/ skin, seeds, stones etc. a liquid waste of juice and wash water (Hemalatha, 2012). These wastes are often managed poorly because of the limited access to disposal facilities. Immaturity of these wastes has been widely recognized as one of the major problems facing their composting process and their subsequent application to land use. To avoid this, waste may be reused or submitted to physical, chemical, biological, thermal or mixed treatments, among which we can find feeding animals, crushing, composting, anaerobic digestion and vermicomposting. Of the treatments mentioned, vermicomposting is presented as a viable alternative to degradation.

Vermicomposting is a green technique that produces vermicompost from different types of organic wastes using specific earthworm species. It helps farmers to reduce their use of chemical fertilizers and the overall production costs (Kaplan,

*Correspondence: eshaayy2013@gmail.com

2016). *Eisenia fetida* is one of the earthworm species that works efficiently in breaking down and decaying natural remains and turning these scraps into high-quality organic compost. It is capable of eating as much as half of its weight daily. The behavioral activity of earthworms (feeding, burrowing and casting) enhances the physical, chemical and biological properties of organic matter and soil, thereby augmenting the growth of agricultural crops naturally and safely (Kumar *et al*. 2018).

Taking all this into consideration, the main objective of this research is to evaluate the physico-chemical properties of different vermicompost prepared from organic waste products of mango pulp and fish waste along with biofertizers with the help of *Eisenia fetida*.

MATERIALS AND METHODS

Collection of samples

Fish waste was collected from fish market, Krishnagiri, Tamil Nadu, India and Mango pulp waste collected from Sri Devaraj Agro Industrial, Krishnagiri.

Pre decomposing preparation method of sample

The bulk amount of fish waste and mango pulp waste was taken into the polyethylene bags. Samples of fish waste and mango pulp waste were mixedin ratio of 1:1, and the samples buried in pit of soil. The upper soil of experimental pit were sprayed with water twice weeklyto maintain moisture level at 60-70%. After 60 days, finally the pit was opened and the pre decomposing samples werecollected.

Vermicompost Experimental Setup

A pilot experiment with six plastic pots (25cm diameter and 40cm height) carrying 3.0 kg of pre decomposed matter with a small hole at the bottom to remove the excess water with three replication was carried out in Kandasami Kandars College, Velur, Namakkal, Tamil Nadu, India. Biofertilizers (*Azospirillum, Phosphobacterium*, and *Rhizobium*) along with 1.0 g/kg to substrate were added as shown Table 1 (Subramaniam, 2006). First generation of mature clitellum developed 20 earthworms *Eisenia fetida* were introduced from each experiments. The compost was maintained at 60-70 % of moisture level throughout the experimental period at 80 days and throughout the study period by periodic sprinkling of adequate of tape water.

Table1. Decomposed substrates along with Earthworm and biofertilizers

Composition	Mango Pulp Waste + Fish Waste (Ratio)
C1	1 : 1
C2	2 : 1
C3	1 : 2
Experiments	Biofertilizers (1gm/kg)
Control	Compost
E1	Compost + Earthworm
E2	Compost + Earthworm + *Azospirillum*
E3	Compost + Earthworm + *Phosphobacterium*
E4	Compost + Earthworm + *Rhizobium*
E5	Compost + Earthworm + *Azospirillum* + *Phosphobacterium* + *Rhizobium*

C- Composition; E-Experiments

Physico-chemical analysis

The physicochemical parameters of vermicompost during the experiments were analyzed for standard methods. pH of vermicompost samples was determined using a double DH2O suspension of compost in the ration 1: 10 (w/v) analyzed in Digital pH meter (Vasanthi *et al*. 2014) and the total organic carbon content was estimated using the method of Abdullah and Chin (2010). The nitrogen was estimated by Micro Kjeldahl methods (Mohee *et al*. 2008; Unmar and Mohee, 2008). Phosphorus was detected by the colorimetric methods (John, 1970). Potassium was determined after digesting the samples in diacid mixture (concentration HNO_3; concentration $HClO_4$, 4:1 v/v), by Flame Photometer [Bansal and Kapoor, 2000]. Sulfur, Zinc, Boron and Iron were measured by the diacid digest using an atomic absorption spectrophotometer (Vasanthi *et al.* 2014).

Statistical analysis

The experimental data was expressed as the mean of three replications. The difference in physico-chemical parameters of fish waste and mango pulp waste vermicompost experiments with biofertilizers with control was statistically computed using One Way Analysis of Variance (ANOVA) was used to define the statistically significant where the Tukey's honestly significant different (HSD) tests at $p < 0.05$ significance level was applied.

RESULTS AND DISCUSSION

Physicochemical characteristics of mango pulp and fish waste

The end product vermicast was collected from each vermicomposting setup and analysed for the physico-chemical composition. The pH and EC of vermicompost, the major nutrients OC, NPK and micro nutrients such as Zn, S and Fe were analyzed.

pH

Change in the value of pH in mango pulp waste with fish waste in composition 1-3 (Control) as well as in vermicompost prepared by different biofertilizers with *Eisenia fetida* in C1 –C3(E1 – E 5) has been demonstrated in Table 2. The pH of control and vermicompost changed from 7.10 to 6.32, 7.44 to 6.83 and 7.07 to 6.64 in C1, C2 and C3, respectively. The lowest pH (6.32) was recorded in the vermicompost of mango pulp effluents and fish waste (1:1) with *E. fetida*. The lowering of pH in end product might be due to the production of CO_2 and organic acid by microbial decomposition during the process of bioconversion of different organic substrates (Sharma *et al*. 2012).

Table 2. The changes of pH level in control and experimental bins after 80 days

Experiments	pH		
	C1	C2	C3
Control	7.10 ± 0.02	7.44 ± 0.02	7.07 ± 0.02
E1	6.32 ± 0.04	6.87 ± 0.02	6.97 ± 0.02
E2	6.80 ± 0.06	6.83 ± 0.02	6.84 ± 0.01
E3	6.68 ± 0.04	6.93 ± 0.02	6.73 ± 0.02
E4	7.04 ± 0.02	7.05 ± 0.02	6.84 ± 0.01
E5	6.87 ± 0.01	6.94 ± 0.02	6.64 ± 0.02

Electrical conductivity (EC)

A significant change in electrical conductivity (EC) was observed in the vermicompost (C1 – C3) of E1 – E5 in comparison to the control (Fig. 1). The EC of control experimental bin was 1.26, 1.94 and 2.02 in C1, C 2 and C3 respectively, and itchanged from 1.26 to 1.75 dS/m, 1.94to 2.36 dS/m and 2.02 to 2.40 dS/m from control to experimental bins, respectively. The significant high EC (2.40 dS/m dS/m) was recorded in the vermicompost of C3, E5 as compared to other combinations. Irshad *et al.* (2013) reported that higher EC values in composted manures could be attributed to the release of salts from the manure with the passage of time. The harmless level of the EC in the Vermicompost should be about 2 dS/m or less (Hoekstra *et al*. 2002; Ofosu-Budu *et al*. 2010).

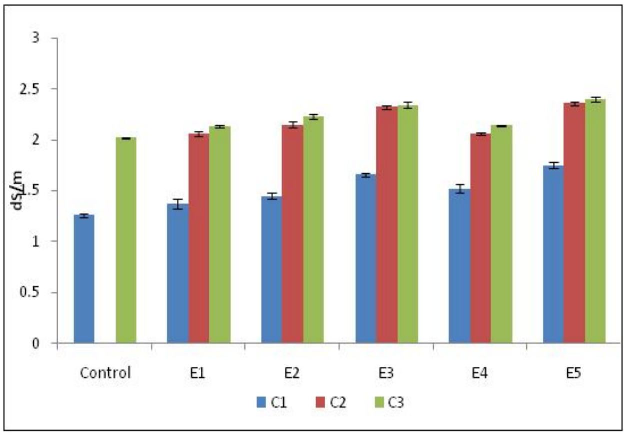


Fig 1: Changes of EC level in control and experimental bins after 80 days

Organic carbon (OC)

Change in the value of pH in mango pulp waste with fish waste in composition 1-3 (Control) as well as in vermicompost prepared by different biofertilizers with *E. fetida* in C1 –C3 (E1 – E 5)has been illustrated in Fig.2. The OC of control and experimental bins changed from 31.46 to 35.01g/kg, 32.45 to 32.40 g/kg and 29.09 to 36.12 g/kg in C1, C2 and C3, respectively. The lowest OC (28.81 g/kg) was recorded in the C2E1. Major function for reduction of organic carbon may be due to aerobic respiration by microorganism as well as earthworms which already stated in the previous section. The organic carbon content declined drastically from the substrate up to 90 days (Suthar, 2007).

Nitrogen

A significant change in nitrogen was observed in vermicompost of different combinations of mango pulp effluents and fish wastes with biofertilizers in comparison to the initial feed mixture (Table 3). The N content of control experimental bin was 1.04, 1.17 and 1.15 g/kg in C1, C 2 and C3 respectively, and changed from 1.04 to 1.66 g/kg, 1.17to 1.74 g/kg and 1.15 to 1.76 g/kg from control to experimental bins, respectively. The maximum increased N (1.15 to 1.76 g/kg) was in the experiment of C3E5. The increased nitrogen content in vermicompost was possible due to released nitrogenous product after metabolism of earthworm i.e. urine, excreta and mucoproteins (Padmavaathiamma *et al*. 2008; Nath *et al*. 2009).

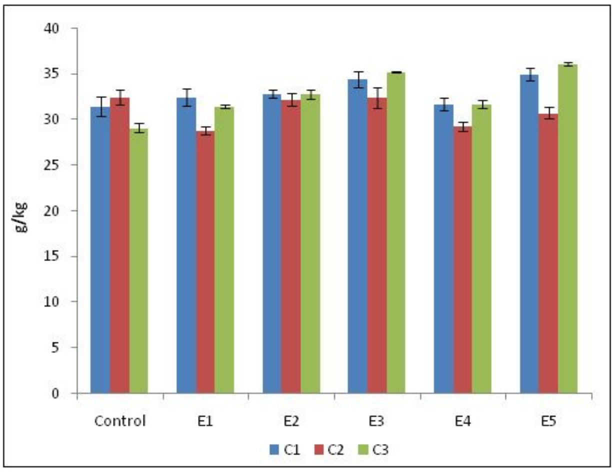


Fig 2: Changes of OC level in control and experimental bins after 80 days

Table 3: The changes of nitrogen level in control and experimental bins after 80 days

Experiments	N		
	C1	C2	C3
Control	1.04 ± 0.02	1.17 ± 0.02	1.15 ± 0.02
E1	1.16± 0.02	1.34 ± 0.02	1.26 ± 0.02
E2	1.29 ± 0.02	1.44 ± 0.02	1.36 ± 0.02
E3	1.34 ± 0.02	1.63 ± 0.02	1.66 ± 0.02
E4	1.48 ± 0.04	1.24 ± 0.03	1.73 ± 0.02
E5	1.66 ± 0.03	1.74 ± 0.02	1.76 ± 0.02

Phosphorus

A significant change in nitrogen was observed in vermicompost of different combinations of mango pulp effluents and fish wastes with biofertilizers in comparison to the initial feed mixture (Fig. 3). The P content of control experimental bin was 0.57, 0.83 and 0.65 g/kg in C1, C 2 and C3 respectively, and changed from 0.57 to 1.16 g/kg, 0.83 to 1.44 g/kg and 0.65 to 1.13 g/kg from control to experimental bins, respectively. The maximum increased N (1.44 g/kg g/kg) in was in the experiment of C2E5.

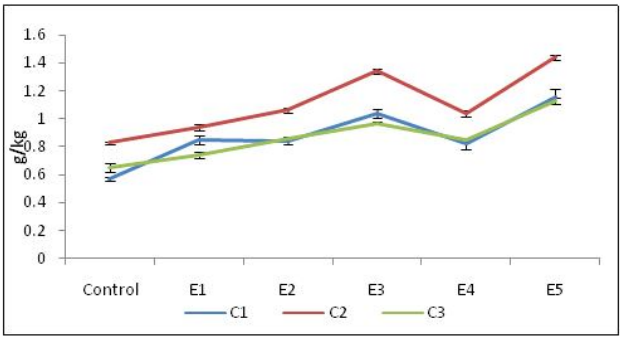


Fig 3: The changes of phosphorous level in control and experimental bins after 80 days

Potassium

Levels of potassium (K) in initial feed mixture as well as in vermicompost prepared from mango pulp effluents and fish wastes with different biofertilizers has been revealed in Fig.4. The K of initial feed mixture and vermicompost changed from 1.35 to 1.47 g/kg, 1.05 to 1.54 g/kg and 1.14 to 1.54 g/kg in C1, C2 and C3, respectively. The maximum increase in K ranged from 1.14 to 1.54 g/kg g/kg which was recorded in combination of mango pulp effluents and fish wastes in the ration of 1:2 with all three biofertilizers and *E. fedita* (C3E5). Sangwan *et al.*(2010) reported an increase in potassium in vermicomposts after bioconversion of sugar industry waste. These differences in the observations can be attributed to the differences in the chemical nature of the inorganic wastes used in vermicomposting system.

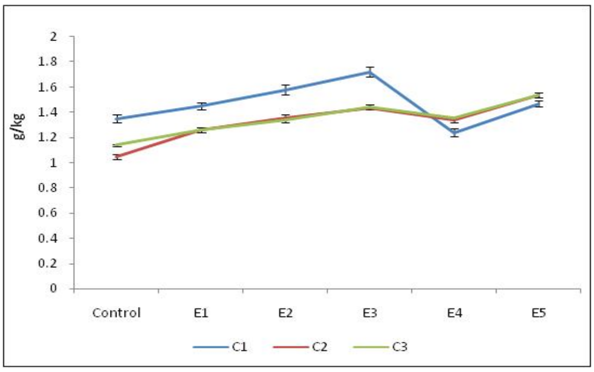


Fig 4: The changes of potassium level in control and experimental bins after 80 days

Sulphur

A significant change in sulfur was observed in vermicompost of different combinations of mango pulp effluents and fish wastes with biofertilizers in comparison to the initial feed mixture (Table 4). The S content of control experimental bin were 1.23, 1.04 and 1.96 g/kg in C1, C 2 and C3 respectively, and changed from 1.23 to 1.35 g/kg, 1.04 to 0.94 and 1.96 to 2.30 g/kg in control to experimental bins, respectively. The maximum increased N (2.30) was in the experiment of C3E3. The presence of more amount of micronutrients in the vermicompost might be due to the release of the excess amount of micronutrients and heavy metals from the earthworm body into the environment through the calciferous glands (Sheikh and Dwivedi, 2017).

Table 4 : The changes of sulfur level in control and experimental bins after 80 days

Experiments	S		
	C1	C2	C3
Control	1.23 ± 0.02	1.04 ± 0.02	1.96 ± 0.02
E1	1.35 ± 0.03	1.26 ± 0.02	2.06 ± 0.02
E2	1.25 ± 0.02	1.15 ± 0.03	2.16 ± 0.01
E3	1.33 ± 0.02	1.36 ± 0.01	2.30 ± 0.02
E4	1.25 ± 0.03	1.16 ± 0.03	2.16 ± 0.02
E5	1.24 ± 0.02	1.24 ± 0.02	2.22 ± 0.04

Zinc

A significant change in zinc was observed in vermicompost of different combinations of mango pulp effluents and fish wastes with biofertilizers in comparison to the initial feed mixture (Fig 5). The Z content of control experimental bin was 1.08, 1.06and 1.5 g/kg in C1, C 2 and C3 respectively, and changed from 1.08 to 1.34 g/kg, 1.06 to 1.30 g/kg and 1.54 to 1.93 g/kg in control to experimental bins, respectively. The maximum increased N (1.93 ± 0.03 g/kg) in the experiment of C3E5. It is probable that the high pH in calcareous soils decrease availability of zinc and iron. In addition, high concentrations of bicarbonate limit zinc and iron transport to branches then decrease of pH can be overcome these barriers.

Iron

Ferrous (Fe) contents in initial feed mixture as well as in vermicompost prepared from mango pulp effluents and fish wastes with different biofertilizers is provided in Fig.6. The Fe of initial feed mixture and vermicompost changed from 0.52 to 1.11 g/kg, 0.30 to 0.74 g/kg and 1.45 to 1.67 g/kg in C1, C2 and C3 respectively

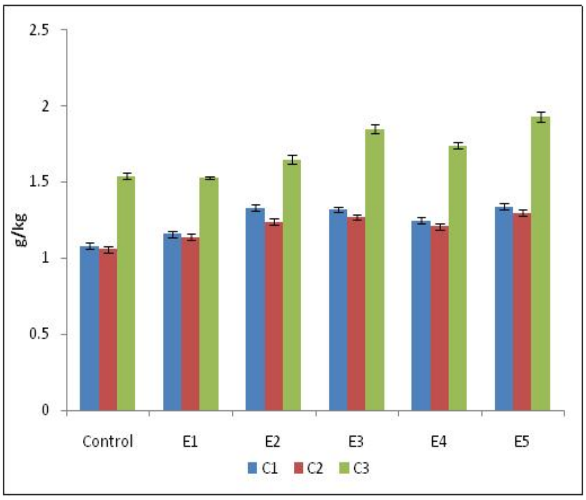


Fig 5: The changes zinc level in control and experimental bins after 80 days

The maximum increase in Fe which ranged from 1.45 to 1.67 g/kg g/kg was recorded in combination of mango pulp effluents and fish wastes in the ration of 1:2 with all three biofertilizers and *E. fedita* (C3E5). Tagliavini *et al*. (2000) had opined that mixing and incubating inorganic iron salts with organic matter increase efficiency of organic matter for removing of iron deficiency.

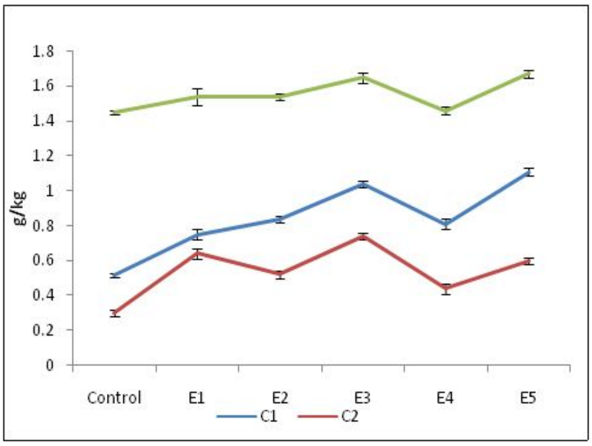


Fig. 6: The changes iron level in control and experimental bins after 80 days

ACKNOWLEDGMENT

The Authors gratefully acknowledge the Head of the Department, Department of Zoology, Kandaswami Kandars College, Velur, Namakkal for their extensive support throughout this study.

REFERENCES

Abdullah, N., Chin, N.L.2010. Simplex-centroid mixture formulation for optimised composting of kitchen waste. *Biores. Technol.***101**: 8205-8210. DOI:10.1016/j.biortech. 2010. 05.068.

Anil Kumar, C.H., Bhanu Prakash, N.B., Balwinder, K. 2018. Potential of Vermicompost for Sustainable Crop Production and Soil Health Improvement in Different Cropping Systems. *Inter. J. Curr. Microbiol. Appl. Sci.***7**: 1042-1055. DOI: https://doi.org/10.20546/ijcmas.2018.710.116

Bansal, S., Kapoor, K. K. 2000. Vermicomposting of crop residues and cattle dung with Eisenia foetida. Biores. Technol. **73**: 95-98. DOI: https://doi.org/10.1016/S0960-8524(99)00173-X.

Hemalatha, B.2012. Recycling of industrial sludge along with municipal solid waste– vermicomposting method. *Inter. J. Advanced Eng. Technol.***3**: 71-74.

Hoekstra, N. J., Bosker, T., Lantinga, E. A. 2002. Effects of cattle dung from farms with different feeding strategies on germination and initial root growth of cress (*Lepidium sativum* L.). *Agric.Ecosyst. Environ.***93**: 189-196. DOI: 10.1016/S0167-8809(01)00348-

Irshad, M., Malik, A. H., Shaukat, S., Mushtaq, S., Ashraf, M. 2013. Characterization of heavy metals in livestock manures. *Polish J. Environ. Studies* 22: 1257-1262.

John, M. K. 1970. Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. *Soil Sci.***109**: 214-220. DOI: https://10.1097/00010694-197004000-00002.

Kaplan, M. 2016. The National master plan for agricultural development in suriname. Final Report. Kaplan Planners Ltd. Regional and Environmental Planning, pp. 255.

Mohee, R,. Driver, M.F.,Sobratee, N.2008. Transformation of spent broiler litter from exogenous matter to compost in a sub-tropical context. *Biores. Technol.***99**: 128-136. DOI:10.1016/j.biortech.2006.11.040.

Nath, G., Singh, K., Singh, D. K. 2009. Chemical analysis of vermicomposts and vermiwash of different combinations of animal, agro and kitchen wastes. *Aust. J. BasicAppl. Sci*. **3**: 3672–3676.

Ngoc, U.N., Schnitzer, H. 2008. Waste management towards zero emissions approach in the fruit juice processing industry. 1st WSEAS International Conference on environmental and geological science and engineering (EG'08), Malta.

Ofosu-Budu, G.K., Hogarh, J.N., Fobil, J.N., Quaye, A., Danso, S.K.A., Carboo, D. 2010. Harmonizing procedures for the evaluation of compost maturity in two compost types in Ghana. *Resour. Cons. Recycling* **54**: 205–209. DOI: 10.1016/j.resconrec.2009.08.001.

Padmavathiamma, P. K., Li, L. Y., Kumari, U. R. 2008. An experimental study of vermi-biowaste composting for agricultural soil improvement. *Biores.Technol.***99**: 1672-1681. DOI: 10.1016/j.biortech.2007.04.028.

Sangwan, P., Garg, V., Kaushik, C. 2010. Growth and yield response of marigold to potting media containing vermicompost produced from different wastes. *Environmentalist* **30**: 123-130. DOI: https://doi.org/10.1007/s10669-009-9251-3.

Sharma, K. K., Zaidi, N. W., Singh, U. S.2012. Effect of biological seed treatment on seed germination and growth promotion of paddy, tomato and mustard. *Vegetos* **25**: 375–386.

Sheikh, M., Dwivedi, P. 2017. Physicochemical parameters of organic manure, soil and impact of organic manure and NPK fertilizer on seed germination of soybean and wheat. *Inter. J. Eng.Technolog.Manag. Res*. **4**:118-130. DOI: 10.29121/ijetmr.v4.i12.2017.604.

Subbu Lakshmi, S. 2015. *Cost effective and ecofriendly technology for the management of fish waste and agroindustrial waste using mushroom and earthworm*. Ph.D. thesis submitted to Manonmaniam Sundaranar University, Tirunelveli Tamil Nadu.

Subramaniam P. 2006. Perspectives of organic agriculture, in vermicomposting technology. Coimbatore: the Director, CAS Department of Agronomy, Tamil Nadu Agriculture University, 126–133.

Suthar, S. 2007. Nutrient changes and biodynamics of epigeic earthworm *Perionyx excavatus* (Perrier) during recycling of some agriculture wastes. *Biores. Technol.***98**: 1608-1614. DOI:10.1016/j.biortech.2006.06.001 .

Tagliavini, M., Abadia, J., Rombola, A. D., Abadia, A., Tsipouridis, C., Marangoni, B. 2000. Agronomic means for the control of iron deficiency chlorosis in deciduous fruit trees. *J. Plant Nutr*. **23**: 2007–2012. DOI: https://doi.org/10.1080/01904160009382161.

Unmar, G., Mohee, R. 2008. Assessing the effect of biodegradable and degradable plastics on the composting of green wastes and compost quality. *Biores. Technol.***99**: 6738-6744. DOI:10.1016/j.biortech.2008.01.016.

Vasanthi, K., Chairman, K., Ranjit Singh, A.J.A. 2014. Sugar Factory Waste (Vermicomposting with an Epigeic Earthworm, *Eudrilus eugeniae* (Kinberg). *Amer. J. Drug Discov.Devel.***4**: 22-31. DOI: 10.3923/ajdd.2014.22.31.