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Production of Vermicompost by Agrowaste using *Eudrilus Eugeniae and Eisenia Fetida* Species *(Linn)*

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ABSTRACT

Sugarcane bagasse as a main substrate and cow dung are used as a waste material in different combinations such as M1-Sugarcane bagasse (100 %), M2- Sugarcane bagasse :cow dung- (80:20 %), M3- Sugarcane :cow dung (60:40%), M4- Sugarcane baggasse:cow dung (40:60), M5- Sugarcane bagasse: dung (20:80%), M6- Cow dung (100%) for preparation of vermicompost along with two species of earthworm's viz. *Eudrilus eugeniae* and *Eisenia ferida*. Based on the findings of present investigation, it could concluded that amongst the various combinations of organic residues evaluated, 100 per cent cow dung was found highest per cent recovery of vermicompost followed by 20:80 combination of Sugarcane bagasse and cow dung. The final results of the experiment showed that on composting the pH of all organic residues decreased slightly during composting. There was gradual increase in electrical conductivity of composting materials from 20 days to the 90 days of composting. As far as the manurial value is concerned, 20:80 combination of Sugarcane bagasse and cow dung found to be the best combination from the point of Micro nutrient contents. Between the two species of earthworms, *Eudrilus eugeniae* species of earthworm found superior over Eiseniaferida species of earthworm in respect of most of the parameters studied. The manurial value of all the compost products improved due to vermicomposting.

Key Words:
Sugarcane bagasse, Cow dung, Vermicompost, Earthworm and Micronutrients.

Introduction

Press mud and bagasse are commonly known as major waste of the sugar industry. Sugarcane bagasse is soft, spongy amorphous and dark brown to brownish white material containing lignin, cellulose, hemicellulose fibres. Lignin degradation takes more time because of its structural complexity (Dominguez et al, 2010). Lignin is a natural polymer having complex phenolic structure. The cellulose and starch contain glucose while pectin contains galacturonic acid monomers (Fernandez et al., 2009). Hemicellulose contains mannans, xylans and galactans. Due to lack of proper waste management techniques either it is discharged in open places or along roadsides or railway tracks or stored in the sugar mill premises (Gopal*et al.,* 2010). Besides the loss of organic matter and plant nutrients, burning of crop residues also causes atmospheric pollution due to the emission of toxic gases methane, carbon dioxide that poses threat to human and ecosystem (Manyuchi and Ashakumar 2013).

Earthworm‘s role as a farmer‘s friend in decomposing organic waste is well known for centuries. Earthworm have real potential to both increase the rate of aerobic decomposition, composting of organic waste and stabilize the organic residues in them, while removing the harmful pathogens and heavy metals from the soil (Seeber et al., 2005). Earthworm can consume and degrade all kinds of organic matter through enzymatic digestion, enrichment by nitrogen excrements and transport of organic and inorganic materials. The beneficial role of earthworm includes fragmentation and breakdown of plant organic material, increasing soil fertility by excreting nitrogen, changing the soil structure by their movement in the soil, causing thorough mixing of the soil, aerating the soil and improving its water holding capacity (Natarajan et al., 2014).

The earthworm, *Eudrillus eugeniae* is commonly known as African worm or Night crawlers and is the second most widely used earthworm for vermicomposting. It is a large composting worm, less tolerant to cold temperatures and best suited to tropical conditions. It is epigeic, lives on the surface of the soil or in the top 10 inches from the surface or on the topsoil under the litter layers (Abbasi et al., 2009).*Eiseniafetida* popularly known as European worm is also epigeic can tolerate wide temperature ranges. *E. fetida* is commonly found in compost heaps, under stones and logs (Suthar S *et al.*, 2008). The species has been used for various toxicological studies as test worm.

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Solid waste management could be enhanced by vermicomposting, which is an appropriate alternative as it is safe, eco-friendly, cheap and quick process (Wilson *et al.*, 2005). Vermicompost contains plant hormones like auxin and gibberellins and enzymes which believed to stimulate plant growth and discourage plant pathogens. It improves the fertility and water holding capacity of the soil (Quaik et al., 2012). It also enriches the soil with favorable microorganisms which add different enzymes like phosphatases and cellulases to the soil. Vermicompost enhances germination, plant growth and thus overall crop yield (Nath et al., 2012). Agricultural waste, kitchen waste has been recycled with vermicomposting along with bio-conversion of organic waste material into nutrition rich vermicompost by earthworm activity (Jyotsana*et al*., 2010). It is therefore imperative to convert the different waste to generate in huge amount to produce good quality vermicompost with minimum period of time. Take this into consideration the present study "Vermicomposting of sugarcane bagasse by utilizing *epigeic* earthworm species" is being undertaken with following objectives: Percent recovery of prepares vermicompost, Changes in chemical properties during vermicomposting and Changes in Micronutrient content during vermicomposting (Lowe et al., 2004).

Materials and Methods

This study was conducted at Armats Biotech Lab, Chennai. Sugarcane bagasse was used as a main substrate and cow dung waste was used as a waste material in different combinations for preparation of vermicompost as M1- Sugarcane bagasse (100 %), M2- Sugarcane bagasse: cow dung- (80:20 %), M3- Sugarcane bagasse: cow dung (60:40%), M4- Sugarcane bagasse: cow dung (40:60), M5- Sugarcane bagasse: cow dung (20:80%), M6- Cow dung (100%). The earthworm species Eudriluseugeniae and Eiseniaferida utilized for vermicomposting. The species Eudriluseugeniae and Eiseniaferida were brought from Hand & Hand organization, Chennai. Vermicomposting was performed in plastic trays. The trays were first thoroughly cleaned with water and two holes were kept at the bottom side of the trays for drainage purpose and then rinsed with distilled water before using for vermicomposting.

Experimental Design

Bottom of the tray was covered with a layer of stones as a bedding material. Immediately above a layer of well mixed partially decomposed waste material as per the respective combination of the treatment was spread and was sufficiently moistened to maintain the moisture around 50 per cent. Then the trays were covered with gunny bags to maintain adequate moisture and body temperature of earthworms and to protect against termites, ants and rats. The organic residues were watered regularly so as to maintain an optimum moisture level of 50 per cent for a period of 90 days.

Inoculation of earthworms

After sufficient watering of the vermibeds layer to 50 per cent moisture content, twenty five earthworms of *Eudrilus eugeniae and Eisenia ferida* species were introduced as per treatment as an optimum inoculating density in the vermibeds of each trays. Optimum moisture level of 50 per cent and average relative humidity was maintained throughout the period of composting.

Incubation study

To understand the nutrient release pattern, changes in chemical properties of compost under the influence of earthworms and time of composting, an incubation study was conducted for 90 days in Factorial Randomized Block Design comprising of six treatment combinations with two species of earthworms replicated three times.

The vermicompost samples from three randomly and well distributed spots in each treatment combinations were collected with the augur without disturbing the live worms at 15 days, 30 days, 45 days, 60 days, 75 days, and 90 days of vermicomposting and treatment wise vermicompost samples were prepared by mixing. pH, Electrical Conductivity, Percent Recovery and Micronutrients were determined from dried samples which were prepared by air drying in shade.

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pH

Vermicompost sample of 10 g was mixed with 5 times the volume of water and shaken vigorously, using the mechanical shaker for 2 and the pH was recorded using digital pH meter.

Electrical conductivity (dSm-1)

The electrical conductivity of vermicompost samples was determined from clear supernatant of overnight kept 1:10 compost: water ratio with the help of conductivity meter.

Micronutrients (Boron ,Sulphur, Nitrate and Zinc)

Micronutrients of vermicompost samples were determined from di-acid extract by Atomic Absorption Spectrophotometry method.

Result and Discussion

Between the two species of earthworms, Eudriluseugeniae species of earthworm found superior over Eiseniaferida species of earthworm in respect of most of the parameters studied. The manurial value of all the compost products improved due to vermicomposting.

TABLE 1: Periodical changes in pH during composting of organic residues

TREATMENT DETAILS		**15 DAYS**		**90 DAYS**	
		EE	**EF**	**EE**	**EF**
M1	**SB (100%)**	**6.74**	**6.75**	**6.42**	**6.36**
M2	**SB:CD (80:20)**	**6.62**	**6.58**	**6.23**	**6.53**
M3	**SB:CD (60:40)**	**6.75**	**6.69**	**6.53**	**6.46**
M4	**SB:CD (40:60)**	**6.82**	**6.84**	**6.56**	**6.52**
M5	**SB:CD (20:80)**	**6.83**	**6.82**	**6.72**	**6.69**
M6	**CD (100%)**	**7.05**	**6.89**	**6.98**	**6.83**

Note: **EE**-EudrilusEugeniae**EF**- EiseniaFerida

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TABLE 2: Periodical changes in BORON (mg / kg) content during composting of organic residues

TREATMENT DETAILS		15 DAYS		90 DAYS	
		EE	EF	EE	EF
M1	SB (100%)	0.41	0.43	0.46	0.41
M2	SB:CD (80:20)	0.44	0.42	0.49	0.43
M3	SB:CD (60:40)	0.44	0.42	0.46	0.42
M4	SB:CD (40:60)	0.45	0.42	0.43	0.46
M5	SB:CD (20:80)	0.46	0.43	0.51	0.44
M6	CD (100%)	0.49	0.44	0.45	0.49

TABLE 3: Periodical changes in SULPHUR (mg / kg) content during composting of organic residues

TREATMENT DETAILS		15 DAYS		90 DAYS	
		EE	EF	EE	EF
M1	SB (100%)	0.53	0.54	0.65	0.65
M2	SB:CD (80:20)	0.54	0.53	0.66	0.64
M3	SB:CD (60:40)	0.56	0.5	0.66	0.67
M4	SB:CD (40:60)	0.55	0.54	0.61	0.61
M5	SB:CD (20:80)	0.52	0.55	0.69	0.64

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M6	**CD (100%)**	**0.57**	**0.56**	**0.52**	**0.57**

TABLE 4: Periodical changes in NITRATE (mg / kg) content during composting of organic residues

TREATMENT DETAILS		**15 DAYS**		**90 DAYS**	
		EE	**EF**	**EE**	**EF**
M1	**SB (100%)**	**1.13**	**1.19**	**1.35**	**1.59**
M2	**SB:CD (80:20)**	**1.19**	**1.16**	**1.46**	**1.44**
M3	**SB:CD (60:40)**	**1.07**	**1.04**	**1.49**	**1.48**
M4	**SB:CD (40:60)**	**1.11**	**1.13**	**1.63**	**1.56**
M5	**SB:CD (20:80)**	**1.14**	**1.20**	**1.77**	**1.53**
M6	**CD (100%)**	**1.19**	**1.21**	**1.79**	**1.59**

TABLE 5: Periodical changes in ZINC (mg / kg) content during composting of organic residues

TREATMENT DETAILS		**15 DAYS**		**90 DAYS**	
		EE	**EF**	**EE**	**EF**
M1	**SB (100%)**	**33.43**	**34.34**	**40.32**	**32.67**
M2	**SB:CD (80:20)**	**32.68**	**33.32**	**39.17**	**36.84**
M3	**SB:CD (60:40)**	**33.30**	**35.33**	**37.81**	**34.52**
M4	**SB:CD (40:60)**	**32.70**	**34.62**	**36.01**	**33.80**

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M5	**SB:CD (20:80)**	**32.11**	**31.72**	**49.55**	**33.76**
M6	**CD (100%)**	**34.21**	**32.18**	**44.32**	**39.27**

PERIODICAL CHANGES IN pH DURING COMPOSTING OF ORGANIC RESIDUES

It was observed that the pH was recorded minimum (6.23) at 90 days in M2 i.e. 80:20 proportion of sugarcane bagasse and Cow dung and M6 i.e. Cow dung (100%) has recorded maximum (6.98). Among the two earthworms species Eudrilluseugeniae has maxmum pH (6.98) after 90 days than E2i.e. Eiseniaferida (6.83). However, the interaction effects i.e. combination of organic materials and earthworm species was found non-significant throughout the period vermicomposting as shown in Table 1. The shift in pH during the study could be due to microbial decomposition during the process of vermicomposting. From the data presented in Table 1, it was observed that there was reduction in pH during the process of vermicomposting. While studying the vermicomposting of some organic residues concluded that the lower pH in end product (vermicompost) might be due to the production of CO2 and organic acids by microbial decomposition, during the process of bioconversion of different substrates in the beds (Monroy et al., 2009).

CHANGES IN CHEMICAL PROPERTIES DURING VERMICOMPOSTING

The chemical changes in vermicompost prepared with sugarcane bagasse as a main substrate combined with cow dung were periodically studied at an interval of thirty days during vermicomposting it was observed that the pH was decreasing and Electrical conductivity was increasing with advancement of number of days from 15 to 90 days.

CHANGES IN MICRONUTRIENT CONTENT DURING VERMICOMPOSTING

The primary nutrient content increased with advancement of days after inoculation From 15 days to 90 days for all the content of Boron, Sulphur, Nitrate and Zinc under the study,

PERIODICAL CHANGES IN BORON CONTENT DURING COMPOSTING OF ORGANIC RESIDUES

The changes in total boron content of different organic residue found to be significant on 15 days as well as on 90 days of composting. At 90 days, i.e. at the end of composting, maximum total Boron (0.51) was observed in treatment M5 i.e.20:80 proportion of sugarcane bagasse and cow dung, while minimum total Boron (0.41) was recorded in treatment M1 i.e.100 per cent sugarcane baggasse. Between two species of earthworm Eudriluseugeniae was found to be significantly superior over Eiseniaferida in increasing Boron content of the residues. The interaction effect of both i.e. combinations of sugarcane bagasse: cow dung and earthworm species did not reach the level of significance on 15 days. Inoculation of either Eudriluseugeniae or Eiseniaferida species caused increased in total boron content of almost all the treatments. Gupta et al., 2009 served that the increase in total manganese content vermicomposting of vegetable waste with Eiseniaferida species of earthworm. The variation in manganese content in cow dung, farm waste, local grass, cashew leaves and mango leaves (Ansari et al., 2010).

PERIODICAL CHANGES IN SULPHUR CONTENT DURING COMPOSTING OF ORGANIC RESIDUES

The changes in total Sulphur content of different organic residue found to be significant on 15 days as well as on 90 days of composting. At 90 days, i.e. at the end of composting, maximum sulphur (0.69) was observed in treatment M5 i.e. 20:80 proportion of sugarcane bagasse and cow dung combination, whereas treatment M6 i.e. 100 per cent cow dung observed minimum sulphur content i.e.0. 57. At the end of composting Eudriluseugeniae recorded maximum total sulphur content. During period of composting Eudriluseugeniae species of earthworm found superior than those treated with Eiseniaferida species of earthworm. Sulphur is an essential plant nutrient and is required by plants in amounts similar to phosphorus. The most important function of sulphur in plants is its involvement in protein synthesis (Ismail 2008). Sulphur is present in the structure of the amino acids cysteine and methionine, both

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of which are important components of proteins. The present study showed sulphur content in vermicompost as maximum, when it was obtained from processed by M5 Eudriluseugeniae compare to other waste

PERIODICAL CHANGES IN NITRATE CONTENT DURING COMPOSTING OF ORGANIC RESIDUES

The changes in total nitrate content of different organic residue found to be significant on 15 days as well as on 90 days of composting. At 15 days, regarding the different organic residue, it was observed that the maximum total nitrate (1.79) in treatment M6 i.e.100 per cent cow dung. At 90, i.e. at the end of composting, maximum total nitrate (1.79) was observed in treatment M6 i.e.100 per cent cow dung. Between two species of earthworm Eudriluseugeniae (1.79) was found to be significantly superior over Eiseniaferida (1.59) in increasing nitrate content of the residues. Lowest nitrate content was also observed in both species. Jioseph et al., (2008) reported that the determination of inorganic N, mainly NH4 + and NO3 -in soil is often useful, because, despite their usually low levels, these inorganic forms are readily available for plant uptake. Khwarirkpam et al., (2009) suggest that in warm, well-aerated, slightly acid to slightly alkaline soils the nitrate is the nitrogen form absorbed by plant in the predominant form. Jadin et al., (2008) shows the relationship between the nitrate concentration and the depths of the soil.

PERIODICAL CHANGES IN ZINC CONTENT DURING COMPOSTING OF ORGANIC RESIDUES

The changes in total Zinc content of different organic residue found to be significant on 15 days as well as on 90 days of composting. At 90 days, i.e. at the end of composting, maximum total zinc (49.85) was observed in treatment M5 i.e.20:80 proportion of sugarcane bagasse and cow dung, while minimum total Zinc (32.67) was recorded in treatment M1 i.e.100 per cent sugarcane waste. Between two species of earthworm Eudriluseugeniae was found to be significantly superior over Eiseniaferida in increasing zinc content of the residues (Malik et al., 2007 and Mayunchi et al., 2013). The interaction effect of both i.e. combinations of sugarcane bagasse: cow dung and earthworm species did not reach the level of significance on 30 days. The results are in agreement with those recorded by Thahir and Zalarisam (2010) in vermicompost prepared with vegetable waste.

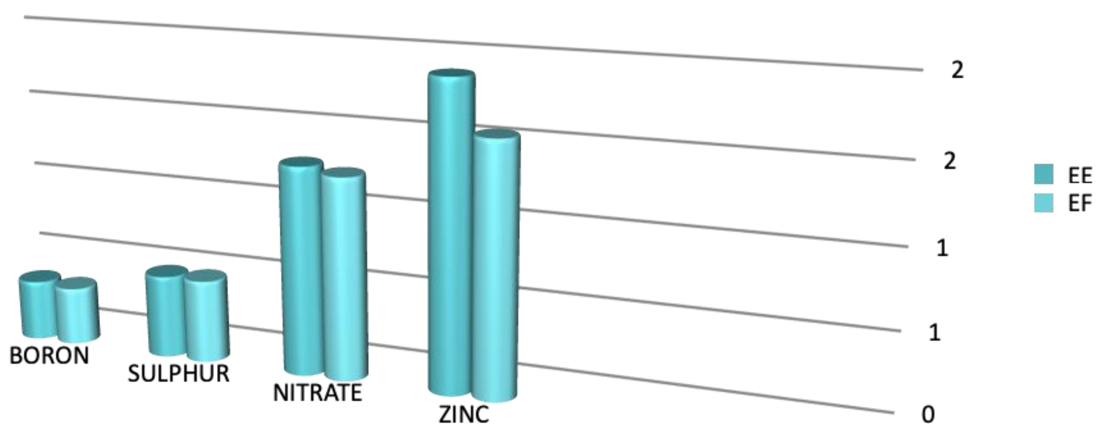

FIG 1:MICRONUTRIENTS ANALYSIS OF VERMICOMPOST USING TWO EARTHWORM

CONCLUSION

It could be concluded from the present investigation that amongst the various combinations of organic residues evaluated, cow dung (100%) was found highest percent recovery of vermicompost followed by the treatment M5 (20:80) combinations of sugarcane bagasse and cow dung. Among the two species of earthworms, Eudriluseugeniae species of earthworm was found superior over Eiseniaferida species of earthworm in respect of most of the parameters studied. As far as the manurial value is concerned, 20:80 combinations of sugarcane bagasse and cow dung were found to be the best combination from the point of micro nutrient contents. The manurial value of all the compost products was improved due to vermicomposting Thus, vermicomposting was proved to be a better technology than that of sole composting and may be preferred for the management and nutrient recovery from the urban waste such as sugarcane bagasse and cow dung.

REFERENCES

1. Abbasi, S. Gajalakshmi and S. A. Abbasi, "Towards modeling and design of vermicomposting systems: Mechanisms of composting /vermicomposting and their implications", Indian Journal of Biotechnology, Vol 8, pp. 177-182, 2009.
2. Ansari and K. Sukhraj, (2010). "Effect of vermiwash and vermicompost on soil parameters and productivity of okra (abelmoschusesculentus) in Guyana", Pakistan JAgric Resources, Vol 23, pp. 137-142.
3. Asha Kumara, Bihari Singh and TriptiGangwar . (2013).Recycling of organic wastes of sugarcane biogases and Poultry waste through vermicomposting using earthworm's species Eisenaferida and Edurilus Eugenia: analysis of mcronutient Asian journal and Env.Research vol.6 (3-4) 52-58.
4. Dominguez,J.Aira ,M. and Gomez –Brandon, M.;(2010). Vermicomposting, Earthworms enhance the work of microbes .In microbes at work,ed.M. Insm,H, Franke. whittle,I. and gobernam.(eds),Boca Raton ,FL,94-115,Sprengir, Berlin.
5. Fernandez Bayo ,J.D, Nogales, R.andRomero,E. (2009).Effect of vermicomposting from wastes of the wine and alcohol industries in the persistence and distribution of imidacloprid and diuron on agricultural soils , J.Agric.Food Chain-57,5435-5442.
6. Gopal, A. Gupta, C. Palaniswami, R. Dhanapal and G. V Thomas,"Coconut leaf vermiwash: a bio-liquid from coconut leaf vermicompost for improving the crop production capacities", Current Science, Vol 98, pp. 1202-1210, 2010.
7. Gupta V and R Garg. "Probiotics". Indian Journal of Medical Microbiology 27 (2009): 202-209.Fatunbi AO and LNcube. "Activities of Effective Microorganism (EM) on the Nutrient Dynamics of Different Organic Materials Applied to Soil". American-Eurasian Journal of Agronomy 2.1 (2009): 26-35.
8. Ismail SA. Role ofearthworm in vermitechnology. Journalof Agricultural Technology. 2008;8(2):403-415
9. Jadia and M. H. Fulekar,(2008)."Vermicomposting of vegetable waste: A bio-physicochemical process based on hydro- operating bioreactor", African Journal of Biotechnology, Vol 7 (20), pp.3723-3730.
10. Joseph PV. Microbiological and physicochemical analysis of vermicompost of fruit waste by Eudriluseugeniae. International Journal of Science and Research Methodology.2018;8(4):77-93
11. Jyotsana P, VijayalakshmiK,Prasanna ND, Shaheen SK. Isolation and characterization of cellulase producing Lysinibacillussphaericus from gut of Eiseniaferida. The Bioscan. 2010;6(2):325-327
12. Khwairakpam M, BhargavaR.Vermitechnology for sewage sludge recycling. Journal of Hazardous Materials. 2009;161(2–3):948-954
13. Lowe CN. "The development of sustainable earthworm populations at Calvert land fill site". Land Degradation Development 1.5 (2004): 27-36.
14. Malik. "Environmental challenge vis a vis opportunity. The cade of water hyacinth". Environment International 33.1 (2007): 122-138.
15. Manyuchi, A. Phiri, N. Chirinda, P. Muredzi, J. Govha and T.Sengudzwa, "Vermicomposting of Waste Corn Pulp Blended with Cow Dung Manure using EiseniaFetida", World Academy of Science, Engineering and Technology, 68, pp. 1306-1309, 2012.
16. Manyuchi, A. Phiri, P. Muredzi and S. Boka, (2013). "Comparison of vermicompost and vermiwashbiofertilizers from vermicomposting waste corn pulp", World Academy of Science, Engineering and Technology (submitted for publication).
17. Mnkeni PNS, Brutsch MO. The Effects of Goat Manure,Sewage Sludge and Effective Microorganisms on the Composting of Pine Bark. Compost Science and Utilization. 2006;14(3):201-210
18. Monroy, F.Aira,M.Dominguez,J.;Reduction of total coil from number during vermicomposting is caused by short term direct effects of slurry Sci.Total Environ. 407:5411-5416. (2009).
19. Monroy F, Dominguez J.Eiseniafetida (Oligochaeta:Lumbricidae) modifies the structure and physiological capabilities of microbial communities improving carbon mineralization during vermicomposting of pig manure.Microbial Ecology. 2007a;54:662-671

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 819 - 827
Received 20 January 2021; Accepted 08 February 2021.

20. Natarajan N, GajendranM.Vermiconversion of paper mill sludge for recycling the nutrients using earthworm Eudriluseugeniae.International organization of scientific research. Journal of Environmental Science, Toxicology and Food Technology. 2014;8(9):06
21. Nath and K. Singh, "Effect of vermiwash of different vermicomposts on the kharif crops", Journal of Central European Agriculture, Vol 13 (2), pp. 379-402, 2012.
22. Palanichamy, B. Mitra, N. Reddy, M. Katiyar, R. B. Rajkumari, C. Ramalingam and Arangantham, (2011)."Utilizing Food Waste by Vermicomposting, Extracting Vermiwash, Castings and Increasing Relative Growth of Plants", International Journal of Chemical and Analytical Science 2 (11), pp. 1241-1246. Quaik,
23. A. Embrandiri, P. F. Rupani, R. P. Singh and M. H. Ibrahim, (2012). "Effect of vermiwash and vermicompost leachate in hydroponics culture of Indian borage (Plectranthusambionicus) plantlets", 11th International Annual Symposium on Sustainability Science and Management, pp. 210-214, 2012.
24. Seeber J., et al. "The effect of macro-invertebrates and plant litter of different quality on the release of N from litter to plant on alpine pastureland". Biology and Fertility of Soils 44.5(2005): 51-67.
25. Suthar S, Singh S. Feasibility of vermicomposting in biostabilization of sludge from distillary industry. Science of the Total Environment. 2008;394:237-243
26. Tahir TA, Hamid FS. Vermicomposting of two types of coconut wastes employing Eudrilluseugeniae: A comparative study. International Journal of Recycling of Organic Waste in Agriculture. 2010; 1(7):1-6
27. Wilson. et al. "Determinants and patterns of population growth in water hyacinth". Aquatic Botany 81.1 (2005): 51-67.
28. Zularisam, Z. SitiZahirah, I. Zakaria, M. M Syukri, A. Anwar and M. Sakinah, "Production of fertilizer from Vermicomposting Process of Municipal Waste", Journal of Applied Sciences 10 (7), pp. 580-584, 2010