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Efficacy of reproduction and vermicomposting ability of eggshell powder using *Eudrilus eugeniae*

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Abstract

Vermicompost is a good organic fertilizer preparing through interaction between earthworm and microorganism, which breakdown the nutrient substrate from organic waste. In this study we used eggshell powder and cow dung mixture for vermicompost. Eggshells were considered as solid bio waste in bakeries, hostel, food processing industries and households. It is rich in calcium carbonate and contains small amounts of protein. The experiment was carried out for 90days, the control and six treatments were maintained in eggshell powder and cow dung mixture was processed using the earthworm, *Eudrius euginae.* During the study period of growth and reproduction rates were recorded at the end of vermicomposting. Treatment T6 showed higher reproduction rate compared to other treatments. Physio-chemical parameters of the vermicompost such as pH, electrical conductivity, organic carbon, total nitrogen, phosphorous and potassium assessed were relatively good in all treatments compared to control. FESEM analysis showed the nutrient elements of vermicompost. Green gram (*Vigna radiata*), Black gram (*Vigna mungo*), and Fenugreek (*Trigonella-foenium-graecum*) seeds was germinated excellently when compared to control and were maintained in triplicates. We can conclude that, the eggshell powder showed good source of substrate for vermicompost, reproduction and survival of worm and also induce the growth of plants.

Keywords: eggshell powder, eudrius euginae, seed germination, trigonella-foenium-graecum, vermicompost, vigna mungo, vigna radiate

Introduction

Vermicomposting is a process of decomposition of organic solid waste deposits by the aerobic activity of earthworms and microorganisms (Lim *et al.*, 2016) [14, 15]. Vermicomposting involves the physical and biochemical action of earthworms in altering organic materials. The goals of vermicomposting are to repeatedly increase the amount and weight of worms and to convert the substrate material into vermicompost within the shortest time and highest recovery as possible (Rupani *et al.*, 2013) [21]. The life span of an earthworm is about 3 to 7 years depending upon the type of species and the ecological situation (Maheswari and Priya 2018) [16]. Earthworms protect millions of 'nitrogen-fixing' and 'decomposer microbes' in their gut. Earthworms are considered farmers friends and an indicator of soil quality because they contribute enriched soil to an agricultural field. These worms are major producers of natural manure without any factories and gifts of farmers. (Annapoorani, 2014) [4]. Eggshell is considered solid waste, which produces several tons per day and it was sent to landfill with a high management cost. **(**Faridi and Arabhosseini, 2018**)** [7]**.** Eggshell waste disposal leads to environmental pollution, causes odor, and invite flies (Kingori, 2011) [11]. Orange skin amended with eggshell and soil could be converted to organic fertilizer through vermicomposting (Lee *et al*., 2016) [13, 14].

Sustainable agricultural production, especially in organic agriculture, requires new means of fertilization and plant protection. The use of variety of fertilizers and other products derived from organic waste is extremely promising in light of renewable resource utilization (Simon and Czakó, 2014) [24]. Use of organic manures alone, as a substitute to chemical fertilizers is not profitable and will not be enough to maintain the present levels of crop productivity of high yielding varieties. Uses of organic manures alongside inorganic fertilizers results in increase in productivity and also sustain the soil health for an extended period (Gawai and Pawar, 2006) [9]. The changes in soil properties improve the availability of air and water, thus encouraging seedling emergency and root growth (Gopinath *et al*., 2008) [10]. Black gram (*V. mungo* L.) is the most important pulse crops next to chickpea, lentil, and mung bean both in area and production (AIS, 2017) [2]. The crop yield of mung is more hooked into an adequate supply of water than on the other single environmental factor. Fenugreek high market value and fair salinity tolerance attract the farmer to include this crop in their cropping strategy particularly in area having salinity problem and development of root system for optimum crop production (Nambiar and Abrol, 1989) [18]. The aim of the study was conducted to evaluate the suitable organic mixtures for vermicomposting using egg shell powder and cow dung and also analysis the physiochemical properties of organic manure which was play a vital role in germination of some of the seeds like green gram, black gram, and fenugreek.

Materials and Methods

Experimental design

E. eugeniae (Kinberg) was collected from the agricultural farmyard in sennanoor and maintained in vermibed (mixture of red soil and cow dung in the ratio 1: 1) at laboratory condition (29˚C 1 70% R.H) for 10 days. The cow dung

was collected from cow farm in sennanoor and the eggshell is collected from various food shops in Coimbatore. The vermibed was prepared by mixing dried cow dung with fine grinds eggshell powder was used in different concentrations maintained for 90 days from December 2018 to February 2019, Department of Zoology, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, and India (Table 1). Eggshell powder particles are floating and not settled on the cow dung mixture and mix thoroughly till they join and made water retains intensively. During the 21 days of primary digesting period water was sprinkled to maintain favorable conditions for earthworms. (Ramalingam and Thilagar, 2000) [20]. Plastic tray and covered with net (prevent the entry of insects and pests) was maintained for all the treatments. Sexually matured 10 earthworms were introduced into the treatments. Moisture content of the treatments was maintained up to 80% of water. The experiments were kept in room temperature under the laboratory condition.

Table 1: Different concentration of eggshell powder and cow dung mixture was used in this study

Treatments	Soil (g)	Egg Shell Powder (g)	Cow dung (g)	Total (g)
Control	500	-	1000	1500
T1	-	500	1000	1500
T2	-	600	900	1500
T3	-	700	800	1500
T4	-	800	700	1500
T5	-	900	600	1500
T6	-	1000	500	1500

The Statistical analysis

The Karl pearson s coefficient of correlation (r) reproduction rate of cocoons, young ones and adults on eggshell powder concentration (Maurya and Chattoraj, 1994) [17].

Physicochemical analysis

After 90 days of the vermicomposting process using eggshell powder and cow dung was modified rich organic manure as casts without any bad odor. Compost like organic waste products were resulted as nitrogen (N), phosphorus (P), potassium (K), organic carbon (OC), electrical conductivity (EC), and pH. Total N and total P contents were determined by Micro Kjeldahl method (1883) [12]. And phosphorus by Olsen method (Okalebo R.J, 2002) [19]. While K was estimated by flame photometric method respectively (Tandon 2005) [26]. The OC was determined by Walkey and Black method (Okalebo R.J, 2002) [19]. Was analyzed. The pH and EC were estimated by potentiometry with the help of a digital pH meter and conductivity meter respectively. Nutrient elements of treatment (T1) were observed, hence taken to field emission scanning electron microscope (FESEM) (Bhat *et al.*, 2017) [5].

Studies on seed germination

Experiments were carried out in Laboratory condition using red soil and different treatment of vermicompost mixed to a fine texture for seed sowing. Green gram, Black gram, and Fenugreek were grown in earthen pots. Red soil and vermicompost 1:1 (100g: 100g = 200g). 10 Seeds of each treatment were sown in each pot for germination. Three replication of each treatment was arranged in a completely randomized design (CRD) (Annapoorani and Sindhu, 2019) [3]. Watering was done every evening until the completion of the experiment.

Results and Discussion

Vermicompost is a good soil fertilizer made up of pharyngeal glandular secretion of earthworm with plant and animal debris mixed, digested and modified as an excretory product known as worm caste which contains essential nutrients for plants to germinate, grow and develop. It increases the soil richness, water-holding, softening, aeration, and porosity of the soil.

Observation of worms during the treatment period

The experimental period was carried out up to 90 days of each treatment. At an interval of 30 days, earthworms in each tray were noticed with minimum disturbance for the morphological changes. After the 30th day of the vermicomposting process, the eggshell powdered and cow dung mixture was stabilized. Gradually changed the texture of eggshell powder and cow dung mixture because the interaction of earthworms enhanced the degradation and realized the nutrition-rich cast material. At the treatment period of 60th day and 90th day, the mixture in trays was separately analyzed for the number of adult worms surviving, several young ones, and the number of cocoons and was used for further analysis. Control and treatment do not show any increased temperature and warmth. These were a positive appearance of treatment and the worms were good and healthy suppressed movement in the day time and active movement in the night time. Vermicomposting ability is stated that providing balance nutrients and gradual nutrient release from organic waste sources like eggshell powder and cow dung mixture during period of treatments. Growth can be positive role from enhancing active cocoons to growth of young ones and adults are multiple in numbers. Correlation co-effection (r) between eggshell concentration and cocoon, young one and adult survival indicated the positive impact (Table 2). Eggshell powder indicating the suitable substrate for reproduction, growth and development of the worms under laboratory condition.

Table 2: Number of *E. eugeniae* observed different stages of reproduction

Treatments	60th day of the Treatments			90th day of the Treatments		
	Cocoons	Young ones	Adult worms	Cocoons	Young ones	Adult worms
Control (Soil- 500g and Cow dung -1000g)	20	80	38	79	140	55
T1 (Eggshell powder – 500 and Cow dung -1000g)	21	84	42	85	156	60
T2 (Eggshell powder – 600 and Cow dung -900g)	25	100	46	102	172	71
T3 (Eggshell powder – 700 and Cow dung -800g)	27	108	49	110	188	83
T4 (Eggshell powder – 800 and Cow dung -700g)	33	132	52	135	196	88
T5 (Eggshell powder – 900 and Cow dung -600g)	36	144	55	147	215	95
T6 (Eggshell powder–1000 and Cow dung -500g)	40	160	61	163	226	122
'r' Value	0.88	0.87	0.93	0.90	0.94	0.87

Fig 1: Adult worm of *E. eugeniae* in 90th day

Fig 2: Young ones of *E. eugeniae* in 90th day

Fig 3: Cocoons of *E. eugeniae* in 90th day

In the case of composting ability showed high range, seed germination and in the process of reproductive analysis recorded normal and active cocoons, young ones and adults are multiple in numbers. This result proves the tea dust and cow dung mixture was the best substrate for vermicomposting (Annapoorani and Sindhu, 2019) [3]. The present study reveals eggshell powder and cow dung mixture give high nutrient yield and produced many worm casts and also observed cocoons and young ones. The population at the end of earthworm showed significant variations among different vermi-setups and the highest population of *E. fetida* was recorded in T75 (126.0) followed by, T50, T100, CD100, and T25. Difference between T100 and CD 100 and between T25 and T50 was not statistically significant for population build-up during vermicomposting. The hatchling success, cocoon viability, and fecundity rate directly affect the final population build-up in vermi-setups (Suthar *et al*., 2018) [25].

Vermicomposting Ability

The most effective use of earthworms in organic waste management could be gained. Vermicompost contains enzymes that can break down the organic matter in the soil to release the nutrients and make it available to the plant roots. Earthworms multiply very rapidly because they are hermaphrodite animals and cross-fertilization occurs as the optimal conditions of moisture, temperature, and feeding materials. Earthworms can live for up to two years.

The control and remaining worm worked treatments were analyzed for the 60th and 90th days each treatment was examined and results were analyzed. The texture of the control and worm in all the treatment T0 to T6 was observed on 60th and 90th days. It takes thirty days for water holding capacity and became compost, to work delivered nutritious good yield. It could be observed that the treatment mixture exhibited a gradual increase and comparatively more granules of worm casts. The experiment reveals that the decomposed mixture has water holding capacity is at a high level and it was found that various macro and micronutrients in the vermicompost.

Physiochemical Parameters

Analysis of various physiochemical parameters plays a key role in determining the quality of vermicompost obtained from the control (T0) and treatment (T6) decomposed by *E. eugeniae*. The Parameters are pH, Electrical conductivity, Organic carbon; Nitrogen, Phosphorus, and Potassium were obtained was good. The Physio- chemical parameters of Vermicompost obtained the nutrient value in (Table 3). The pH value range is 6.7 to 7.9 and EC ds/m value is 0.52 to 0.71, OC% value is ranging between 10.05 to 17.19 of the eggshell powder and cow dung mixture in treatments. Similarity was observed in the Nitrogen and Phosphorus in all the treatments and gradually increased T0 to T6. Increased content of Potassium (K) were obtained in T3 to T6. Plants require N-P-K nutrients for growth. Chemical fertilizers boosted NPK for food productivity but it decreases the nutrient quality and affects soil fertility. The only alternative solution for this problem is vermicompost which assures both food safety as well as farm security. Vermicompost not only biofertilizer but it is also a treatment for waste management. (Sharmila *et al*., 2019) [23]. (Agarwal and Sunita, 1999) [1]. Also found that the NPK value of vermicompost processed by earthworms from the same feedstock (cattle dung) significantly increases by 3 to 4 times. It also enhances several micronutrients. Above results were go in line with present investigation.

Table 3: Nutrient elements in different treatments of vermicompost in 90th day.

Parameters	pH	(EC)ds/m	(OC) %	(N) %	(P) %	(K) %
Control (Soil- 500g and Cow dung -1000g)	6.7	0.52	10.05	0.69	0.25	0.20
T1 (Eggshell powder – 500 and Cow dung -1000g)	6.5	0.20	09.08	0.55	0.12	0.17
T2 (Eggshell powder – 600 and Cow dung -900g)	6.6	0.35	12.21	0.63	0.16	0.21
T3 (Eggshell powder – 700 and Cow dung -800g)	6.8	0.43	13.03	0.70	0.22	0.38
T4 (Eggshell powder – 800 and Cow dung -700g)	7.0	0.47	15.00	0.86	0.26	0.42
T5 (Eggshell powder – 900 and Cow dung -600g)	7.9	0.56	15.78	1.08	0.28	0.48
T6 (Eggshell powder–1000 and Cow dung -500g)	7.5	0.71	17.19	1.42	0.30	0.56

Electrical Conductivity (EC), Organic Carbon (OC), Total Nitrogen (N), Phosphorous (P) and Potassium (K) Treatment (T1) is the low value of nutrient elements of Ca and P, other elements like C, M and Si were medium level, O as high due to content added in vermicompost 500 g of eggshell and 1000g of cow dung, this results combined with following (Sangwan *et al*. 2010; Bhat *et al*. 2015a; Lim and Wu 2016) [22, 6, 14, 14]. Vermicomposting of organic materials increases the potassium, sodium and calcium concentrations in the final feed mixtures. The changes in the nutrient contents (pH, electrical conductivity, organic carbon, C: N ratio, nitrogen, phosphorus, potassium, sodium) the vermicompost suggests mineralization of organic wastes by earthworms (Bhat *et al*. 2017) [5].

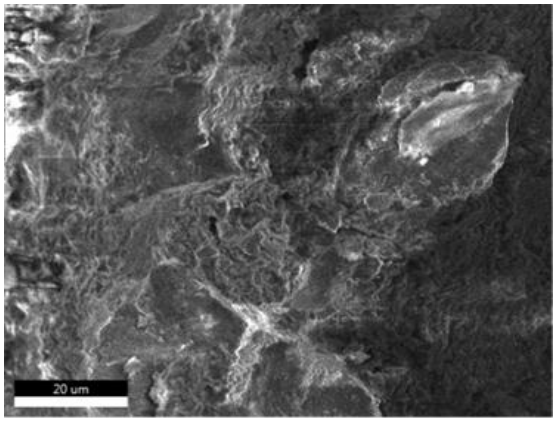

Fig 4: a) FESEM Image

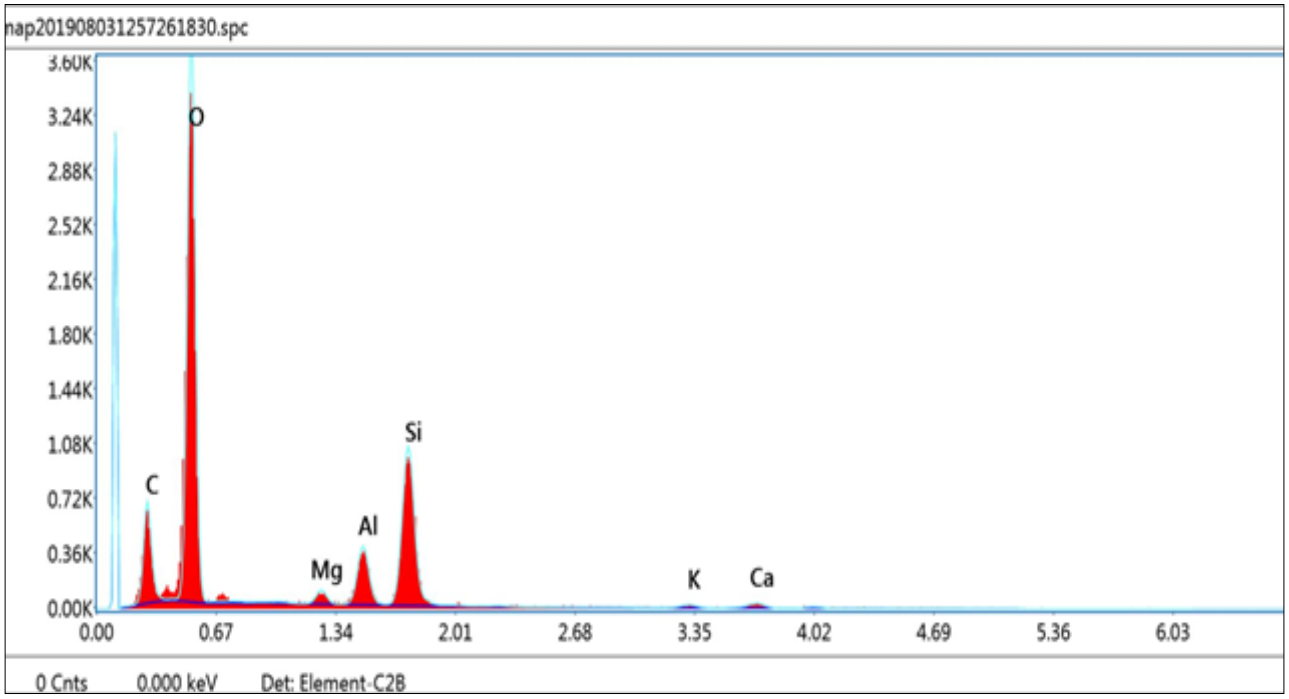

Fig 4: b) EDAX APEX of vermicompost Treatment (T1)

Germination studies

Vermicompost gives readily available nitrogen and much nutrition in the soil, which facilitates uptake by plants. The data showed that application of vermicompost significant role in germination and increase in plant height, nutrient content, and uptakes in all treatments (t1-t6) compared to control.

The germination study revealed the ability of compost by producing good sprouts green gram, black gram, and fenugreek at the beginning of the treatment.

Growths of the plants were excellent on the treatments T1 to T3, because of the minimum amount eggshell powder and cow dung mixture ratio and suppressed growth was noted in T4 to T6 by the results of maximum amount of eggshell powder and cow dung mixture was showed in Table 1 when compared to control.

Artificial chicken eggshell has a rich amount of calcium and this calcium can be used very effectively in various applications. When used as a fertilizer for soil it enriched the pH and calcium content. This enrichment is very beneficial for plants suffering from blossom end root diseases (Gaonkar and Chakraborty, 2016) [8].

In this study also application of eggshell powder increases the growth parameter in the treatment T1-T3, sprouts produced best in all the concentrations. In the direct seed germination test, the highest rates of germination were obtained in unamended soil using all three test plants, which indicates the vermicompost had an inhibitory effect. This is contrast to the results of (Zaller 2007) [27].

Who showed a stimulatory effect on germination when the growth medium was composed of varying proportions of vermicompost mixed with soil?

Conclusion

Vermicompost from the eggshell powder was found in rich nutrient content and best for rapid multiplication of *E.euginae*, optimum eggshell powder and cow dung proportion has been found for all the treatment.

In this connection, the eggshell powder can be taken as the most suitable substrate for the production of organic fertilizer by the vermicomposting process and also cocoon, young one and adult *E.euginae* population were increased that leads to nourished soil climate.

The rich source of macronutrients such as nitrogen, potassium and phosporous is the best biofertilizer for seed germination.

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