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Small-Scale Compost Production through Vermiculture Biotechnology

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Abstract: *This experiment was conducted on small scale compost production using cow dung through the vermiculture biotechnology. Four samples of earthworm such as Lumbricus castaneus, Aporrectodea caliginosa, Eisenia fetida and Aporrectodea longa were cultured in four different beds separately as well as mixed culture of above all species was performed in one single bed. Vermicompost was found from five culture beds as 12,14,15,13 and 14 kg respectively. Odorless, blackish color and crumbly vermicompost were observed in 3 samples whereas deep brown and damp vermicompost was found in other two samples. Though very little differentiation was found in chemical analysis, however, overall nutritional status of five vermicompost was observed almost similar but the productive ability was found strong by Eisenia fetida. In addition, a total 1193 earthworms were harvested while 285 new individuals were found in this research during three months of culture and total mortality of earthworms was recorded 7%. Finally, it is proved that nonpoisonous and environmental friendly vermicompost production is very potential by earthworm culture.*

Keywords: *Earthworm, vermiculture, vermicompost, small scale, biotechnology*

1. Introduction

Compost is a key ingredient in organic farming and modern methodical composting is a multi-step, closely monitored process with measured inputs of water, air and carbon and nitrogen-rich materials [1]. This nutrient rich compost is used in gardens, landscaping, horticulture and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids and as a natural pesticide for soil [2].In ecosystems, compost is useful for erosion control, land and stream reclamation, wetland construction, and as landfill cover. Vermicompost is the product or process of composting using various worms, usually red wigglers, white worms and other earthworms to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials, and vermicast [3]. Vermicast, also called worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by an earthworm. These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than do organic materials before vermicomposting. Containing water-soluble nutrients, vermicompost is an excellent, nutrient-rich organic fertilizer and soil conditioner which is 100% natural organic fertilizer [4].

An earthworm is a tube-shaped, segmented animal commonly found living in soil that feeds on live and dead organic matter. Hermaphrodites earthworms digestive system runs through the length of its body. It conducts respiration through its skin [5]. Earthworm is the group of Oligochaeta in the phylum Annelida which is divided by some different categories such as terrestrial (megadriles, microdriles) and semiaquatic (Tubificidae, Lumbriculidae, and Enchytraeidae etc.) [6],[5]. Vermiculture is the side issue of the breeding of common earthworms for use in vermicomposting. The use of worm farms for vermicomposting is becoming a favorite way of converting waste to a valuable product while also growing more worms to increase the capacity of the worm farms. Vermicompost is naturally designed to benefit plants where the nutrients in earthworm compost are very easily absorbed by the roots of plants. Unlike chemical fertilizers, vermicompost is not easily flushed from the soil because of the worm mucus that it contains. Plants have longer to obtain the nutrients and get the maximum benefit. As the compost is passing through the body of the worms it is enriched with bacteria and microbes. These help plants to become more disease resistant and also repel some plant pests. Vermicompost is helpful to grow plant faster and germination of seeds is encouraged, the growth of the plant is stronger and the crop yield improved. The distribution of the compost through the soil also helps to encourage healthy root growth [7].

Though lots of researches have been done on vermicomposting in different countries, however, very limited research has been found in Bangladesh [8],[9],[10], [11], [12], [7], [13], [15],[5]. Due to Bangladesh is over populate agro-based country, need more production for every day diet and for that reason farmer always use chemical fertilizers, pesticides, insecticides etc. As a result, different common human disorders are commonly seen in Bangladesh through intake those chemicals via food intake. As vermicompost is a completely organic eco-friendly product and easier to process and use in agriculture that could be reduced chemical use and save life from different disorders. This can be a livelihood business. Thus, this research was carried out a small scale bio-fertilizer production through different earthworm culture using cow dung which will be practiced in every household. Other objectives are to observe the productivity of different species of earthworms and to compare the compositions of different vermicompost.

2. MATERIALS AND METHODS

2.1. Experimental Set Up

The experiment for small scale vermicomposting was conducted on the small area of land nearest the fish breeding house of the Department of Genetic Engineering and Biotechnology (GEB) at Shahjalal University of Science and Technology (SUST), Sylhet, Bangladesh. The duration of the culture was 3 months from March to May 2014. Five sanitary pad rings were bought and brought to the experimental side and used this rings for production of vermicompost [16]. The size of the cement rings were 80 cm in diameter and 20 cm in height. Due to earthworm is sensitive to light a plastic roof was made above the culture bed. In addition, fencing around the culture bed was also made for safety purposes.

2.2. Raw Sample Collection and Bedding

One week old cow dung from a dairy farm was brought to the experimental site through a local van and equally distributed and filed up in all the rings. Bedding is any material that provides the worms with a relatively stable habitat with high absorbency, good bulking potential, low protein and/or nitrogen content etc.

2.3. Stocking of Earthworm

Various species of earthworm was collected from the various part of Sylhet, Bangladesh and from them four different species was identified and stocked for composting. Four different earthworm species such as *Eisenia fetida*, *Aporrectodea caliginosa*, *Lumbricus castaneus* and *Aporrectodea longa* was stocked in four different bedding rings at stocking rate with 200 individuals for each ring. In addition, 200 mixed earthworms from above four species with 50 individuals of each were stocked in fifth bedding ring. The species earthworms were identified according to the various morphological features like its external appearance, color of body, size of body etc. [5].

2.4. Monitoring of Earthworm Culture

The compost heap should be checked almost every day during the culture period. For the purposes of culture management, different physicochemical parameters such as moisture, aeration, temperature, pH etc. was tried to maintain properly. Sometimes water was sprayed on the worm compost for maintaining the above parameters. To maintained aeration upwelling was done and to avoid high temperature and heavy rain plastic shed was set above the bedding so that temperature was control as 10°C to 35°C. One other important parameter is pH which was tried to adjust as 5 to 9. In order to protect the earthworm population from predators such as birds, rats, snakes, cock-roaches and ants etc, the compost heap was covered by nylon net.

2.5. Vermicompost and Earthworms Harvesting

Blackish, odorless and crumbly substrate vermicompost was harvested after three months of experiment. Composts were passed through the nylon net and earthworms were collected and the compost was measured as well as the quantity of worms was counted.

2.6. Vermicompost Analysis

Compositions of the compost were analyzed in the Central Laboratory of the Soil Resource Development Institute at Farm Gate, Dhaka, Bangladesh. Different chemical parameters of vermicompost such as organic carbon, nitrogen, potassium and phosphorus were analyzed according to the laboratory procedure which is used in that institute. Percentage of organic carbon and nitrogen (Kjeldahl's method) was measured by the equations of $\frac{10(BT)}{B}$x0.003x$\frac{100}{Weight\ of\ sample}$x1.3 and Burette reading-Blank reading x 1.14 respectively. Furthermore, percent of phosphorus (Klett Summerson method) was estimated by the principle of X x 0.25 where X is the ppm of phosphorus read from the standard curve and percent of potassium (Flame photometer method) was calculated by the formula of 0.05 xX whereas X is the ppm of potassium read from the standard curve.

3. RESULTS AND DISCUSSION

3.1. Harvested Products

In this study, vermicompost was produced by small scale technique using cow dung and end of the research 68 kg compost was harvested. Almost same amount of the compost was harvested from different earthworm culture, however, comparatively higher product was harvested in bedding 3 with *Eisenia fetida* followed by bedding type 2, 4, 5 and 1 respectively (Table 1). A total 1193 earthworms were harvested while 285 new individuals were found in this research and the mortality of the experimental earthworms was found 7% only (Table 1). The highest survival was found in bedding 1 and 3 with *Lumbricus castaneus* and *Eisenia fetida.*

Table 1. *Harvested earthworm and vermicompost from different culture*

Culture types	Earthworms (stocked)	Earthworm (harvested)	New found (number)	Mortality (number)	Vermicompost Production (Kg)
Bedding 1 with *Lumbricus castaneus*	200	235	44	9	12
Bedding 2 with *Aporrectodea caliginosa*	200	230	50	20	14
Bedding 3 with *Eisenia fetida*	200	255	64	9	15
Bedding 4 with *Aporrectodea longa*	200	228	43	15	14
Bedding 5 with mixed species	200	240	57	17	13
Total	1000	1193	258	70	68

3.2. Physical Properties of the Vermicompost

Physical properties of harvested vermicompost were analyzed whereas blackish color was seen in samples 1 with *Lumbricus castaneus*, 2 with *Aporrectodea caliginosa* and 5 with mixed sample while sample 3 with *Eisenia fetida* and sample 4 with *Aporrectodea longa* were observed deep brown in color (Table 2). All samples were identified with odorless. Soft and crumbly vermicomposts were observed samples 1, 2 and 5 whereas dense and damp type compost was traced in other two samples.

Table 2. *Physical properties of the vermicompost*

Properties	Sample 1 *(L. castaneus)*	Sample 2 *(A. caliginosa)*	Sample 3 *(E. fetida)*	Sample 4 *(A. longa)*	Sample 5 (Mixed species)
Color	Blackish	Deep Brown	Blackish	Deep Brown	Blackish
Odor	Odorless	Odorless	Odorless	Odorless	Odorless
Texture	Soft	Dense	Soft	Dense	Soft
Substrate type	Crumbly	Damp	Crumbly	Damp	Crumbly

3.3. Chemical Properties of Vermicompost

In this study, few chemical compositions of the vermicomposts such as organic carbon, nitrogen, potassium and phosphorus were analyzed and calculate with percent (Table 3). The highest organic carbon concentration was found 15.52% in sample 3 followed (in lower level) by samples 1 (13.82 %), sample 5 (12.74 %), sample 4 (11.29 %) and sample 2 (9.89 %) respectively. The highest nitrogen level of harvested vemicompost was found in sample 1, 3, 4, 5 and 2 respectively whereas the highest phosphorus was observed in sample 3, 2, 4, 5 and 1 in that order. Furthermore, highest potassium was seen in sample 3, 1, 5, 4, and 2 consequently. Overall nutritional status of five vermicompost was observed and similar results were seen while little bit difference was found (Table 3). The highest nutritional conditions were found in sample 3 followed (in lower level) by samples 1, 5, 4 and 2 respectively (Table 3).

Table 3. *Chemical properties of Vermicompost*

Composition	Sample 1 (*L. castaneus*)	Sample 2 (*A. caliginosa*)	Sample 3 (*E. fetida*)	Sample 4 (*A. longa*)	Sample 5 (Mixed species)
Organic carbon (C)	13.82%	9.89%	15.52%	11.29%	12.74%
Nitrogen (N)	1.47%	0.82%	1.32%	1.09%	0.97%
Phosphorus (P)	0.12%	0.24%	0.28%	0.19%	0.16%
Potassium (K)	0.38%	0.24%	0.49%	0.31%	0.33%

Vermicompost is one of the special types of the compost which is produced by earthworm culture. In this present experiment, compost production through small scale vermiculture biotechnology was observed whereas production of vermicompost, physical and chemical properties of vermicompost was analyzed. In addition, earthworm’s mortality and new harvested earthworms were studied. In the case of the physical properties, color of the harvested vermicompost was found initially brown and after few days it became brownish black and then after few days it changed into blackish. This kind of changes suggests that the maturity of vermicompost is positively correlated with the black color. Initially there was odor from the cow dung which was used this vermicompost process but gradually the odor of the bedding material decreased and finally become odorless. It shows that the maturity of vermicompost is negatively correlated with the odor of the vermicompost [13],[7]. According to the result of the chemical properties of this vermicompost it was found that species 3 with *Eisinia fetida* productivity was comparatively more than the other earthworm species because *Eisinia fetida* showed comparatively more nutrient value than the other cultured earthworm species in both amounts and percentage. The sample 5 with mixed earthworm showed middle value among the obtained chemical properties of vermicompost whereas sample 2 with *Aporrectodea caliginosa* had less productive compared to the other earthworm species in both nutrient percent and amount. This finding was almost similar to findings of Garg et al and Walkowiak et al. [10],[13]. Sample 3 with *Eisenia fetida* showed maximum productivity and there was so many reasons behind it like as breaking down organic wastes because of its rapid growth rate, reproductive potential, temperature tolerance range and it’ s occurrence in organic wastes with a wide range of moisture content [3] and has been used for recycling a wide variety of wastes. This findings are similar to the research findings of other studies [9],[10],[11],[12],[15], [17]. Sample 5 with mixes of all earthworm species also showed near about good chemical and it proves that mixed culture of earthworms also can be used for the vermiculture process. The finding of this present research is also agreed with the research work of Suthar and Chattopadhyay [15],[18]. The findings of the organic carbon and nitrogen concentrations in this vermicompost support the research work of Karthikeyan et al. [19]. The observed phosphorus content is related to the findings of Sinha et al. [20]. The percentage of potassium in sample 3 with *Eisina fetida* was found maximum 0.49% and sample2 with *Aporrectodea caliginosa* was 0.24%which is attributed to the production of carbonic, nitric and sulphuric acids by microorganisms present in the gut of earthworms and this percentage agree with Kaviraj and Sharma [9]. The production of vermicompost and harvested the new earthworms of this experiment was near similalar. According to the various researches, the chemical property of the compost such as Nitrogen, Phosphorous and Potassium concentration are recorded 0.92%, 0.14% and 0.26% etc. But in this research Nitrogen, Phosphorous and Potassium percentage were found 1.47%, 0.38% and 0.49% respectively. Therefor, if we compare compost and vermicompost according to their nutrient quality then it can say that the vermicompost is better than normal compost, which is proved by REOPA [21].

4. CONCLUSIONS

High nutrient eco-friendly vermicomposts is beneficial for plant growth and crop yield. This small scale vermicompost research should be practiced by farmers themselves for the productivity of soil and reduce the chemical fertilizer use. This vermicopmost will also be given support to good ecosystem. Vermiculture is also helpful in the waste treatment by which we can keep our surroundings clean. There for this research is now an appropriate research for time demands to produce nonpoisonous agriculture products. During this experiment, some problems were faced to maintain logistic supports. Difficulties were also faced during compost chemical analysis due to most expensive. In future, it should be analyzed in semi intensive and large scale as well as lots of nutrient should be analyzed while in this research analyzed only four chemicals.

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