Research Paper

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Vermicomposting of poultry feather using *E. foetida* and indigenous earthworm: A comparative study

Biotechnology

KEYWORDS : Vermicomposting, Poultry feather, epigeic, Eisenia foetida, Indigenous earthworm

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ABSTRACT

The increasing size of poultry processing plant has intensified the problem of disposal of poultry waste mainly, the feathers. An alternative technology, vermicomposting has been used for the management of feather waste. The efficacy of the epigeic worm Eisenia foetida and Indigenous earthworm (Campus) in composting poultry feather with cow dung in ratio 3:1 was studied. The bedding contain pre-digested feather with cow dung in ratio 3:1 and maintained in triplicates. 20 adult worms of each earthworm species was introduced in respective tubs, and control without worms. Poultry feather was composted for about 60 days. Vermicompost, samples were subjected to physico-chemical analysis using standard methods and their results were reported as Mean ± SEM (p ≤ 0.05). The levels of Carbon, Nitrogen, Phosphorus, Potassium and C:N ratio showed significant increase in set up worked by Eisenia foetida than the Indigenous worm.

Introduction

The growth of industries and increasing human population has led to an increased accumulation of waste materials. Poultry feather is one of the waste produced in large amounts as a by product at poultry processing plants, reaching millions of tons annually (1). A single feather containing keratine require five to seven years for its degradation. Chicken feathers consist of approximately 91% protein (keratin), 1% lipids and 8% water. Most feather waste is land filled and also used for natural gas production and preparation of animal feed which involves expense and can cause contamination of air, soil and water (2). Incineration of feather is also difficult, which releases sulphur in large quantities. Vermicomposting is a simple biotechnological process of composting, to tackle the problem of safe disposal of waste as well as to release the most needed plant nutrients for sustainable productivity (3). Though the practice of vermiculture is atleast a century old however, it is being received worldwide with diverse ecological objectives such as waste management, soil detoxification, and regeneration, organic and sustainable agriculture (4). Earthworms are nature's best soil chemist and agriculturalists. Without earthworm, soil become dense, hard packed and in hospital for plant roots (5). The worms turn common soil into superior quality and facilitate the amount of air and water into the soil. They break down organic matter and eat, leaving behind castings that are an exceptionally valuable, type of fertilizer. Due to the biological, chemical and physical actions, earthworms have been employed in the bioremediation strategies to promote biodegradation of organic contaminants. Earthworms aerate and bioturbate soil and improve their nutritional status and fertility (6), the actions of earthworms reduce the decomposition period and improve the quality of the organic fertilizer. There were reports, that vermicomposting using *E.foetida* for decomposition of different types of organic wastes viz. domestic as well as industrial waste resulted in increase in the yield of value added material(7). In this study, decomposition of poultry feather mixed with cow dung in 3:1 ratio to assess the efficacy of *E.foetida* and indigenous earthworm in composting poultry feather, and to evaluate the vermicomposts thus obtained for the availability of C, N, P and K as plant nutrients.

Materials and Methods

Composting materials

The poultry feathers were collected from Adithya Poultry Farm, Sundarajanpatti, and Tamil Nadu. It was dried and shredded into small pieces. One week old cow dung was used in experiments, as fresh cow dung can be dangerous for earthworms due to decomposition process, as the heat generated can kill the worms.

Eisenia foetida, one of the best known species for its feeding behaviour was procured from Tamil Nadu Agriculture University, Madurai and Indigenous earthworm was collected from the college campus.

Design of experiment

The experiment was set up in plastic tubs, with holes at bottom to remove excess water, to maintain humidity and aeration tubs were covered with wet gunny bags. The collected poultry feather was mixed with cow dung, covered and left for pre-digestion for 20 days till all the feathers were partially decomposed.

The vermi-bed contained pre-digested feather with cow dung in 3:1 ratio, maintained in triplicates for both the experimental and control set up. 20 adult earthworms each of *E.foetida* and indigenous earthworms were introduced, into respective experimental tubs. The moisture content was maintained by sprinkling adequate amount of water, throughout the study period of 60 days.

Analytical Procedures:

PHYSICAL PARAMETERS: The pH was measured using pH meter (Elico L127). Electrical conductivity was determined according to method in reference (8). CHEMICAL PARAMETERS: Organic carbon, total nitrogen, available organic phosphorus and potassium were determined as described in the references (9 - 11). All the above parameters were analyzed in the compost and vermicompost on the 60^{th} day. The data obtained was represented as mean ± SEM (p≤0.05).

Results

After 60 days of experimental period both earthworm species converted the pre-digested poultry feather into vermicompost and the vermicompost was dried directly in sunlight to separate the earthworms from the compost. Vermicompost thus obtained was subjected to physico-chemical analysis for the pH and Electrical Conductance and for the plant nutrients like Carbon, Nitrogen, Phosphorus and Potassium (Table-1).

Discussion

Knowledge of vermiculture and vermicomposting is rapidly increasing as more researchers and entrepreneurs conduct studies regarding the ability of the earthworms to process organic waste in to usable soil amendments (12). Vermiculture is a mixed culture containing soil bacteria and earthworms which provides the use of natural bioreactor, the earthworm for cost effective and environmentally sound technology of waste management. The pre-digestion of poultry feather made the organic waste simpler for the earthworms to consume. The auto heating during pre-digestion also helps in digestion of waste, as the heat released during pre-digestion, enables the earthworms to breed successfully (13). Certain species of earthworms can ingest organic waste rapidly and fragment them into fine particles by passing them through gizzard converting portion of it into earthworm castings and also help maintain an aerobic condition in the vermicomposting process (14).

Physico-Chemical characterization of Vermicomposts:

Physical Parameters:

The quality of the soil was improved significantly in terms of physical, chemical and biological properties as the worms thoroughly up turn and disperse the soil, ingest large volumes of soil and excrete castings rich in nutritive materials (N, P, K and micronutrients) along with millions of beneficial soil microbes including Nitrogen fixers (15). The pH of the compost is important, as the application of compost to the soil can alter the soil pH, which in turn affects the availability of nutrients to the plants. Worms can survive in a pH of 5-9. Vermicompost worked by both worms tolerated a pH range of 6-7, and both species was comfortable to breed in the wastes. Earthworms by passing through the soil and organic matter gradually make acid soil less acidic and alkaline soil less alkaline (16). Electrical conductivity represents the amount of soluble metals ions present in the vermicompost, can be utilized by the plants. *E.foetida* used in vermicomposting of municipal solid waste was proved to be significant by increase in electrical conductivity (17). Similarly the Electrical conductivity was higher in the poultry feather vermicompost worked by *E.foetida* than the indigenous worm, proving that the vermicompost has enormous amount of soluble metal ions (Table-1).

Chemical Parameters
Vermicompost contained high concentrations of organic material, silt and clay and was also rich in many soil nutrients such as nitrogen, sulphur, potash, phosphorus, calcium, magnesium etc (18). The level of organic carbon in vermicompost worked by *E. foetida* contained 198.8 ± 1.89 g/Kg which was significantly higher when compared to that of indigenous earthworm 163 ± 7.48 ($p \le 0.05$).The total nitrogen content was observed to be high in vermicompost of *E. foetida* resulted in the loss of carbon which could be attributed to the mineralization of organic matters. Feather, being a keratinaceous substance, has been reported to have higher amounts of carbon (40-80%), nitrogen (2.5-4.2%), phosphorus (1-2%) (19). It was stated that earthworm population contributes nitrogen to soil through vermicasts, decomposition of dead worms and release of mucus (20). The organic nitrogen of ingested soil gets incorporated in the worm biomass during their feeding behaviour in soil layers. Thus the organic nitrogen of the ingested organic matter will be recycled and returned to the soil. Also the available phosphorus content in *E. foetida* worked vermicompost was significantly high (Table-1) and the magnitude of transformation of phosphorus from organic to inorganic state and into available form was found to be considerably higher in the case of earthworm inoculated organic wastes than in controls. Volume reduction of substrates during vermicomposting could be due to the increased microbial activity and by the acid phosphatase activity of cocoon and adult worms are causes for the increased phosphorus content (21). The microbial biomass rapidly store significant amount of easily soluble phosphorus and also prevents it from absorption or other fixation processes (22). The *E. foetida* worked vermicompost contained higher amount of Potassium than that obtained from indigenous earthworm. Due to the keratinaceous nature feather contains about 0.8-1.5% of potassium (19) so also the compost (23). Vermicasts have higher waste exchange capacity, total exchangeable potassium, manganese and calcium. This increase may be due to the breeding activity of earthworms and the added effect of the cattle manure that adds to the nutrient mineral content of the soil. The usual recommended range for C/N ratio at the start of the composting process is about 30/1, but this ideal ratio may vary depending on the bioavailability of carbon and nitrogen. As carbon gets converted to carbon-dioxide and during the composting process, the C/N ratio of final compost was typically close to 10/1. Lower the C/N ratio higher will be the nitrogen content, since poultry waste has high nitrogen content the C/N ratio was found to be lower. The C:N ratio decreased with time in both the control and worm worked composts depicting advanced degree of organic matter stabilization. Many factors affect the biological activity, although the C:N ratio seems to be the most important factor that controls the composting rate, since the microorganisms demand for the Carbon and Nitrogen as energy sources to grow and multiply was enormous. Higher the ratio more the time for decomposition, where as lower the ratio faster the mineralization and thus nutrients eventually become available, for the organism as large amount of nitrogen has been utilized (24).

The study revealed that *E. foetida* have high efficacy over Indigenous earthworm in composting the Leaf litter waste and the bio-chemical analysis of the vermicomposts revealed the presence various components in appropriate amount that reflect the quality of the organic manure. The use of indigenous earthworms from the campus to compost leaf litters efficiently in order to get a value added product is a new initiative to make the campus a litter free zone.

Table:1 Physico-Chemical Characterization of Poultry Feather Vermicompost

Parameters	Control	E. foetida	Indigenous worm
pH	6.4	7.2	7.1
EC †(mS)	5.97 ± 6.97	10.6 ± 8.26	6.73 ± 4.73
Organic C ($g\ Kg^{-1}$)	276.9 ± 19.87	198.8 ± 1.89	163 ± 7.48
Total N ($g\ Kg^{-1}$)	0.95 ± 0.06	0.96 ± 0.07	0.93 ± 0.1
Available P ($g\ Kg^{-1}$)	16.5 ± 1.63	17.6 ± 1.03	15.5 ± 0.81
Potassium ($g\ Kg^{-1}$)	83.3 ± 5.16	86.7 ± 6.23	80 ± 4.99
C:N Ratio	291.47	207.08	175.27

Average of triplicate represented as Mean ± SEM ($p \le 0.05$), † Electrical Conductivity.

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