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Effect of vermicompost on soil fertility and the nutritional status of *Andrographis paniculata* and *Euphorbia hirta*

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Abstract
The consumption of organic wastes by earthworms is an ecologically safe method to naturally convert many organic wastes into environmentally beneficial products. Worm farming and the benefits of vermicompost has been well documented and has attracted a lot of interest in recent years. In this context, the present study attempts to evaluate the effect of vermicompost on soil fertility and the nutritional status of the two selected medicinal plants, namely *Andrographis paniculata* and *Euphorbia hirta*.

Keywords: *Eudrilus eugeniae*, *Andrographis paniculata*, *Euphorbia hirta* and Poultry farm solid waste (PFSW)

Introduction
Chemical fertilizers which ushered the 'green revolution' in the 1950-60's came as a 'mixed blessing' for mankind. It boosted food productivity, but at the cost of environment & society. It dramatically increased the 'quantity' of the food produced but decreased its 'nutritional quality' and also the 'soil fertility' over the years. In addition, it killed the beneficial soil organisms which help in renewing natural fertility. It also impaired the power of 'biological resistance' in crops making them more susceptible to pests and diseases. Therefore, to overcome the above said adverse effects of chemical fertilizers, interest was stimulated towards the production and use of organic manures [1]
Organic waste used as fertilizers is a valuable resource because it provides large amounts of macro and micronutrients for crop growth at a cheaper rate. Furthermore, it is also environmentally safe. Processing of this waste material through controlled bio-oxidation processes, such as composting, reduces the environmental pollution by transforming these materials into a safer and more stable product suitable for application to soil [2]. Composting is the purposeful biodegradation of organic matter, using micro-organism and or earth worms producing good quality fertilizers rich in nutrients. The earth worms in the soil converts the organic wastes to rich compost called worm casting, vermicast, or vermicompost, a nutritive soil amendment rich in microbial flora [3]. Reported increased amounts of organic carbon, microbial population, dehydrogenase activity, improved pH, conductivity, soil porosities, water-holding capacities and decreased bulk density in soil amended with vermicompost.

2. Materials and Methods
2.1 Earthworm used for Vermicompost
Vermicompost was prepared by using earthworm species *Eudrilus eugeniae,* collected from Vermigold unit, Udumalpet Thaluk, Coimbatore.

2.2 Preparation of Vermicompost [4]
Two earthen pots were converted as vermicompost pits for preparing the compost. First a basal layer of vermibed composting broken bricks (3cm) followed by a layer of coarse sand to a total thickness of 6cm was laid to ensure proper drainage. This was followed by a 15cm moist layer of loamy soil. Small lumps of poultry farm solid waste (PFSW) including birds excreta and feathers were scattered over the soil in the vermicompost pit. About 30 earthworms (*Eudrilus eugeniae*) were inoculated into the soil. The setup was kept covered with coconut leaves. Periodically sprinkling of water was continued for 30 days to keep the soil moist. After 30 days dark brown vermicompost was collected and used for the present investigation.

2.3 Medicinal plant
In the present investigation the medicinal plants *Andrographis paniculata* and *Euphorbia hirta* grown in vermicompost was used to analyze its nutritional status.

2.4 Experimental setup
Garden soil was collected and manured with vermicompost obtained after complete composting of PFSW. Four earthen ports were filled with 4 kg of clean (free stone, pebbles, twigs and other organic waste) soil and 500 g of sand and mixed to ensure adequate pore space. Five hundred g of half an inch sized brick pieces were spread at the bottom of each pot to ensure easy drainage of excess amount of water. Pots were separated based on the soil amendment with PFSW vermicompost (250 g) and soil without any amendment was maintained as control. The saplings of *Andrographis paniculata* and *Euphorbia hirta* were planted separately in the four pots.

2.5 Physical parameters of the soil
Soil samples amended with vermicompost were taken from each pot after 30 days of incubation for physical analysis. Samples A and B were soil with vermicompost and samples C and D were control without vermicompost. Soil analysis was done according to [5]

2.6 Phytochemical analysis of *Andrographis paniculata* and *Euphorbia hirta*
Preparation of extract
The leaves of plants *Andrographis paniculata* and *Euphorbia hirta* were shade dried for 21 days. The aqueous extracts of the dry leaves was prepared by mixing 5g of the plant material with 100 ml of distilled water. The solution was allowed to boil in a microwave oven for 2 minutes and then filtered using Whatman No.1 filter paper and the analysis was carried out immediately without storage. The presence of the phytochemicals Flavonoids, Saponins, Steroids and Tannins was tested following the Procedure of Evans [6]

3. Results
In the present study it was observed that the poultry farm soild waste (PFSW) vermicompost improved the soil fertility and the nutritional status of *Andrographis paniculata* and *Euphorbia hirta.*

3.1 Physical parameters of the soil
3.1.1. pH
The pH of the soil in control and with worm casts of *E. eugeniae* were measured. The control showed a pH value of 7.43 and the vemicompost amendmed soil recorded a pH value of 6.65 (Table 1 and Fig.1).

3.1.2 Electrical Conductivity
In control it was found that the electrical conductivity was only 0.210 mS/cm; whereas, it was 2.45 mS /cm in the soil amended with vermicompost (Table 1 and Fig.1).

3.1.3 Moisture
A significant increase in the moisture content was observed with soil amendment with PFSW vermicomport, the percentage of moisture recorded being 18.32 whereas, it was only 1.50% with soil and without vermicompost (Table 1 and Fig.1).

3.2 Chemical parameters of the soil
3.2.1. Nitrogen content
The Nitrogen content of vermicompost amended soil was higher (0.70%) than the soil without compost (0.14%) (Table 2 and Fig. 2).

3.2.2 Phosphorous content
The total Phosphorous content in the soil without vermicompost was 0.11% and with soil amended with PFSW vermicompost it was 0.50% (Table 2 and Fig. 2).

3.2.3 Potassium content
Similar to nitrogen and phosphorus content, an increase of potassium in the soil amended with vermicompost (0.21%) was observed over that of soil without vermicompost (0.06%) (Table 2 and Fig. 2).

3.2.4 Carbon content
A tremendous increase in the carbon content was observed in the soil amended with PFSW vermicompost. It recorded a value of 21.1%, whereas it was 4.1% in the soil without vermicompost (Table 2 and Fig. 2).

3.3 Phytochemical analysis
3.2.1 Phytochemical analysis of *Andrographis paniculata*
The phytochemical analysis of *A. paniculata* grown in soil amended with Poultry farm soild waste showed an increase in Flavonoids, and a decrease in steroids over that of plants grown in control. However, there was no change observed in the saponin content between the two experimental groups (Table 3)

3.2.2 Phytochemical analysis of *Euphorbia hirta*
The phytochemical analysis of *Euphorbia hirta* grown in soil amended with Poultry farm soild waste showed an increase in Flavonoids, Saponin and Tannin over that of plants grown in control. The present results also indicate absences of steroids in plant grown in vermicompost amended soil (Table 4).

4. Discussion
The use of organic matter such as animal waste, human waste, food waste, yard wastes and sewage sledges has long been recognized in agriculture as beneficial for plant growth and yeild. Litter and manure component of this waste has a high nutritional value and can be used as organic fertilizers when processed through controlled bio-oxidation,thus recycling essential nutrients such as nitrogen, phosphorous and potassium. Composting has been long recognized as a cost effective and environmentally safe processes for bio-degrading this organic waste [7]. A process related to composting, which improves the beneficial utilization of organic waste is vermicomposting. Vermicomposting is a term given to the process of conversion of organic matter by earthworm into vermicompost. Cast formation by earth worms may be directly facilitated by mixing of organic matter with soil, grainding of organic matter in the intestine during digestion and the effect of bio-activity of the microflora in the gut of the earth worms.
The effect of nutrient transformation during the biological activity of earth worms in soil and in vermicomposts have been well documented by various research studies [8]. Several authors have reported that ornamental and horticultural plants grown in vermicompost amended soil yielded more when compared to those grown in soil without organic amendment [9-13]. Henceforth, vermicompost waste providing to be a

highly nutritive organic fertilizer and more powerful growth promoter over the conventional chemical fertilizer [14, 15].

Vermicomposting converts the nutrients contained in the organic matter to more bio available forms such as nitrate or ammonium nitrate, exchangeable phosphorus and soluable potassium,calcium and magnesium [16]. Vermicast is also belived to contain hormones and enzymes which it acquires during the passage of organic matter through the earthworm gut. These hormones and enzymes play a vital role in stimulating plant growth and disease resistance [17]. Furthermore, when used as an soil amendment, it helps in maintaining high microbial population and activities, that favour plant growth.

For healthy growth and optimal yield nutrients must be available to plants in correct quanity, proportion and in a usable form at the right time. The casts of earthworm is considered as one of the most useful and active agent in introducing this suitable physical, chemical and biological environment in the soil, thereby directly increasing soil fertility and crop production [18]. Waste from poultry industry includes a mixture of bird excreta, dead birds, broken eggs and feathers, waste feed and bedding materials a highly nutritive input that can be reused through vermicomposting. Hence in the present investigation the above said waste was composted using the earthworm species *Eudrilus eugenia.* And its effect on the soil's physical and chemical property was observed. In addition the nutritional quality of the plants *Andrographis paniculata* and *Euphorbia hirta* grown in soil amended with Poultry Farm Solid Waste (PFSW) vermicompost was assessed by the phytochemical analysis. The results of the present study suggest that the PFSW vermicast was useful in improving the physical and chemical properties of the soil.

The physical property in terms of pH, electrical conductivity and moisture was different in soil with vermicast. The pH, electrical conductivity and moisture content were 6.65,2.45 mS/cm and 18.32% respectively in soil amended with vermicompost; whereas, in control the pH was 7.43,electrical conductivity 0.210mS/cm amd moisture 1.50%. Similar observation on the physical properties of soil amended with different vermicompost were recorded by [19-21]

The positive effect of PFSW vermicompost on the chemical property of the soil is quite evident with an increase in total nitrogen, phosphorous, potassium and carbon content that was observed. In the control soil the nitrogen, phosphorus, potassium and carbon content were 0.14, 0.11, 0.06 and 4.19% respectively, whereas it was 0.70, 0.50, 0.20 and 21.16% respectively in the soil with vermicompost amendment. Release of mineral elements from soil mineralization has been found to be a major gut activity in the earth worms during their process of digestion. Therefore, a significant proportion of the ingested material assimilated by earth worms is secreted as intestinal cutaneous mucous with a greater C/N ratio than original resources [22]. As a result part of the nitrogen and carbon assimilated may be in excess and have to be excreated. This accounts for the increased nitrogen and carbon content observed in the vermicast of PFSW. Another reason for the increased nitrogen excretion is the rapid turnover of nitrogen in earthworm biomass. Increased content of phosphorous and potassium observed in the present study could possibily be due to the above said reason.

Earthworm activity resulting from their feeding and metabolism in soil releases micro and macro nutrients through cast production that enriches the soil. The changes in the pH observed between the compost amended soil and the control could be due to the changes brought about by the earthworm cast rich in mineral elements. The microbial activity of the earthworm gut ensures that considerable amount of water and intestinal mucus is added to the worm casts. This property of the vermicast is known to increase the physical structure of soil by improved water holding capacity.

Plant synthesized a vast range of organic compounds that are classified as primary and secondary metabolites. They serve a variety of ecological and physiological functions in plants [23, 24]. Based on their origin secondary metabolites are grouped as flavonoids, terpenoids and alkaloids. Flavonoids are polyphenolic compounds with diverse processes such as UV protection, pigmentation, stimulation of nitrogen-fixing noudles and disease resistance. In the present investigation on *Andrographis paniculata* and *Euphorbia hirta*, it was observed that the application of vermicompost increased the flavonoid content along with saponin and tannins. This increase in secondary metabolites might correspond to the increased availability of micro and macro nutrients of soil amended with vermicompost. According to the C/N hypothesis when organic carbon is readily available there is increased production of carbon containing compounds such as starch, cellulose and secondary metabolites including flavonoids and terpenoids [25]. Similar observations on increased flavonoid content in various plants grown in organic fertilizer has been reported by [26-28]. It was also observed that the steroid in plants grown in soil with vermicompost was absent when compared to the control, which proves to be a beneficial property conferred by the vermicompost on the nutritional status of the plant.

The overall findings of the study indicates not only an increase in plant nutrients due to earthworm activity, but also an improvement in physical and chemical nature of soil that results in stimulated plant growth therefore it could be concluded that Poultry Farm Solid Waste vermicompost could be used as an organic fertilizer to improve yield and quality. Nevertheless the impact of this fertilizer on field application is wanting and therefore requires further research.

Table 1: Effect of PFSW vemicompost on the physical parameter of the soil

Parameters	Ph	Electrical conductivity Ms/cm	Moisture %
Control	7.43	0.210	1.50
PFSW Vermicompost	6.65	2.45	18.32

Table 2: Effect of PFSW vemicompost on the chemical parameter of the soil

Parameters	Nitrogen %	Phosphorous %	Potassium %	Carbon %
Control	0.14	0.11	0.06	4.19
PFSW Vermicompost	0.70	0.50	0.20	21.16

Table 3: Phytochemical analysis of the plant *Andrographis paniculata*

Test	Control	Treated
Flavonoids	+	++
Saponins	+	+
Steroids	++	+
Tannins	+	++

+++ = High Intensity, ++ = Low Intensity, + = Lowest Intensity, -- = Absent

Table 4: Phytochemical analysis of the plant *Euphorbia hirta*

Test	Control	Treated
Flavonoids	++	+++
Saponins	+	++
Steroids	+	
Tannins	++	+++

+++ = High Intensity, ++ = Low Intensity, + = Lowest Intensity, -- = Absent

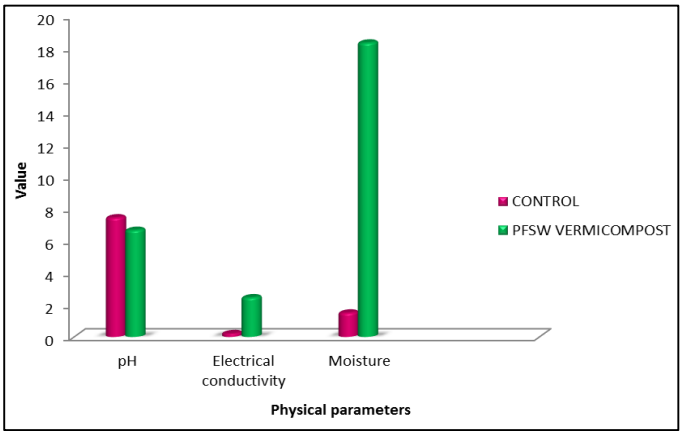

Fig 1: Physical parameters of the soil treated with Vermicompost

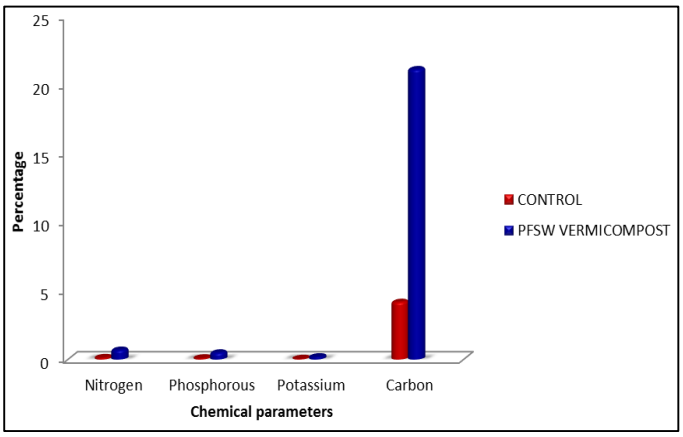

Fig 2: Chemical parameters of the soil treated with Vermicompost.

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