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Potential Of Vermicompost Produced From Banana Waste (Musa paradisiaca) On The Growth Parameters Of Solanum lycopersicum.

R.S.Achsah[1] And M.Lakshmi Prabha[2]*

Department Of Biotechnology, Karunya University,Coimbatore-641114, Tamil Nadu,India.

***Corres. Author: lakshmi.prabha48@gmail.com**
Mobile no: +91 9442424136

Abstract: Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, flower and fruit crops. The utilization of organic residuals reduces production costs and eliminates the need for landfill disposal and incineration. Vermicomposting is an appropriate alternative for the safe, hygienic and cost effective disposal of urban waste. The present study has been carried out to find the potency of vermicompost using *Musa paradisiaca* (banana peel) waste and *Eudrilus eugeniae* earthworm as it effectively decomposes the waste. To analyse the efficiency of vermicompost the physicochemical parameters like pH and the level of macro and micronutrient content namely nitrogen, phosphorous, potassium, iron and copper in the vermicompost has been studied. The enzymes (amylase,cellulase and invertase) and total macronutrients (N, P and K) and micronutrients (Fe and Cu) showed elevated levels in vermicompost than control (raw waste). The efficacy of vermicompost has also been checked and studied on the vegetable plant *Solanum lycopersicum* (tomato). The growth parameters namely root length, shoot length and number of leaves has been studied. Finally, it has been compared with the plants grown using chemical fertilizer (NPK). Hence based on the studies performed it was concluded that vermicompost obtained from the degradation of *Musa paradisiaca* (banana peel) waste by *Eudrilus eugeniae* is an effective biofertilizer which would facilitate the uptake of the nutrients by the plants resulting in higher growth and yield.
Keywords: Biofertilizer, chemical fertilizer, *Eudrilus eugeniae, Musa paradisiaca, Solanum lycopersicum,* vermicompost.

INTRODUCTION

Modern society is unable to manage the enormous amount of household, industrial and agricultural waste that it creates. A large fraction of this waste is organic in nature, especially pertaining to agricultural and household waste. India produces 3,000 million tons of organic waste every year. In fact this waste has value and should be used as feedstock for making useful items, such as energy, fertilizer or recycled raw material[1].

Instead of making use of this “waste” it is frequently disposed of by means of landfill, incineration or land application. Each of these methods is an imperfect solution. Landfilling requires vast amounts of land that could better serve as agricultural, residential or recreational space. Landfill leachate often contains toxic compounds that can leach into ground water, contaminating drinking or irrigation water. Incineration does not require as much land and may generate power, but if done improperly it can create air pollutants, most notably green house

gases. Incineration also produces a small amount of ash that must be landfilled. Applying organic waste to the land means that the waste has not been stabilized and could contain pathogens [2]. Society needs a better way of turning waste into a usable form.

Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. Vermicomposting differs from composting in several ways[3]. Vermicomposting can be carried out cheaply and mesophilically, leaving no waste and creating a product that will increase the yield of organic farmers. Thus, vermicomposting simultaneously solves two burdensome problems of modern society. Vermicomposting also saves land and waste transportation costs of Landfilling and incineration. It helps to avoid unsightly and hygienic conditions that indiscriminate littering creates. Their small cylindrical bodies behave as bioreactors that aerate soil and breakdown organic waste into nutritious fertilizer. This fertilizer contains various types of plants-beneficial substances, such as growth hormones, macro and micronutrients, usable nitrogen, and helpful microorganisms [4].

Banana is the second largest produced fruit after citrus, contributing about 16% of the world's total fruit production. India is the largest producer of banana, contributing to 27% of world's banana production. Banana is highly nutritious and easily digestible than many other fruits rich in potassium and calcium and low in sodiumcontent. Whole banana plant is useful in food, feed, pharmaceutical, packaging, and many other industrial applications .Peel is rich source of vitamins, starch , crude protein , crude fat , total dietary fibre, and polyunsaturated fatty acids, particularly linoleic acid and a-linolenic acid, pectin, essential amino acids (leucine, valine, phenylalanine and threonine), and micronutrients (K, P, Ca, Mg) [5].

MATERIALS AND METHODS

Vermicomposting is an eco-biotechnological process that transforms energy rich waste and complex organic substances into stabilized humus like product called vermicompost. Hence vermicomposting has become an appropriate alternative for safe, hygienic and cost effective disposal of wastes [6]. Vermitechnology therefore saves the environment by processing the banana wastes into high value organic manure.

In the present study, the banana waste was collected from Karunya University Ladies Hostel,Coimbatore,India and composted by using *Eudrilus eugeniae*. The vermicompost was collected and used for analyzing enzymes, physicochemical parameters, level of macro and micronutrients, biochemical parameters and its effect on growth parameters of *Solanum lycopersicum* was studied.

COLLECTION OF WASTE: The banana peels (*Musa paradisica*) waste was collected from Karunya University Ladies Hostel, Coimbatore. The collected wastes were allowed to partial decomposition for 20 days. Then the waste was mixed with cow dung in a ratio of 3:1.

COLLECTION OF EARTHWORM

Selection of earthworm species for vermicomposting process

For composting we selected the African species of earthworms i.e. *Eudrilus eugeniae* which are efficient to maintain vermicomposting process in India. *Eudrilus eugeniae* is found to be a very efficient species for culture maintenance in India. The exotic earthworms *Eudrilus eugeniae* were collected from Selvam Organics, Udumalpet, Coimbatore.

ESTIMATION OF PHYSICOCHEMICAL PARAMETERS : pH

5g of finely powdered vermicompost was taken in a volumetric beaker and 50ml of distilled water was added and the pH was measured by pH meter[7].

ENZYMES INVOLVED IN THE DEGRADATION OF COMPLEX ORGANIC MATERIAL INTO SIMPLE COMPOUNDS

Amylase, cellulaes and invertase, are the enzymes involved in the degradation of complex organic material into simple compounds

Amylase: Procedure

1.0ml of starch solution and 1.0ml diluted enzyme was added together in a test tube and incubated it at 27°C for 15 minutes. The reaction was stopped by the addition of 2.0ml of dinitrosalicyclic acid reagent. The solution was heated in a boiling water bath for 5 minutes. While the tubes are warm, 1.0ml potassium sodium tartrate solution was added and then cooled in running tap water and made up the volume to 10ml by addition of 6.0ml water. Prepare a standard graph with 0-100μg maltose .Read the absorbance at 560nm and terminated the reaction at zero time in the control tubes.The amylase activity was calculated using the standard graph. Activity was expressed as mg of maltose produced during 5 minutes incubation with 1% starch.

Cellulase: Procedure

0.45ml of 1% carboxy methyl cellulose (CMC) solution was added at a temperature of 55°C and 0.05ml of enzyme extract was taken and incubated the mixture at 55°C for 15 minutes. Immediately after removing the enzyme substrate mixture from the bath 0.5ml dinitrosalicyclic acid reagent was added and the mixture was heated in boiling water bath for 5 minutes. While the tubes are warm, 1.0ml of sodium potassium tartrate solution was added and then cooled to room temperature. Water was added to make 5.0ml of volume and measured the absorbance at 540nm. A standard graph was plotted with glucose in the concentration range 100μg to 500 μg/ml. Enzyme activity was expressed as the mg glucose released per minute per mg protein.

Invertase : Procedure

Pippetted out 1ml of vermicompost and 1ml of 0.3M sucrose solution in a test tube and incubated it at 37^0C for 15 minutes. The reaction was stopped by the addition of 2.0ml of dinitrosalicyclic acid reagent. The solution was heated in a boiling water bath for 5 minutes. While the tubes are warm, 1.0ml potassium sodium tartarate solution was added and then cooled in running tap water. Read the absorbance at 560nm and terminated the reaction at zero time in the control tubes. Prepare a standard graph with 0-100μg glucose. The invertase activity was calculated using the standard graph. Activity was expressed as mg of glucose produced during incubation with 0.3M sucrose.

NUTRIENT CONTENT

Macronutrients and Micronutrients

Many researchers highlighted the role of earthworms in breakdown of organic wastes. Earthworms can consume almost all kinds of organic wastes and convert it into vermicompost. Vermicompost have higher content of macro and micro nutrients like nitrogen, phosphorus, potassium, calcium, sodium, magnesium and micronutrients namely iron, copper, zinc and manganese respectively [8].

ESTIMATION OF TOTAL NITROGEN

The nitrogen in organic material is converted to ammonium sulphate by H_2SO_4 during digestion. This salt, on steam-distillation, liberates ammonia which is collected in boric acid solution and titrated against standard acid [9].

ESTIMATION OF TOTAL PHOSPHORUS

Inorganic phosphate reacts with ammonium molybdate in an acid solution to form phosphomolybdic acid. Addition of a reducing agent reduces the molybdenum in the phosphomolybdate to give a blue colour, but does not affect the uncombined molybdic acid. The blue colour produced is proportional to the amount of phosphorus present in the samples[7].

ESTIMATION OF TOTAL POTASSIUM

In flame photometry, the solution under test is passed under carefully controlled conditions as a very fine spray in the air supply to a burner. In the flame, the solution evaporates and the salt dissociates to given neutral atoms. A very small proportion of this move into a higher energy state. When these excited atoms fall back to the ground state, the light emitted is of characteristic wavelength which is measured [7].

ESTIMATION OF IRON AND COPPER

The technique involves determination of concentration of a substance by the measurement of absorption of the characteristic radiation by the atomic vapour of an element. When radiation characteristic to a particular element passes through the atomic vapour of the same element, absorption of radiation occurs in proportion to the concentration of the atoms in the light path[10].

DETERMINATION OF TOTAL CARBOHYDRATE BY ANTHRONE METHOD

Carbohydrates are first hydrolysed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This compound forms with anthrone a green coloured product with an absorption maximum at 630 nm[11].

ESTIMATION OF PROTEIN

The blue colour developed by the reduction of the phosphomolybdic-phosphotungstic components in the Folin-Ciocalteau reagent by the aminoacids tyrosine and tryptophan present in the protein plus the colour developed by biuret reaction of the protein with the alkaline cupric tartrate are measured in the Lowry's method[12] .

STUDY ON THE EFFECT OF VERMICOMPOST ON THE GROWTH OF *Solanum lycopersicum* (Tomato)

The seeds of *Solanum lycopersicum* were grow in two different pots T_1, T_2, T_3

T_1 – Control (without vermicompost).
T_2 – Chemical Fertilizer NPK
T_3 – Vermicompost
The following parameters were observed on 30thday of planting.

1.Root length,2.Shoot length and 3.Leaf count.

After treatment, stem cuttings were carefully removed from the soil without any damage and washed in running water to remove the adhering soil particles. The length of the root, shoot and leaf counts were done.

1. **Root length :** The length of the root was measured from collar region to the growing tip of the root and expressed in cm.

2. **Shoot length :**The length of the shoot was measured from collar region upto tip of the shoot and expressed in cm

3. **Number of leaves/needles :**The total number of leaves per needles in each plant was counted and expressed as number of leaves per plant.

RESULTS AND DISCUSSION

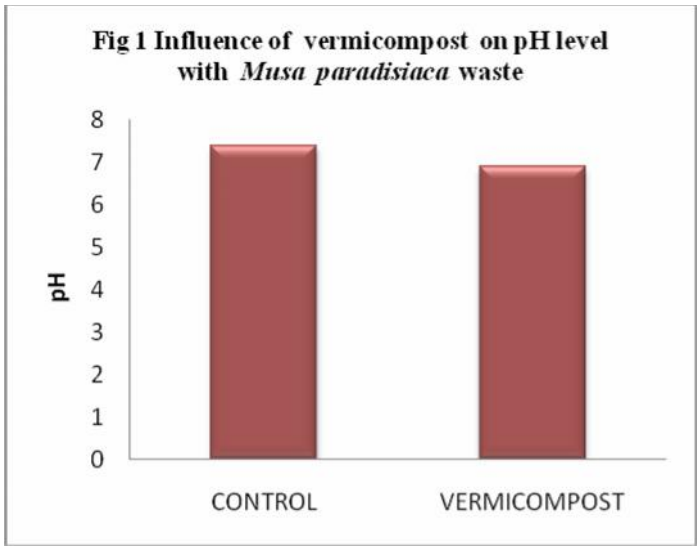
The earthworm *Eudrilus eugeniae* were collected from Selvam Organics, Udumalpet, Coimbatore, India. *Musa paradisiaca* (peels) were collected from Karunya Ladies Hostel Campus, Coimbatore,Tamil Nadu, India. The earthworm was studied to find the degrading potential of *Musa paradisiaca*. Hence the following study like physicochemical parameters, enzymes, macro and micro nutrients in vermicompost were analysed in order to find the quality of vermicompost after 45 days of vermicomposting process.The control taken for analysis is the raw waste. The effect of vermicompost on growth parameters of selected vegetable plant namely *Solanum lycopersicum* was studied. The results of the present study are discussed under the following headings.

ASSAY OF PHYSICOCHEMICAL PARAMETERS IN VERMICOMPOST

Analysis of various physicochemical parameters play a key role in determining the quality of vermicompost obtained from *Musa paradisiaca* decomposed by *Eudrilus eugeniae.*

pH

The level of pH during decomposition of waste composted *by Eudrilus eugeniae* is depicted in Figure 1. The level of pH was decreased from 7.0 to 6.9 in vermicompost when compared to control. Decrease of pH in vermicompost might be due to participation of microbes in the decomposition during vermicomposting. Production of CO_2, and organic acids by microbial decomposition during vermicomposting was the underlying factor for the pH decrement[13]. However the present results showed that earthworms are sensitive to changes in pH and prefer conditions of neutral reaction[14].



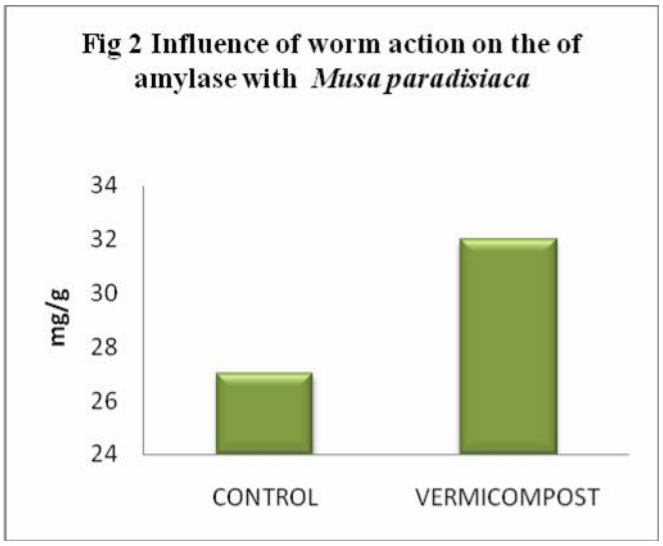
ENZYMES PRESENT IN VERMICOMPOST

Enzymes involved in the degradation of complex organic materials into simple compounds

Earthworms have shown higher activities of vital enzymes which are necessary to degrade complex biomolecules into simple compounds utilizable by symbiotic gut micro flora. It is therefore easy to speculate that vermicompost are rich in enzymes, which accelerated the mineralization rate and converted the wastes into organic fertilizer with higher nutritional value. Hence amylase, cellulase and invertase were assayed in vermicompost obtained with *Musa paradisiaca* waste by *Eudrilus eugeniae*.

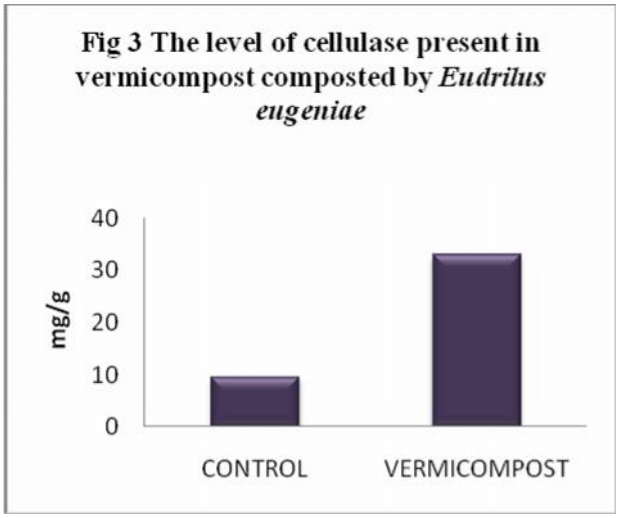
Amylase

The activity of amylase present in vermicompost after the inoculation of selected earthworm is depicted in Figure 2. The results revealed that a significantly higher amylase activity was noticed in vermicompost when compared to control ($P<0.05$). The reason for increase of activity of amylase in vermicompost is due to the presence of rich starch in the organic substrate (*Musa paradisiaca*), abundance of amylase producing bacteria namely *Bacillus spp, Pseudomonous* which exhibit higher amylase activity.



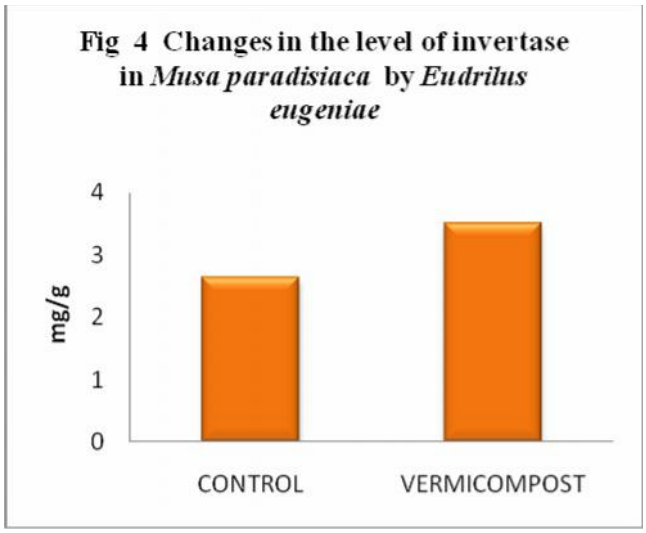
Cellulase

The activity of cellulase present in vermicompost after the earthworm inoculation is depicted in Figure 3. In the present study, the cellulase activity was increased in vermicompost when compared to control. The enzyme cellulase acts upon the substrate carbohydrate which is metabolized by the reproductively active worms. The worms require more energy and since increased enzyme activity was noticed during the active phase of reproduction. The cellulase activity was increased during the metabolism of carbohydrates[15].



Invertase

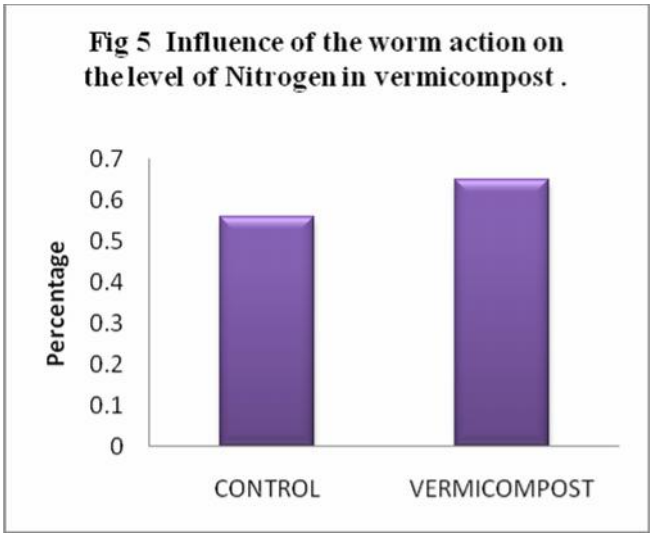
The activity of invertase present in *Musa paradisiaca* waste after earthworm inoculation are exhibited in Figure 4. The activity of invertase present in *Musa paradisiaca* waste composted by *Eudrilus eugeniae* is found to be increased significantly (P>0.0001, significant).It is increased directly by worms own enzyme and indirectly by stimulation of the microflora. The earthworms predate microbes for source of their food. During their passage through the gut, the gut microflora gets enhanced in population which may be responsible for the increased enzyme activities[16].



MACRONUTRIENTS AND MICRONUTRIENTS PRESENT IN VERMICOMPOST

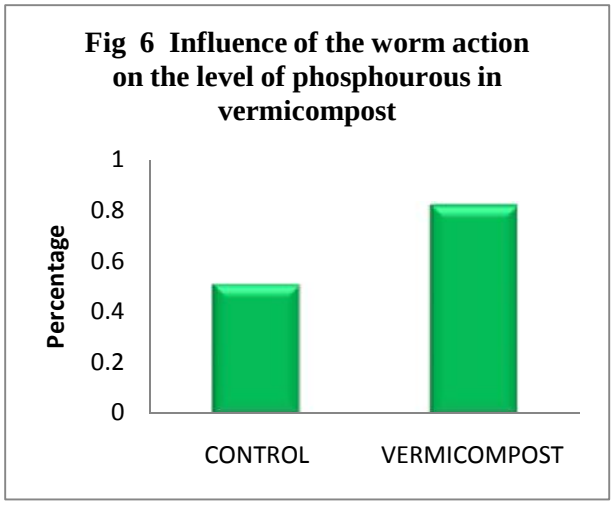
Macronutrients: Nitrogen

The nitrogen content present in *Musa paradisiaca* waste composted by *Eudrilus eugeniae* is represented in Figure 5. Increase in nitrogen content in the vermicompost is due to the fact that earthworms enhanced the nitrogen cycle which attributed to the increased levels of nitrogen in vermicompost. The losses of organic carbon might be responsible for nitrogen addition in the form of mucus, nitrogenous excretory substances, growth stimulatory hormones and enzymes from the gut of earthworms[17] .



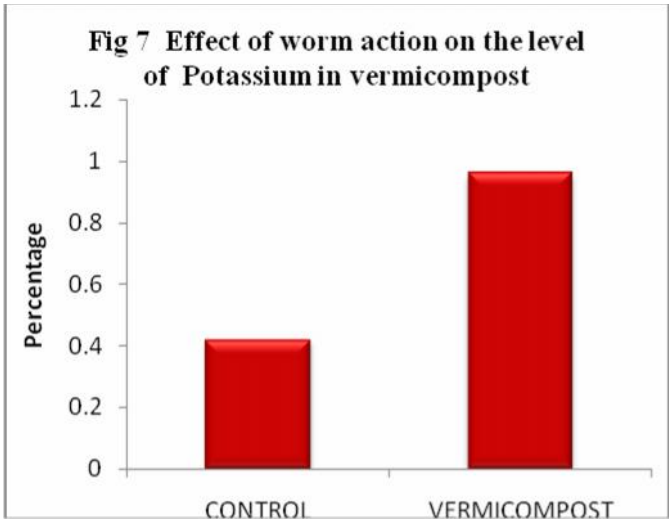
Phosphorous

Figure 6 illustrates the phosphorous content present in vermicompost. Phosphorous content present in vermicompost is high compared to control. The enhanced phosphorous level in vermicompost is due to mineralization of phosphorous during vermicomposting. The release of phosphorous in the available form is performed partly by earthworm gut phosphatases and further release of phosphorous might be attributed to the phosphorous-solubilizing microorganisms present in vermicompost.



Potassium

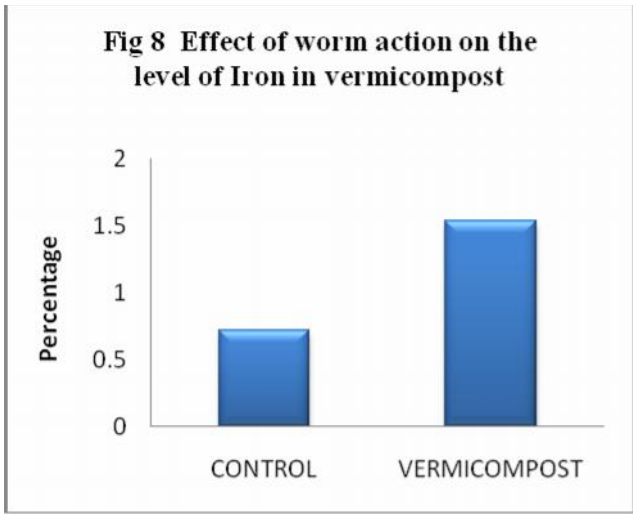
Figure 7 depict the potassium content present in vermicompost. The total potassium present in vermicompost higher than in control. The increase of potassium content in vermicompost might be due to changes in the distribution of potassium between non exchangeable and exchangeable forms. The earthworm processed waste material contains high concentration of exchangeable potassium, due to enhanced microbial activity during the vermicomposting process, which consequently enhanced the rate of mineralization[18].



Micronutrients

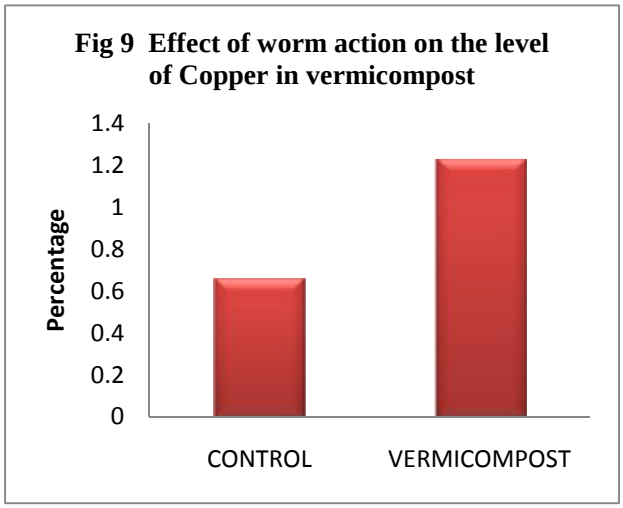
Iron

The Iron content of vermicompost are shown in Table 8 and Figure 8**.** Iron content in vermicompost was increased when compared to control. The presence of enzymes and co-factors in the earthworm gut increased the iron content in the vermicompost[8].



Copper

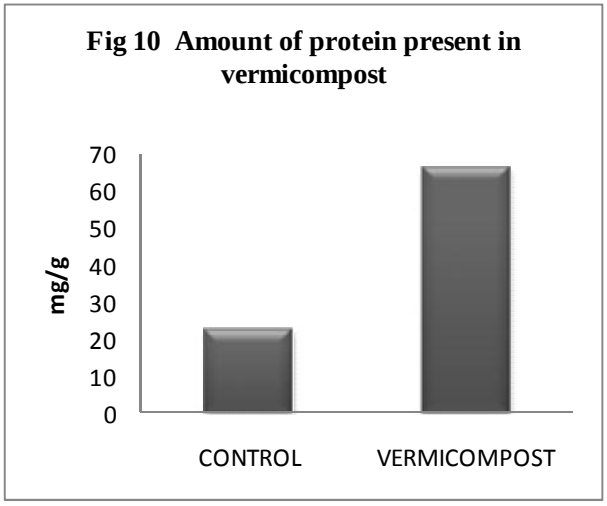
The copper content of vermicompost is depicted in Figure 9. Higher a content of copper was seen in vermicompost when compared to control. Increase of copper content in vermicompost might be due to the increased content of several Cu containing oxidizing enzymes. The copper was found to be increased in worm casts[19].



BIOCHEMICAL STUDIES IN VERMICOMPOST

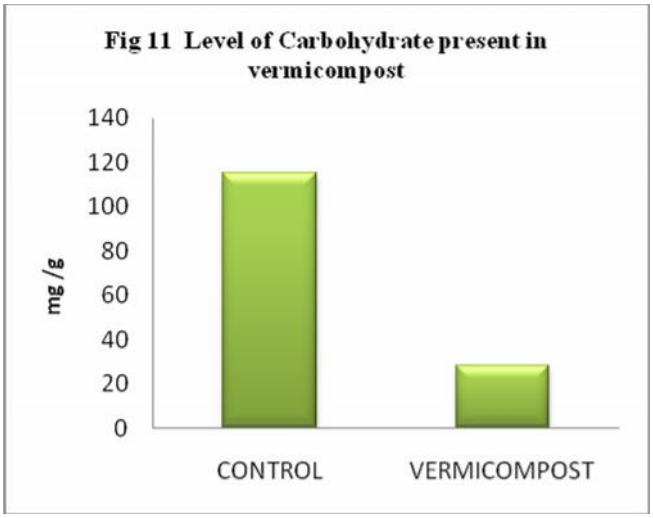
PROTEIN

The reason for increase in protein content in vermicompost might be due to the presence of proteolytic enzymes that are secreted by the gut of earthworms. Protein and carbohydrate in vermicompost[20].



CARBOHYDRATE

In contrast to protein content the carbohydrate content was found to be lower in vermicompost when compared to control. The reason for decrease of carbohydrate content in vermicompost is due to decline in substrate content.

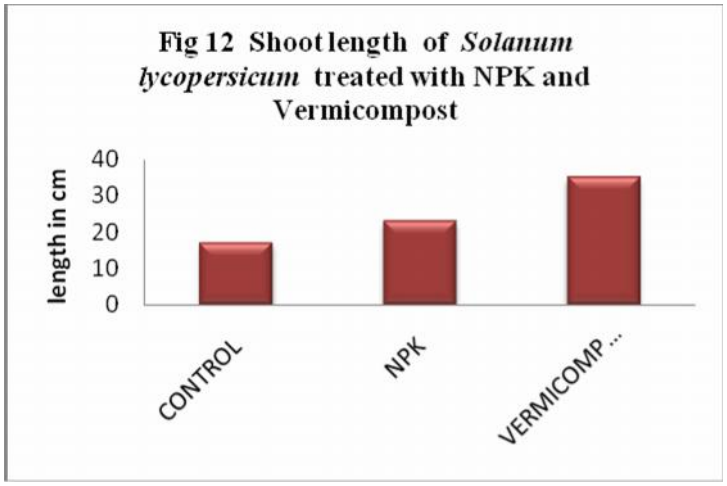


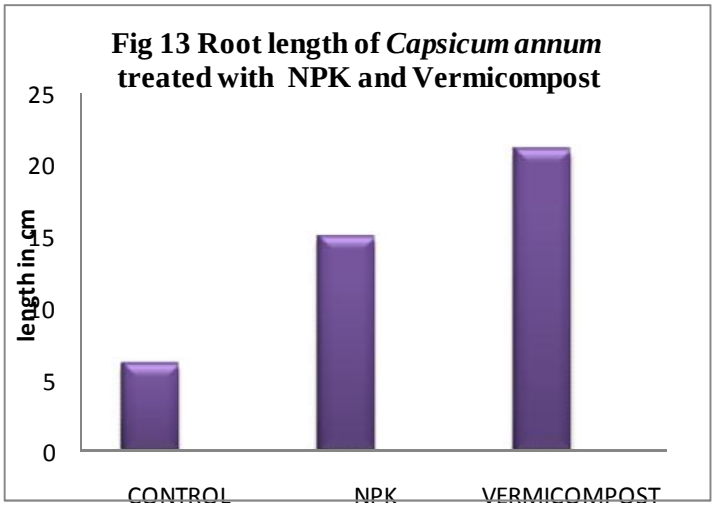
STUDY ON THE EFFECT OF VERMICOMPOST ON GROWTH OF *Solanum lycopersicum.*

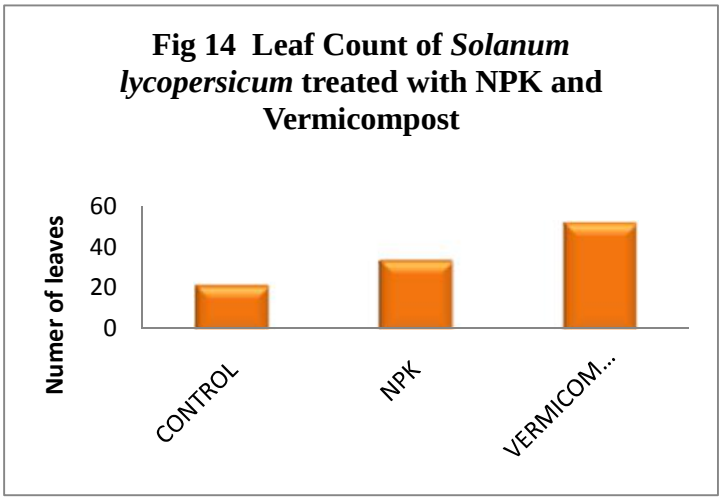
The vegetable plants play a vital role in maintaining health to control and cure certain diseases and hence an attempt was made to study the effect of vermicompost on growth parameters like shoot and root length and number of leaves of the selected vegetable. The *Solanum* lycopersicum(TNAU tomato,Hybrid CO3) was bought from Tamil Nadu Agricultural University, Coimbatore. The selected plant namely *Solanum lycopersicum* showed the maximum root length , shoot length and leaf count in vermicompost treatment compared to the chemical fertilizer treated plant (NPK 19:19:19) and the control after 30 days of growth period.

Vermicompost contains macro and micro plant nutrients in an available form that plants can easily assimilate for their growth and development. This quality manure also contains some of the secretions of worms and its associated microbes, which acts as growth promoters along with other nutrients. Because of all these vital substances, vermicompost has multifarious effects that influence the growth of *Solanum lycopersicum*. The results of the present study are in bar graph. The impact of vermicompost on the growth and flowering of several vegetables showed maximum growth and yield[21].

The growth parameter such as shoot length, root length and number of leaves showed greater growth in vermicompost than control and chemical fertilizer NPK.







CONCLUSION

Vermicompost contains macro and micro plant nutrients in an available form that plants can easily assimilate for their growth and development. This quality manure also contains some of the secretions of worms and its associated microbes.which acts as growth promoters along with other nutrients. Because of all these vital substances, vermicomposting has multifarious effects that influence the growth of the plants. Investigations

were carried out to explore the potential of selected earthworm namely *Eudrilus eugeniae* in the degradation of *Musa paradisiaca* waste and to convert the waste into organic manure called as vermicompost. The study involved the collection of coir waste namely *Musa paradisiaca* from Karunya University Ladies Hostel, Coimbatore. Our study was involved in the collection and culturing of the most commonly used composting earthworm species namely *Eudrilus eugeniae* and their degrading efficiency was studied. In this study an efficient protocol was standardized to study the presence of macro and micro nutrients before and after the inoculation of specific earthworm species. The major thrust of the work was focused on the potency of the earthworm *Eudrilus eugeniae* with respect to the biodegradation of the banana waste (*Musa paradisiaca*).

The physicochemical parameter pH was tested and was found that the earthworms were sensitive to pH and that they can grow only in pH 6.9 to 7.2.The enzymes amylase, cellulose and invertase considerably increased in vermicompost than raw waste . The macronutrient test also confirmed the presence of high concentration of potassium, phosphorous and nitrogen in vermicompost. The micronutrients copper and iron was also higher in vermicompost. The carbohydrate concentration was found by the biochemical test which indicated that carbohydrate decreased .The prescence of protein indicates the enzymes produced by the micro organism. The vermicompost of *Musa paradisiaca* was treated with plant *Solanum lycopersicum* and their growth parameters was observed. Root length, shoot length, number of leaves was greater in the plant treated with vermicompost than the plant treated with chemical fertilizer (NPK). Thus it is concluded that vermicompost is more efficient compared to the plant grown using chemical fertilizer (NPK).

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