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ANALYSIS OF NUTRIENT CONTENTS IN VERMICOMPOST

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ABSTRACT

In the modern age of development, the increasing quantity of solid waste is one of the growing problems in both developed and developing countries. India produces 1,20,000 tonnes of solid wastes everyday. The rapid increase in the volume of waste is one aspect of the environmental crisis, accompanying global development. Wastages such as grated coconut meat, spent tea and used sugarcane had contributed negative impacts to the environment. Vermicomposting is a very effective, eco-friendly, cheap and easy method of recycling biodegradable waste using selected species of earthworms. Vermicompost have higher content of macro and micro nutrients like nitrogen, phosphorus, potassium, calcium, sodium, magnesium and micronutrients namely iron, copper, zinc and manganese which play a major role in solid waste management.

INTRODUCTION

In the modern age of development the increasing quantity of solid waste is one of the growing problems in both developed and developing countries. Due to the rapid growth in industrialization, the most of the rural population have shifted towards the urban area in search of employment. India produces 1,20,000 tonnes of solid wastes everyday. The rapid increase in the volume of waste is one aspect of the environmental crisis, accompanying global development. Most common practices of waste processing are uncontrolled dumping which causes mainly water and soil pollution. Although various physical, chemical and microbiological methods of disposal of organic solid wastes are currently in use, these methods are time consuming and expensive [1].

All human activities generate some kind of by-products or wastes, which are apparently of no use to us and have to be discarded. Solid waste management is essential to maintain healthy environment. The common solid wastes produced by the towns and cities are mainly the organic wastes. They include kitchen wastes, vegetable market waste, sewage sludge, animal excreta, weeds, coir waste, leaf litter, paper and pulp waste, agricultural residues, feed and fodder wastes and aquatic biomass [2].

The Green Revolution in India, which was heralded in the 1960's was a mixed blessing. Ambitious use of agrochemicals boosted the food production but also destroyed the agricultural ecosystem [3]. Of late, Indian farmers and agricultural scientists have realized this and are anxious to find alternatives perhaps, a non-chemical agriculture and have even revived their age-old traditional techniques of natural farming [4].

Scientists are working to find economically cheaper and safer alternatives to agro-chemicals. The practice of vermiculture is atleast a century old and now it is being revived worldwide with diverse ecological objectives such as waste management, soil detoxication, regeneration and sustainable agriculture [5].

Earthworm farming (vermiculture) is another biotechnique for converting solid organic waste into compost [6]. Vermiculture biotechnology refers to the breeding and propagation of earthworms. The vermiculture

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provides for the use of earthworms as natural bioreactors for cost-effective and ecofriendly waste management[7]. Earthworm fecundity is based on the rate of cocoon production, hatching success of cocoons and number of offspring's emerging from each cocoon. The success of the composting depends upon the fecundity of the earthworm. It has the efficiency to consume all types of organic rich waste material including vegetable wastes, leaf litter waste, industrial, dairy farm wastes, garden waste, sugar mill residues, slaughterhouse waste, hatchery waste and municipal wastes[8].

Selection of earthworm species is very important factor because only few species are able to survive and adjust to a particular type of environment. The exotic earthworm species namely *Eudrilus eugeniae* is commonly used for breaking down the organic waste like leaf litter. The ability of the exotic composting species, *Eudrilus eugeniae* to transform the leaf litter into valuable compost is considerable. *Eudrilus eugeniae* a tropical earthworm commonly called African night crawler, is large in size, grows rapidly, breeds fast and is capable of decomposting large quantities of organic materials into usable vermicompost [9].

Vermicompost contain enzymes like amylase, lipase, cellulase and chitinase, which continue to break down organic matter in the soil (to release the nutrients and make it available to the plant roots). They also increase the levels of soil enzymes like dehydrogenase, acid and alkaline phosphatases and urease. Use of vermicompost over the years build up the soil's physical, chemical and biological properties restoring its natural fertility. Vermiculture biotechnology will bring in 'economic prosperity' for the farmers, 'ecological security' for the farms and 'food security' for the people [10].

Vermicompost contain nutrients that are changed to forms which are more readily taken up by plants, such as nitrate, exchangeable phosphorous and soluble potassium, calcium and magnesium. Use of vermicompost promotes soil aggregation and stabilizes soil structure. This improves the air, water relationships of soil, thus increasing the water retention capacity, encouraging extensive development of root system of plants and enhancing the mineralization of nutrients resulting in boosting up of crop productivity [11]. Vermicompost being available indigenously at lower cost, results in enhanced crop yield by creating and maintaining better physical and chemical environment for sustaining higher productivity [12]. Vermicompost is a rich source of vitamins, hormones, enzymes, macro and micronutrients which when applied to plants help in efficient growth [13].

MATERIALS AND METHODS

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 [14].

Estimation of total nitrogen (Pellett and Young, 1980)

Principle

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

Procedure

1. 10ml of vermicompost was measured and transferred to 30ml digestion flasks followed by the addition of 1.9g potassium sulphate, 80mg mercuric oxide and 2 ml of concentrated H_2SO_4.
2. Boiling chips were then added and the samples were digested till the solution becomes colourless.
3. After cooling, the digest was diluted with a small quantity of distilled ammonia - free water and transferred to the distillation apparatus.
4. The kjeldahl flask should be rinsed with successive small quantities of water.
5. 100ml conical flasks containing 5ml of boric acid solution with a few drops of mixed indicator with the tip of the condenser dipping below the surface of the solution were placed.
6. 10ml of sodium hydroxide thiosulphate solution was added to the test solution in the apparatus. It was then distilled and the ammonia was collected on boric acid.
7. The solution was titrated against the standard acid until the first appearance of violet colour, the end point.
8. A reagent blank was run with an equal volume of distilled water and subtracted the titration volume from that of sample volume [15].

Calculation

The nitrogen content of the samples can be calculated based on any one of the following formula as the case may be

$$\frac{\text{Nitrogen}}{\text{kg}} = \frac{(\text{ml HCL} - \text{ml blank}) \times \text{normality} \times 14.01}{\text{Weight (g)}}$$

Estimation of total phosphorus (Jackson, 1973)

Principle

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.

Procedure

1. 0.2 g of pure $KH_2PO_4$was dissolved in 400ml of distilled water and 25ml of 7N $H_2SO_4$was added and made up to 1000ml to get 50ppm of phosphorus (50µg/ml).

2. Phosphorus standards ranging from 0 to 20ppm were prepared. 5.0 ml of this solution was pipetted out and the volumemade up to 50ml.
3. This contains 50 ppm of phosphorus. 5.0ml of this solution was pipetted out into a 25ml volumetric flaskand 2.5ml of Bartons reagent was added finally made up to 25ml.
4. Intensity of the colour of each standard was measured on the colorimeter and a standard curve was drawn.
5. 1ml of vermicompost was taken in standard flasks and added 15ml of the triple acid mixture.
6. The samples were digested over heated stand bath, made up the volume to 500ml with distilled water.
7. Into 25ml volumetric flasks pipetted out 10ml of aliquot and added 2.5ml of Bartons reagent and the volume was made upto 250ml with distilled water.
8. After few minutes, the intensity of yellow colour developed was read at 470nm in a spectrophotometer.
9. From the standard curve, the concentration of phosphorus in the sample was read in ppm.[16].

Calculation

Weight of the sample taken = 'W' g (1g)
Volume of the triple acid extracts = 'V' ml (50)
Aliquot taken for the colour development = 5ml

Corresponding from the standard graph = ppm

$$p = \frac{ppm}{10^6} \times \frac{v}{2.5} \times \frac{10}{w} \times 100$$

$$p = \frac{ppm}{10^6} \times \frac{50}{2.5} \times \frac{100}{1} \times 100$$

Estimation of total potassium (jackson, 1973)
Principle

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.

Reagents

Triple acid: 9:2:1 ratio of concentrated nitric acid: concentrated sulphuric acid and concentrated perchloric acid

Procedure

1. For potassium estimation 1.0 ml of the vermicompost was taken in the microkjeldahl flask and 12ml of triple acid was added and the samples were digested over heated stand bath and made up to 50ml with distilled water.
2. The potassium content was fed directly to the flame photometer after adjusting the flame photometer to zero with blank and standardizing with 100 ppm of potassium solution with 100 galvanometer readings.
3. The galvanometer readings were noted. From the standard curve drawn the corresponding ppm was read. From the ppm, the percentage of sodium and potassium was calculated [17].

Calculation

$$\text{Na content } (\%) = ppm \times 100 \times 100$$

$$\text{Potassium content } (\%) = ppm \times \frac{100}{10^6} \times \frac{100}{1} \times 100$$

Weight of the sample taken = 'W' (g)
Volume made upto = 'V' (ml)
Content of K or Na in sample material

$$\text{With reference to standard graph } = \frac{ppm}{10^6} \times \frac{100}{1} \times 100$$

$$\text{The precentage of K or Na } = \frac{ppm}{10^6} \times \frac{100}{w}$$

Estimation of total calcium (Jackson, 1973)
Principle

The pH of the sample is made sufficiently high (12-13) to precipitate magnesium as hydroxide, and calcium only is allowed to react with EDTA in the presence of a selective indicator.

Reagents

- Ammonium chloride- Ammonium hydroxide buffer(pH-10).
- Prepare the buffer by mixing 100ml of 1N Ammonium chloride with 500ml of 1N ammonium hydroxide.
- Potassium Cyanide: 3.5% solution: Dissolve 3.5 gram of potassium cyanide in water and dilute to 100ml.
- Solochrome black I indicator: Sodium 1 hydroxy 2 Naphthalaro – 6 Nitro 2 Naphthol 4 Sulphonate Magnesium Indicator. Dissolve 0.5gm of indicator in 4.5% solution of hydroxylamine hydrochloride in ethanol.

Procedure

- 5ml of vermicompost was pipetted out into a conical flask.
- 5ml of potassium cyanide solution, 10 ml of ammonium chloride-ammonium hydroxide buffer and 2 drops of solochrome black indicator were added on to it.
- The above solution was titrated against EDTA. At the end point the red colour of the solution changes to pure blue. 5ml of the blank solution is also titrated [17].

Calculation

The percentage of calcium content was calculated by using the formula

$$Ca\ (\%) = \frac{V \times N}{Wt} \times \frac{100}{5} \times \frac{100}{1000} \times 20$$

Estimation of iron, manganese, zinc and copper
Principle

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.

Reagent

Triple acid***:*** 9:2:1 concentrated nitric acid, concentrated sulphuric acid and concentrated perchloric acid

Procedure

1. 1.0 ml of vermicompost was taken into microkjeldahl flasks and added 12ml of triple acid, digested the samples over heated sand bath, made up to 100 ml with distilled water.
2. The contents were directly fed in to the atomic absorption spectrophotometer with the nm of 248.3, 213.9, 279.5 and 324.8; the corresponding iron, manganese, zinc and copper were respectively estimated.
3. The corresponding ppm was read from the standard curve drawn [18].

RESULTS AND DISCUSSION

Nitrogen

The Nitrogen content present in *Bauhinia purpurea* waste composted by *Eudrilus eugeniae* is represented in Table-1 and Figure-1.

In the present study the nitrogen content in vermicompost is found to be increased significantly and the variation of control at 5% level. Increase in nitrogen content in the vermicompost is due to earthworm recycle nitrogen in very short time, addition of their metabolic and excretory products (vermicast), mucus, body fluid, enzymes and decaying tissues of dead worms. [19] reported that increase in nitrogencontent was found in the final product in the form of mucus, nitrogenous excretory substances, growth simulating hormones and enzymes from earthworms.

Phosphorous

Table-2 and Figure-2 depicts the Phosphorous content present in vermicompost.

The above Table-2 and Figure-2 illustrates the level of high phosphorous content present in vermicompost when compared to control. The maximum level of phosphorous content was noticed on 60^{th} day of vermicomposting. [20] observed that leaf litter was found to contain more available phosphorus after ingestion by earthworms, which may be due to the breakdown of the leaf material by worms.

Potassium

The Potassium content in vermicompost is represented in Table3 and Figure-3.

The effect of worm action on vermicompost was found to be more on 60^{th} day of composting when compared to control and the level of potassium was found to be significant at 5% level on 60^{th} day of composting. An increased in potassium level during vermicomposting may be due to the microbespresent in the gut of earthworms which might have played an important role in this process. [21] claimed that acid production by the microorganisms is the major mechanism for solubilizing insoluble potassium in the organic waste [22].

Calcium

The Calcium content in vermicompost is represented in Table-4 and Figure-4.

The level of calcium was found to be elevated on the 60^{th} day of composting when compared to control and the level of calcium was found to be significant at 5% level on 60^{th} day of composting. The increase of calcium level in the vermicompost is due to the presence of calciferous glands present in the earthworm that are involved in the production of calcium carbonate that might favour the calcium availability in the vermicompost. [23] reported that the increased level of calcium is due to the gut process associated with calcium metabolism which is primarily for enhanced calcium content in worm cast.

Iron

Table-5 and Figure-5 depicts the content of Iron in vermicompost.

Higher levels of iron content were noticed in vermicompost on 60^{th} day of composting when compared to control. The iron content was found to be significant at 5% level on 60^{th} day of composting. The presence of enzymes and co-factors in the earthworm gut increased the iron content in the vermicompost. Our results are in accordance with the presence of iron content in vermicompost [24].

Copper

Table-6 and Figure-6 depicts the Copper content present in vermicompost.

The results revealed that in vermicompost the copper content is higher in 60^{th} day of composting when compared to control. The copper content was found to be significant at 5% level on 60^{th} day of composting. Higher levels of copper content in vermicompost might be due to the presence of copper containing oxidizing enzymes. Copper is responsible for healthy, vigorous growth and strengthens stalks, stems and branches. It is also necessary for the production of plant proteins. Our results are in accordance with Suthar (2007) who reported that elevated levels of copper in vermicompost.

Zinc

The Zinc content of *Bauhinia purpurea* waste composted by*Eudrilus eugeniae* is illustrated in Table-7 and Figure-7.

The zinc content in vermicompost was found to be elevated in 60^{th} day of composting when compared to control. Zn is essential for the transformation of carbohydrates and it regulates the consumption of sugars. The soil pH is the most important factor controlling the Zn availability. The findings of the present study are in accordance with the study who found that zinc content was increased in the vermicompost [25].

Manganese

Table-8 and Figure-8 represents the contents of Manganese in vermicompost.

Higher manganese content was observed in vermicompost when compared to that of the control. Increase of manganese content in vermicompost is due to mineralization of this element by the earthworm activity. Manganese is a catalyst for many enzymes and also facilitates the photosynthesis and chlorophyll production. [26] suggested that the application of vermicompost increased the available Mn concentration, almost 2-3 times as compared with the control.

Table 1. Influence of worm action on the level of Nitrogen in vermicompost

Waste	Species	Level of Nitrogen Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudriluseu geniae***	0.31±0.02	1.3±0.02**	2.01±0.02**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 2. Effect of worm action on the level of Phosphorous in vermicompost

Waste	Species	Level of Phosphorous Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	0.52±0.02	0.60±0.02**	1.06±0.02**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 3. Level of Potassium present in vermicompost

Waste	Species	Level of Potassium Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	0.63±0.02	0.72±0.02**	0.92±0.02**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 4. Influence of worm action on the level of Calcium in vermicompost

Waste	Species	Level of Calcium Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	0.73±0.02	0.96±0.02**	1.27±0.02**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 5. Effect of worm action on the level of Iron in vermicompost

Waste	Species	Level of Calcium Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	96±2	132±2**	141±2**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 6. Influence of warm action on the Copper level in vermicompost

Waste	Species	Level of Calcium Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	3.5±0.2	4.2±0.2	5.1±0.2**

Table 7. Changes in the level of Zinc in vermicompost

Waste	Species	Level of Zinc Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	***Eudrilus eugeniae***	16.4±0.2	18.3±0.2**	21.3±0.53**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Table 8. Level of Manganese in vermicompost

Waste	Species	Level of Manganese Present		
		Control	Vermicompost	
			30 days	60 days
Bauhinia purpurea	*Eudrilus eugeniae*	68.02±0.02	80.7±0.53**	90.6±0.02**

Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.

Figure 1.

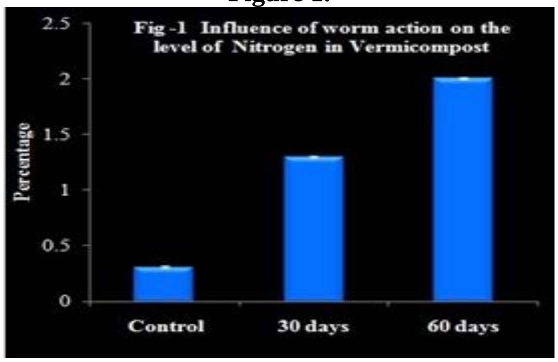


Figure 2.

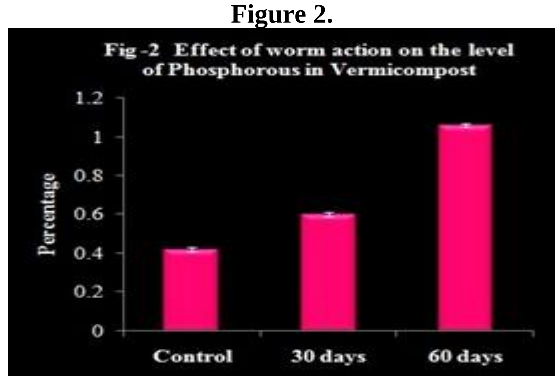


Figure 3.

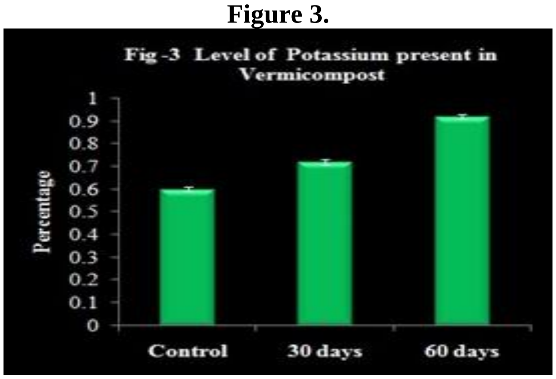


Figure 4.

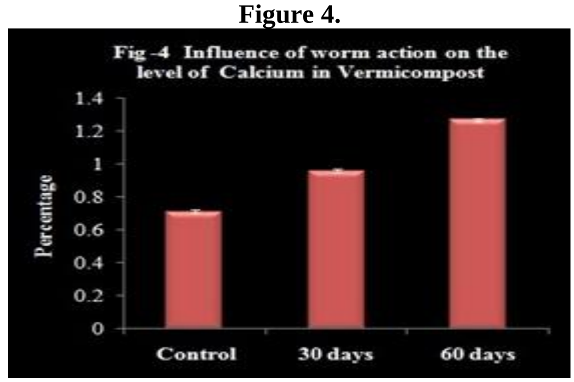
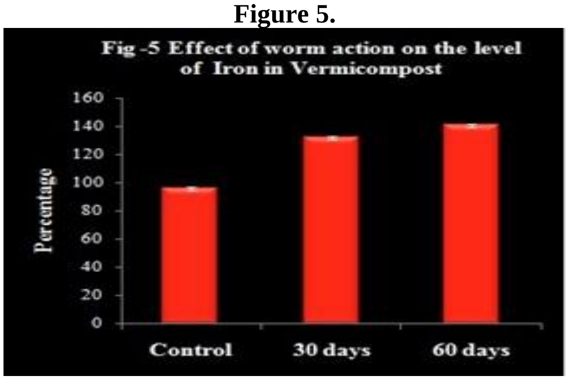


Figure 5.



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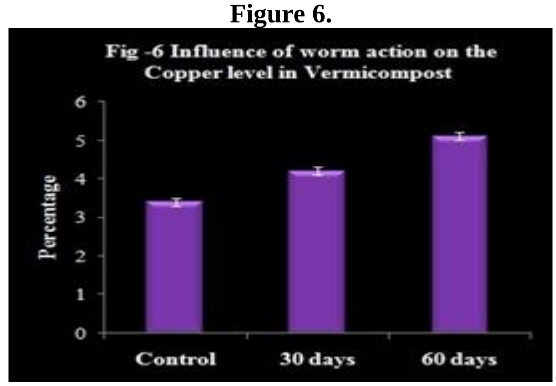


Figure 7.

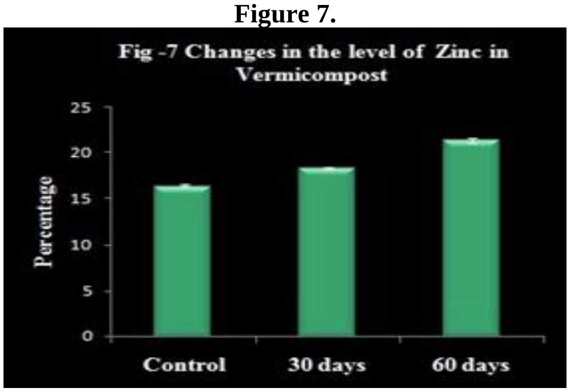
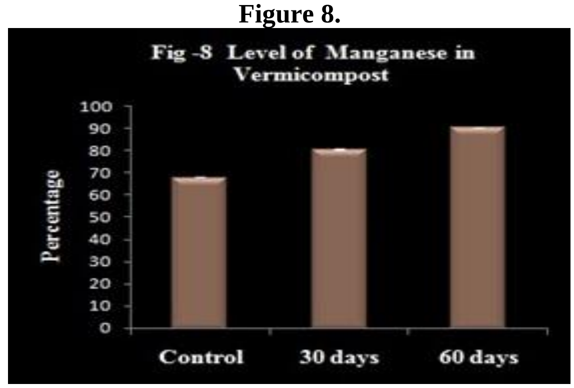


Figure 8.



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