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Research Article

# Nutrients Analysis of Vermicompost of Water Hyacinth Supplemented with Probiotics

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## Abstract

Aquatic weeds are still regarded by many people as a menace because they are not yet aware of the great potential and economic value of these profusely growing uncomfortable plants. This research work presents vermicomposting of aquatic weed water hyacinth (*Eichornia crassipes*) supplemented with probiotics *Lactobacillus sporogens* using *Eisenia fetida*. The nutrients of vermicompost was analysed after 60 days to determine the amount of macro and micronutrients. Aquatic weed supplemented with probiotic bacteria *Lactobacillus sporogens* showed 18.03% nitrogen, 32% phosphorus, 26.86% potassium, 10.49% Zinc, 42.88% copper, 31.22% Iron, 27.45% calcium and 43.69% magnesium than the vermicompost of non supplemented aquatic weed alone. The results of the study showed that enrichment of probiotics with water hyacinth increased the amount of macro and micronutrients in the vermicompost and could be a used as a good biofertilizer in the field to increase the fertility of soil. Moreover, it is an ecofriendly method to solve the chronic problem of Eutrophication in aquatic water habitats.

**Keywords:** Water Hyacinth; *Lactobacillus sporogens*; Vermicompost; Macro and Micronutrients

## Introduction

Earthworms accelerate organic matter degradation by increasing the available surface area of organic matter through comminution [1]. Given the most favorable conditions of temperature (20–30$^0$C) and moisture (60–70%), about 5 kg of worms (numbering approximately 10,000) can vermiprocess 1 ton of waste into vermicompost in just 30 days. Earthworms‟ body work as a "biofilter‟, and they have been found to remove the biological oxygen demand (BOD5) by over 90%, chemical oxygen demand (COD) by 80–90%, total dissolved solids (TDS) by 90–92% and the total suspended solids (TSS) by 90–95% from wastewater. Most significant is that there is no sludge formation. Earthworms have been used for land recovery, retrieval and rehabilitation of sub-optimal soils such as poor mineral soils, polder soils, open cast mining sites, closed landfill sites and cutover peat [2].

Vermicomposting simultaneously solves two burdensome problems of modern society. Vermicomposting also saves land and waste transportation costs of Land filling 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 [3].

Water hyacinth (Eichornia crassipes) is a fast growing perennial aquatic plant found in wetlands and which prefers nutrient enriched water [4]. It can cause infestations over large areas of water surfaces and leads to series of problems such as decrease of biodiversity, blockage of rivers and drainage systems, depletion of dissolved oxygen, alterations in water chemistry, environmental pollution, decreased fish population, restricting access to fishing sites and loss of fishing equipment. All of which result in reduction in catch and subsequent loss of lively hoods [5].

Probiotics are one example of microbial-based inoculants which may contain a single-species inoculant or complex cultures where numerous microbial species are grown together [6]. Probiotics are defined as "a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance" [7]. Use of complex cultures has received more attention because they contain not only those microorganisms, which improve soil fertility but also species of beneficial microorganisms, which can suppress soil borne pathogens [8]

Bacteria in the earthworm gut destroy harmful chemicals ingested by worms and also break down organic wastes. Nitrogen fixation and Nitrogenase activity in casts is higher thus contributing to higher nitrogen fixation in casts than surrounding soil [9]. Considering the importance of bacteria and earthworm in the process of making vermicompost, this research was aimed to analyse the nutrients of vermicompost of water hyacinth supplemented with probiotic bacteria Lactobacillus sporogens.

## Materials and Methods

### Earthworms and substrates

Earthworms, *Eiseniafetida* were obtained from a culture bank maintained in the vermicompost unit of Dharangathara Chemical Works Ltd, Sahupuram, Thoothukudi, India. Water hyacinth was taken from Thamirabarani river, near Eral and Cow dung was obtained from a local farmyard near A.P.C.Mahalaxmi College for Women, Thoothukudi. Sporlac sachet was purchased from medical shop and added with water hyacinth in the ratio of 1g/1kg for the experiment.

### Experimental design

The Water hyacinth was dried in air, cut into small pieces and mixed with fresh cow dung (nutrient mixture) in a ratio of 5:1 for the experiment. This mixture was pre decomposed for 15 days to make it palatable for the earthworms.

Vermicompost was prepared in wooden box of 3 feet breadth and 2 feet height. A thin layer of 1.5 cm thick sterilized soil is filled at the bottom and broken bricks of 5 cm size were spread over the bottom layer as the supporting material for vermicomposting. Partially decomposed cow dung was placed over the soil layer. The experiment was setup by taking 2kg nutrient mixture (on dry weight basis) in each wooden box and no extra feeds were provided during the study. Twenty five earthworms, *Eisenia foetida* were released over the mixture. The compost of mixture was covered with paddy straw. For control (C), water hyacinth residues were chopped into 1cm size pieces left to undergo natural decomposition without the addition of earthworms. Two vermibeds were prepared for vermicompost of water hyacinth by earthworm (E1) and vermicompost of water hyacinth by earthworm supplemented with *L. sporogens* (E2).Three replicates were setup for statistical analysis of the results.

Vermicomposting was conducted in the Vermicompost Unit of A.P.C.Mahalaxmi College for women, Thoothukudi, in darkness at an average T°C at 25°C and a substrate moisture content of 70 -75%. The experiment was conducted for 60 days after releasing the earthworms. The experimental set up was kept under shadow and covered with jute sheet. The physical parameters such as pH, temperature and moisture content were monitored with utmost care. The nutrient content of the vermicompost was analysed after 60days.

Micro Kjeldhal method was used for measuring nitrogen. Available phosphorus was determined by using the spectrophotometer following the stannous chloride method. Potassium was determined by acid digestion method using flame photometer with standard solution [10]. For analysis of Ca, Mg, Cu, Zn and Fe samples were digested in microwave digester and then analysed by Atomic Absorption Spectrophotometer. All the samples were analysed in triplicates and the mean results were recorded.

## Results and Discussion

At the end of experimental period the nutrient content of vermicompost was analysed to determine the amount of macro and micronutrients in the three vermicomposts composted by *Eisenia fetida*. The amount of nutrients is presented in table 1. The increasing percentage of nutrients in the experimental vermicompost is compared to the control and is shown in figure 1.

| S. No | Sample | Macro Nutrients (g/kg of dry mass) | | | Micro Nutrients(mg/kg of dry mass) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | P | K | Zn | Cu | Fe | Ca | Mg |
| 1 | (C) | 5.92 ± 0.86 | 4.68 ± 0.44 | 3.35 ± 0.78 | 286 ± 47 | 220 ± 68 | 922 ± 120 | 448 ± 26 | 325 ± 55 |
| 2 | (E1) | 8.68 ± 1.20 | 7.24 ± 0.68 | 5.40 ± 0.72 | 480 ± 38 | 315 ± 92 | 1460 ± 284 | 670 ± 12 | 478 ± 88 |
| 3 | (E2) | 9.75 ± 0.93 | 8.76 ± 0.83 | 6.30 ± 0.56 | 510 ± 60 | 410 ± 44 | 1748 ± 156 | 790 ± 62 | 620 ± 23 |

**Table 1:** Amount of Macro and Micro nutrients in the control and experimental vermicompost.

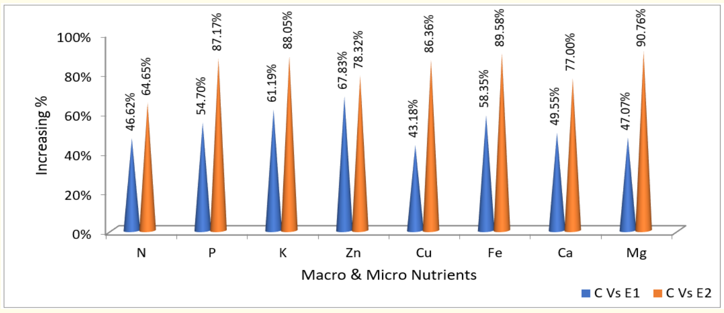


**Figure 1:** Increasing % of Macro and Micro nutrients in the control & experimental vermicompost.

### Macronutrients

Vermicompost of water hyacinth showed rich in macronutrients NKP (nitrogen 46.62%, potassium 54.70% and phosphorus 61.19%) and micronutrients (Zn 67.83%, Cu 43.18%, Fe 58.35%, Ca 49.55% and Mg 47.07%) than the control. Earthworms after ingesting microbes into its gut proliferate the population of microbes to several times in its excreta (vermicast). The microorganisms not only mineralize complex substances (organic waste) into plant available form but also can synthesis whole series of biologically active substances [11]. Earthworms prime the symbiotic gut microflora with secreted mucus and water to increase their degradation of ingested organic matter and the release of assimilable metabolites [11].

During vermicomposting process, the organic matter passes through the worms gut undergoes physical, chemical, and biochemical changes by the combined effect of earthworms and microbial activities. Earthworms not only help the proliferation of microbes by speeding up physical degradation process of organic matter when it passes through the gut but also stimulate other free living aerobic microbial activities in the casts favoring further decomposition [12]. Organic matter that passes through the gut of earthworms released as vermicast results in an increased level of microbial population, microbial activity, microbial respiration, enzyme activity and NPK enrichment, production of polysaccharide gum by bacteria, establishment of lignocellulolytic, nitrifying and nitrogen fixing microorganisms etc. By the action of gut microbes of the earthworm degrade the macronutrients nitrogen, phosphorus and potassium in the aquatic weed water hyacinth. This is the reason of the increased macronutrients and micronutrients of vermicompost of water hyacinth than the natural compost.

### Micronutrients

Vermicompost of water hyacinth supplemented with *L. sporogens* showed rich in micronutrients (Zn 78.32%, Cu 86.36%, Fe 89.58%, Ca 77.00%, Mg 90.76%) than the control and vermicompost of water hyacinth. Bacteria of the genus *Lactobacillus* are often characterized by zymogenic microorganisms, i.e., those which are able to ferment carbohydrates in to Lacticacid. *Lactobacillus* spp. is often found in commercially available microbial inoculants and are reported to have beneficial effects on the growth and yield of crop plants [13]. According to Higa [14] there is a high level of zymogenic activity in freshly plowed soil, much of it due to *Lactobacillus* spp. It is important to realize that most zymogenic microorganisms produce extracellular enzymes which ferment substrates outside their cells. Consequently, if conditions are favorable, these fermentative enzymes are capable of inducing substrates fermentation long after the organism itself has "died-away" (i.e., no longer detectable).

Most Lactobacillus inoculants contain large populations of Lactic acid bacteria as well as a high level enzymatic activity. Proper soil management practices are vital to maintain a high level of zymogenic activity [15]. The possible reason for the increasing amount of micronutrients in the vermicompost of water hyacinth supplemented by *L. sporogens* in the present study could be the fermentation of water hyacinth and complete degradation of micronutrients by the zymogenic activity of *Lactobacillus sporogens.*

## Conclusion

Vermiremediation of hydrocarbon contaminated soil can improve the remediation directly or indirectly due to the several functions of earthworms in the soil. In the bioaugmentation, bacteria belong to the genera *Bacillus* is widely used. The most commonly used earthworm species for removal and biodegradation of organic contaminants is *Eisenia fetida*. This study confirms the role of *Lactobacillus sporogens* in degrading the nutrients of water hyacinth. Several aquatic species, such as *Elodea canadensis,* Water hyacinth (*Eichhornia crassipes*), *Ceratophyllum demersum* etc are used for phytoremediation to remove heavy metals form effluents. The use of plants in conjunction with plant associated bacteria (rhizosphere or endophytic) offers greater potential for bioremediation of organic compounds and in some cases inorganic pollutants than using plants alone in bioremediation. Supplementation of suitable microbes with water hyacinth for bioremediation and safe removal of heavy metal accumulated plants by vermicomposting could be an eco friendly and economically feasible strategy for bioremediation.

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