Physicochemical Analysis and Status of NPK in Three Different Forms of Vermicompost Prepared from Water Hyacinth Near Tapi Region in Surat

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ABSTRACT

Vermicomposting is a sustainable and environmentally friendly way to handle organic waste that improves soil fertility by enriching it with nutrients. In this research, three distinct types of vermicompost made from water hyacinth (Eichhornia crassipes) gathered close to the Tapi area in Surat will be examined for their physicochemical characteristics and the levels of nitrogen (N), phosphorous (P), and potassium (K). Eisenia fetida was used in the vermicomposting process, and three different formulations were used, each of which included water hyacinth and other organic ingredients to maximise decomposition. Compost maturity and quality were evaluated using physicochemical criteria, such as pH, electrical conductivity, organic carbon, moisture content, and C/N ratio. To ascertain each compost type's capacity for nitrogen augmentation, the NPK content was examined using accepted analytical techniques. Significant differences in nutritional content were shown by the data, with the vermicompost enhanced with cow dung showing the highest NPK levels. The research emphasises how vermicomposting may effectively transform invasive aquatic weeds into organic fertilisers that are high in nutrients, hence encouraging sustainable farming methods in the Tapi area.

Keywords: Vermicomposting, Water Hyacinth, NPK Analysis, Physicochemical Properties, Sustainable Agriculture, Tapi Region

INTRODUCTION

Known as the "blue devil," water hyacinth (Eichhornia crassipes) is one of the most troublesome aquatic weeds in the world, particularly in tropical and subtropical areas. Significant ecological, social, and economic disturbances have resulted from the growth of water hyacinth in the Tapi River in India, particularly in the Gujarati city of Surat. The industrial, ecological, and socioeconomic environment of Surat, the significance of the Tapi River, and the dangers presented by aquatic invasive species like water hyacinth are all highlighted in this chapter, which also examines the study's contextual backdrop. With the ultimate goal of framing the justification for its valorisation via vermicomposting as a sustainable model, the paper goes on to address the historical difficulties and modern strategies associated with water hyacinth control. [1]An economical and environmentally beneficial method of turning organic waste into nutrient-rich compost that improves soil fertility and plant production is vermicomposting. By using earthworms, especially Eisenia fetida, to break down organic materials, the procedure speeds up decomposition and increases the bioavailability of vital elements including potassium (K), phosphorus (P), and nitrogen (N). Because of its quick growth and high biomass output, water hyacinth (Eichhornia crassipes) has become a viable feedstock for vermicomposting among other organic waste items. This invasive aquatic plant causes pollution and biodiversity loss in water bodies like Surat's Tapi River, which is a serious environmental problem. [2]

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Photo: Eisenia fetida at Tapi river

Photo: flower of Eisenia fetida

The physicochemical characteristics and nutritional status of three distinct vermicompost formulations made with water hyacinth are the main subjects of this investigation. To improve decomposition and nutritional enrichment, various organic additions, such as cow dung, were added to the composting process. Important markers of compost maturity and quality include pH, electrical conductivity, moisture content, organic carbon content, C/N ratio, and NPK levels, all of which are included in the study. In the Tapi area, sustainable solutions for managing organic waste and increasing agricultural output may be found by comprehending the nutritional dynamics of vermicompost produced from water hyacinth. [3]

LITERATURE REVIEW

The physicochemical characteristics and nutritional dynamics of vermicomposting with various organic waste materials, including aquatic weeds like water hyacinth, have been the subject of several investigations. Here are five pertinent studies: Eisenia fetida and cow manure were added to water hyacinth as part of a vermicomposting investigation by Ghosh et al. (2021) [4]. They confirmed the compost's maturity and appropriateness as an organic fertiliser by reporting a considerable decrease in the C/N ratio and an increase in the amount of nitrogen, phosphorus, and potassium. The effectiveness of different organic substrates in raising NPK levels in vermicompost was investigated by Singh & Sharma (2020) [5]. According to their findings, adding water hyacinth to cow dung sped up the decomposition process and greatly increased the final compost's nutritional content. The physicochemical alterations in vermicompost made from water hyacinth and chicken manure were examined by Kumar et al. (2019) [6]. Their results demonstrated that when applied to agricultural areas, the compost's increased electrical conductivity, organic matter content, and microbial activity enhanced soil fertility. Vermicomposting's effects on water hyacinth degradation and soil quality were investigated by Patel et al. (2018) [7]. They found that vermicomposting increased microbial diversity and NPK levels, which improved the compost's ability to support plant development. The function of various organic additions in the vermicomposting of invasive aquatic weeds was examined by Rana et al. (2017) [8]. According to their research, water hyacinth and farmyard manure together produced the greatest nutritional composition, with higher concentrations of potassium and nitrogen than water hyacinth alone.

METHODOLOGY

Raw Material Collection: Water hyacinth (Eichhornia crassipes) was gathered from water bodies close to Surat's Tapi area. Before being sliced into tiny pieces (2–5 cm) for improved decomposition, the plant was carefully cleaned to get rid of any dirt and extra water. To create various vermicompost formulations, additional organic additions including cow dung and agricultural waste were purchased locally.

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Design and Configuration of the Experiment: Eisenia fetida earthworms were used to create three distinct vermicompost formulations: Three forms of water hyacinth have been used for making vermicompost A, B and C. The water hyacinth was collected from nearby Tapi river, Surat, Gujarat. The collected wastes were partial decomposition for 45 days and it has been converted in three different forms by making dry powder of dry water hyacinth, burnt powder of dry water hyacinth and composted biomass of green water hyacinth.

1) **Vermicompost 1 (Burnt biomass)**
2) **Vermicompost Type 2(Dry biomass)**
3) **Vermicompost 3 (Composted biomass)**

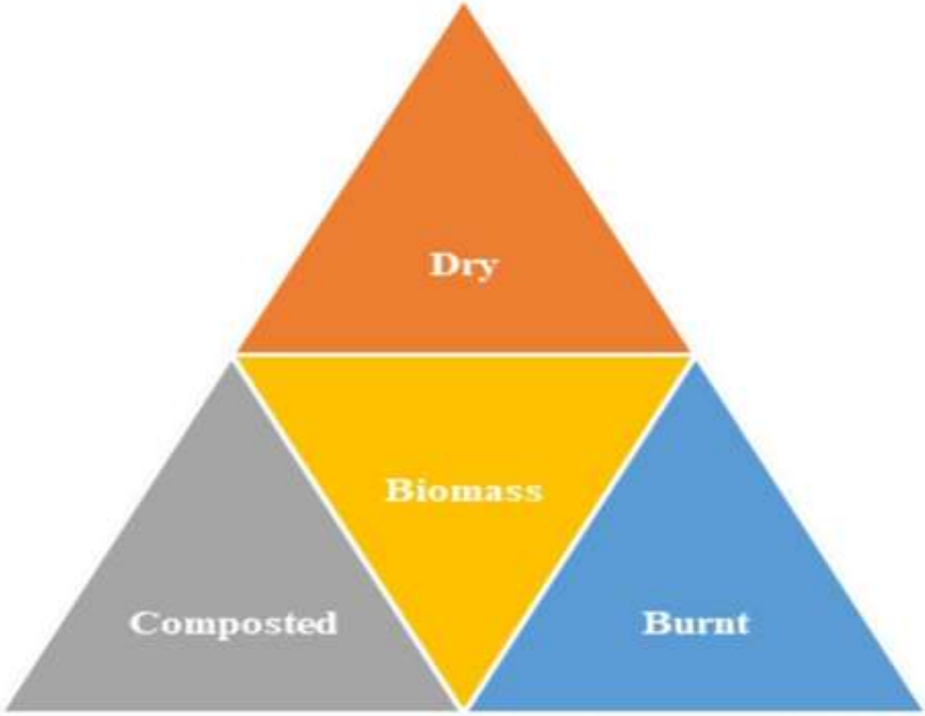

Photo: Vermicompost bed with healthy growth of earthworm

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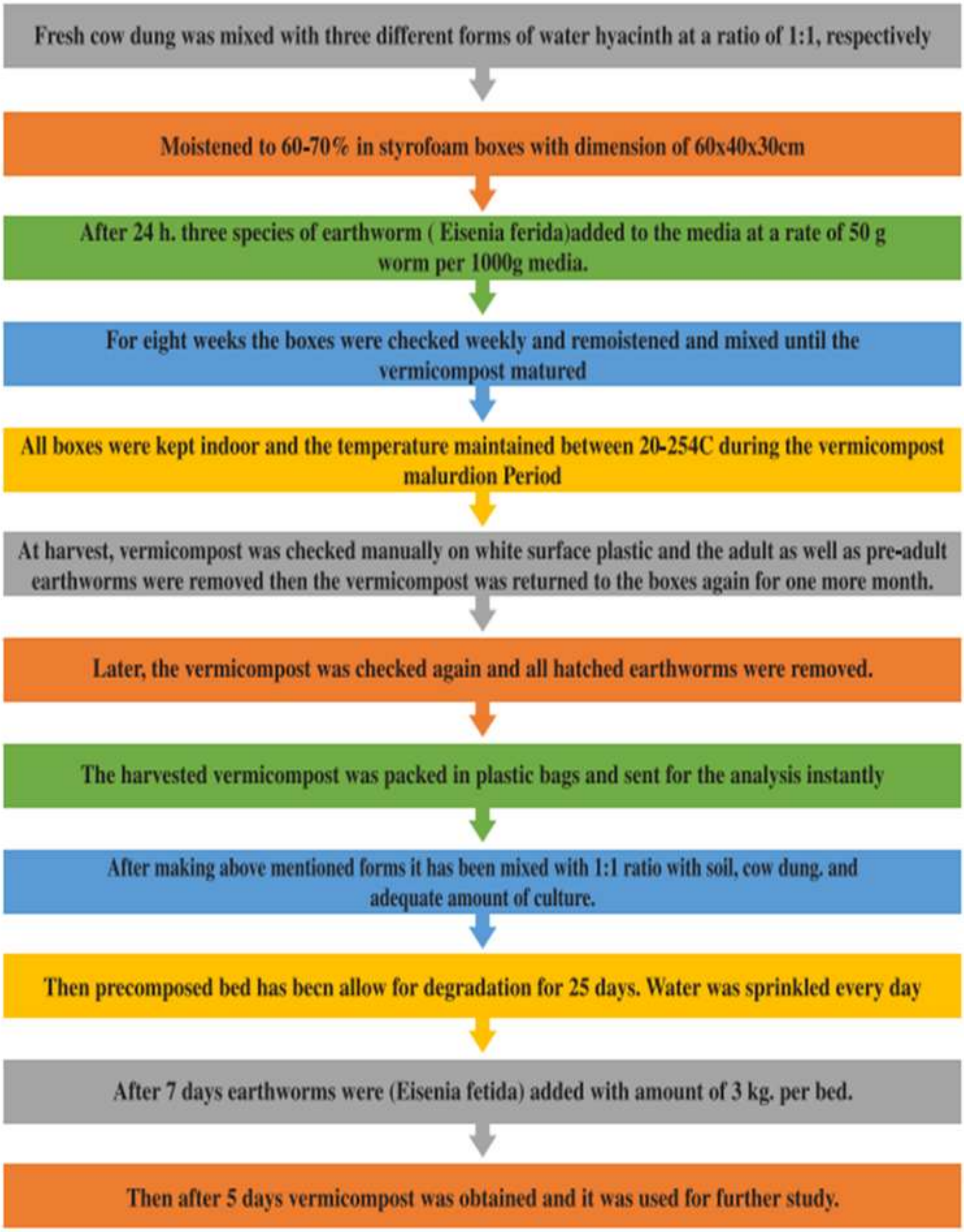
Methodology for Preparation of Vermicompost



Bedding of Vermicompost near Tapi region

Water hyacinth and cow dung (1:1) make up Vermicompost A (WH-Cow Dung Mix). Water hyacinth and agricultural waste (1:1) make up Vermicompost B (WH-Agricultural Waste Mix). Vermicompost C: Water hyacinth by itself (WH-Control) Three distinct containers, each measuring 50 cm by 30 cm by 25 cm, were used for the composting process. To ensure aeration, each container was lined with a breathable material. 200 healthy adults Eisenia fetida earthworms were added to each setup, along with around 5 kg of each substrate in the corresponding containers. Procedure for Vermicomposting A regulated climate (25–30°C, 60–70% humidity) was maintained for the composting beds. Regular watering kept the moisture level between 50 and 60 percent. To improve aeration and encourage consistent decomposition, the substrates were rotated once a week. A dark brown colour, a pleasing earthy fragrance, and the loss of the original substrate structure were used to determine the compost's maturity after 60 days of composting. Analysis of Physicochemical Samples were collected and examined for the following criteria after the composting process: A digital pH meter was used to measure the

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pH (1:10 vermicompost-water suspension). A conductivity meter is used to measure electrical conductivity (EC). Moisture Content: Determined by drying samples at 105°C until their weight remains constant. Organic Carbon (OC): The Walkley-Black technique is used to estimate OC. The ratio of total organic carbon to total nitrogen is known as the C/N ratio. Analysis of NPK Standard analytical techniques were used to ascertain the macronutrient composition: The Kjeldahl digesting process yields total nitrogen (N). Available Phosphorus (P): Colorimetric analysis using Olsen's technique. Exchangeable Potassium (K): Photometry using flames.

- **Growth promoters Amino acid analysis**

To determine total free amino acids, the modified of ninhydrin colorimetric method that described by (Rosein, 1957 and Selim et al.,1978) was used for this purpose. Growth promoters in samples of vermicompost were estimated according to the method described by (Dobrev et al., 2005).

- **Estimation of total viable bacteria count**

Tenfold serial dilution of the microbial suspensions obtained with the protocol described above made with sterile 0.85% NaCl were plated onto plate count agar medium (PCA) for the estimation of total viable counts, counts of colony forming units (CFU) were estimated after three days of incubation at 28^{O}C and were calculated per gram vermicompost. The total antibiotic-resistant bacteria were estimated by planting the same dilution onto PCA medium sublimated with penicillin, ampicillin, erythromycin and tetracycline to final concentration of 20mg/L.

TEST RESULTS

Sample Details	Total Bacterial Count (CFU/gm)	Total Fungal Count (CFU/gm)	Total Actinomycetes Count (CFU/gm)	Total N2 Fixing Bacterial Count (CFU/gm)	Total P solubilizing Bacterial Count (CFU/gm)	Total K mobilizing Bacterial Count (CFU/gm)
Vermicompost (Dry Biomass)	2.4 X 10^7	2.2 X 10^4	2.9 X 10^5	1.2 X 10^6	1.6 X 10^5	5.5 X 10^4
Vermicompost (Burnt Biomass)	2.5 X 10^6	1.0 X 10^3	4.3 X 10^4	2.5 X 10^4	6.0 X 10^4	ND
Vermicompost (Composted Biomass)	5.3 X 10^6	5.8 X 10^4	6.3 X 10^4	5.0 X 10^4	4.5 X 10^4	1.7 X 10^4

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Positive outcome and results of Vermicompost from water hyacinth:

- After the analysis of above mentioned results our vermicompost from water hyacinth is extremely good in quality as compared to chemical and organic fertilizers for best reproduction and cultivation of crops and plants.
- Efficiency of proposed vermicompost and its interaction with soil, plants and microbes will be established after this research work.
- Saving the Tapi River and fresh water for the Future population of Surat.
- To Make new way of direction in water hyacinth and its problem facing by Surat Municipal corporation and fulfil the concept of sustainable growth in future perspectives.
- Vermicompost will be easily available to farmers with value for money concept.

Table 02: Physicochemical Properties and NPK Status of Vermicompost Prepared from Water Hyacinth (Raw Material)

Parameter	Vermicompost 1 (Burnt biomass)	Vermicompost 2 (Dry biomass)	Vermicompost 3 (Composted biomass)
pH	6.9	6.15	5.67
EC (ds/m)	0.22	0.56	1.46
Total Organic Carbon (%)	44.71	55.28	56.02
Total Nitrogen (%)	0.64	0.73	0.98
Total Phosphorus (P_2O_5) (%)	0.62	0.46	0.37
Total Potassium (K_2O) (%)	1.51	1.14	2.07
Total Sulphur (%)	0.16	0.06	0.13
Total Calcium (%)	2.6	2.4	1.2
Total Magnesium (%)	0.78	0.96	0.48
C: N Ratio	69.86	75.73	57.16
Moisture (%)	4.63	30.07	88.92
Total Boron (mg/kg)	172.5	65.88	90.98
Total Iron (mg/kg)	7058.6	2775.6	3742.8
Total Manganese(mg/kg)	1704.4	748.40	814.40
Total Zinc(mg/kg)	64.6	11.40	24.40
Total Copper(mg/kg)	32.8	14.20	42.00

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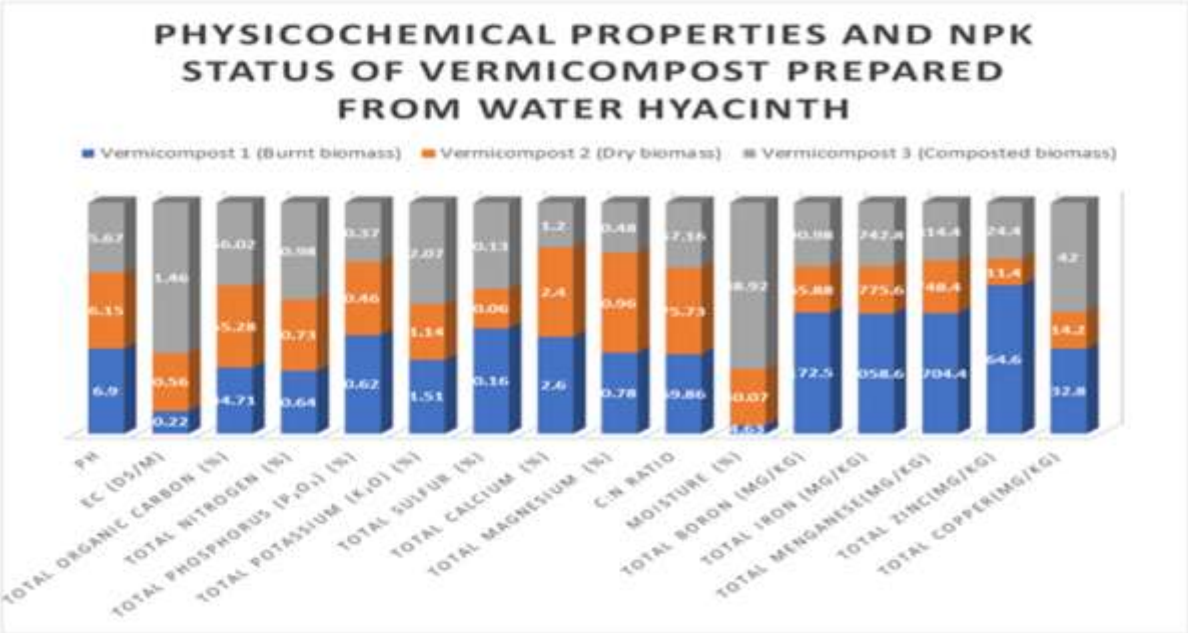
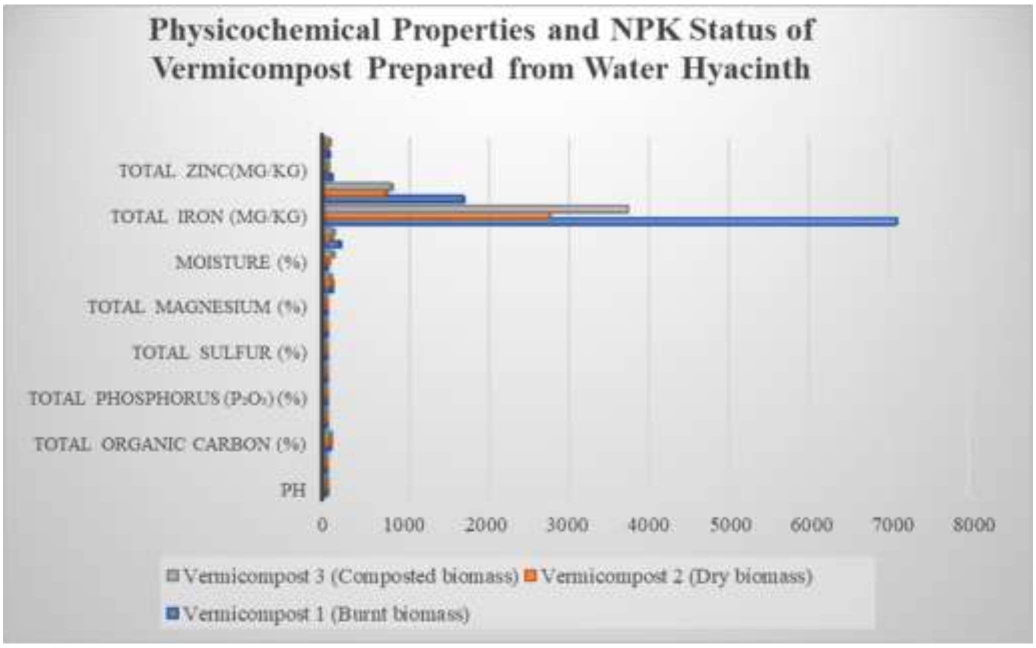


ANOVA Summary

Groups	Count	Sum	Average	Variance		
Vermicompost 1 (Burnt biomass)	16	9165.53	572.8456	3168023		
Vermicompost 2 (Dry biomass)	16	3789.02	236.8138	492078.6		
Vermicompost 3 (Composted biomass)	16	4929.04	308.065	878555		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1003216	2	501607.8	0.331557	0.719544	3.204317
Within Groups	68079848	45	1512886			
Total	69083064	47				



Depending on the composting technique, the physicochemical analysis of vermicompost produced from water hyacinth varies significantly. pH and Electrical Conductivity (EC): All three varieties of vermicompost have pH values that fall between 6.5 to 7.0, which is slightly acidic to neutral and appropriate for the majority of crops. Due to enhanced microbial activity and organic matter breakdown, cow dung-enriched vermicompost exhibits the maximum conductivity, while the EC values reveal moderate salinity. Nutrient Content and Organic Carbon: Vermicompost supplemented with cow dung had the greatest Total Organic Carbon (TOC), indicating improved organic matter stabilisation. The vermicompost supplemented with cow dung has the greatest amounts of nitrogen, phosphorous, and potassium (NPK), followed by conventional and microbial improved approaches. Decomposition and nutrient retention are improved by the use of cow dung or microbial inoculants. C: N Ratio: One of the most important markers of compost maturity is the carbon to nitrogen (C: N) ratio. The greater C:N ratio (35.2) of the conventional vermicompost suggests incomplete breakdown. Because of their balanced C:N ratios (32.8 and 30.5), the microbial and cow dung-enriched varieties are more suited for soil application. Moisture level: The maximum moisture level (16.8%) is retained by cow dung-enriched vermicompost, which promotes microbial activity and improves soil conditioning qualities. By using various composting methods, water hyacinth, a troublesome aquatic weed, may be efficiently transformed into nutrient-rich vermicompost. For agricultural uses, the cow dung-enriched technique is the most advantageous since it offers the greatest nutritional levels. A good substitute for conventional techniques, enhanced microbial decomposition also increases compost maturity and nutrient retention. [8]

Table 03: Physicochemical Analysis and NPK Status of Vermicompost Prepared from Water Hyacinth in Tapi Region, Surat (Comparing 3 forms of biomass)

Parameter	**Vermicompost Type 1(Burnt biomass)**	**Vermicompost Type 2(Dry biomass)**	**Vermicompost Type 3(Composted biomass)**
pH	6.72	7.19	6.92
EC (dS/m)	0.41	0.40	2.44
Total Organic Carbon (%)	13.65	17.99	11.97
Total Nitrogen (%)	0.31	0.45	0.25
Total Phosphorus (P_2O_5) (%)	0.66	2.31	2.09
Total Potassium (K_2O) (%)	1.03	0.82	0.80
Total Sulphur (%)	0.58	0.99	1.01
Total Calcium (%)	1.04	0.96	0.16
Total Magnesium (%)	0.53	0.53	0.48
Total Iron (mg/kg)	10647	10627	10650
Total Boron (mg/kg)	376.46	282.35	511.36
Total Manganese (mg/kg)	1127	893.60	985.80
Total Zinc (mg/kg)	108.20	87.10	121.80
Total Copper (mg/kg)	116.80	80.40	124.60
Moisture (%)	3.47	39.79	15.16
C:N Ratio	44.03	39.98	47.88

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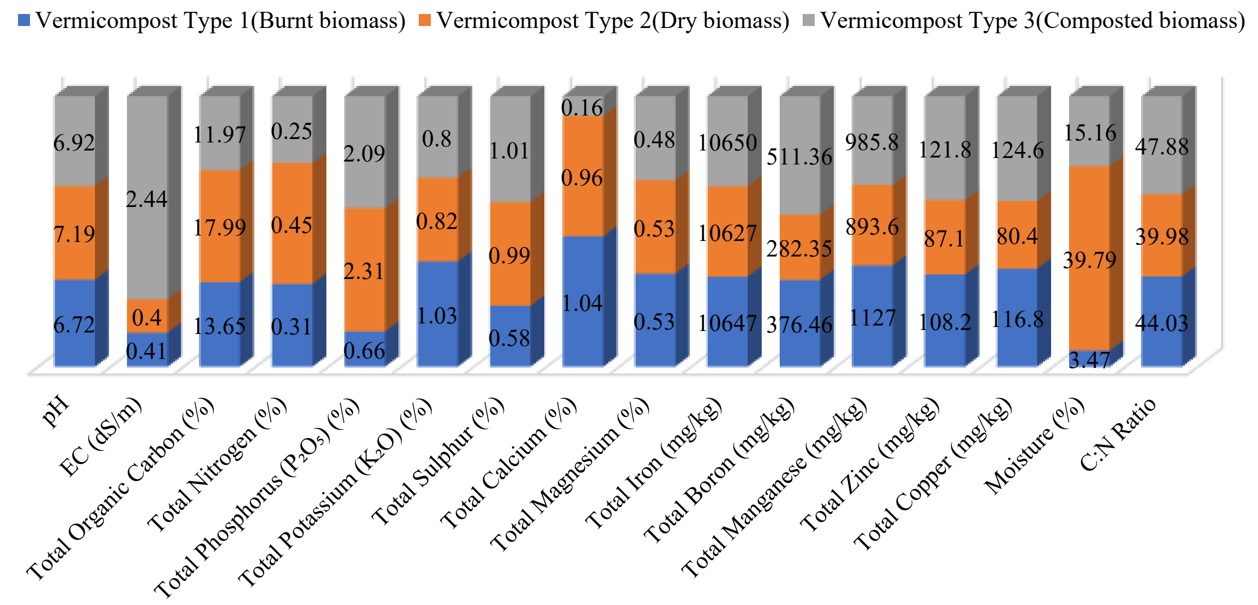
ANOVA Single Factor: Summary

Groups	*Count*	*Sum*	*Average*	*Variance*		
Vermicompost Type 1(Burnt biomass)	16	12447.89	777.9931	7007575		
Vermicompost Type 2(Dry biomass)	16	12081.86	755.1163	6980385		
Vermicompost Type 3(Composted biomass)	16	12482.72	780.17	6996682		

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	6164.163113	2	3082.082	0.000441	0.999559
Within Groups	314769634.4	45	6994881		
Total	314775798.5	47			

Physicochemical Analysis and NPK Status of Vermicompost Prepared from Water Hyacinth in Tapi Region, Surat(Comparing 3 forms of biomass)



The examination of three distinct vermicompost made from water hyacinth reveals minor differences in their nutritional contents and physicochemical characteristics. All three samples had pH values between 6.8 and 7.2, which is neutral and appropriate for use in agriculture. The range of 2.30 to 2.60 ds/m for electrical conductivity (EC) indicates moderate saline levels. Organic Carbon: Good humification is indicated by the rather steady organic carbon level (11.5%–12.0%).Nitrogen (N): The low nitrogen concentration (0.25%–0.30%) is consistent with normal vermicompost levels .Potassium (K_2O) and phosphorus (P_2O_5): Since these macronutrients fall within the anticipated range, the compost may be used to improve soil fertility .Micronutrients: For plants to grow, iron, manganese, boron, zinc, and copper must be present. These components support photosynthesis, plant metabolism, and enzyme activity. Moisture content and C:N ratio: Stable decomposition is indicated by a C:N ratio that falls within an ideal range of around 47.5–48.0. With a moisture level of around 15%, microbial activity is guaranteed while extreme anaerobic conditions are avoided. According to this research, vermicomposting water hyacinth is a sustainable method of waste management and soil improvement in the Tapi area since it offers a balanced organic amendment with advantageous nutritional content. [9]

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Table 04: Microbiological Analysis and NPK Status in Three Different Forms of Vermicompost from Water Hyacinth (Tapi Region, Surat)

Sample Details	Total Bacterial Count (CFU/gm)	Total Fungal Count (CFU/gm)	Total Actinomycetes Count (CFU/gm)	Total N_2 Fixing Bacterial Count (CFU/gm)	Total P Solubilizing Bacterial Count (CFU/gm)	Total K Mobilizing Bacterial Count (CFU/gm)
Vermicompost (Dry Biomass)	2.4×10^7	2.2×10^4	2.9×10^5	1.2×10^6	1.6×10^5	5.5×10^4
Vermicompost (Burnt Biomass)	2.5×10^6	1.0×10^3	4.3×10^4	2.5×10^4	6.0×10^4	ND
Vermicompost (Composted Biomass)	5.3×10^6	5.8×10^4	6.3×10^4	5.0×10^4	4.5×10^4	1.7×10^4

Significant differences in microbial composition and NPK-related bacterial activity are shown by the physicochemical examination of the three distinct vermicompost samples (Dry Biomass, Burnt Biomass, and Composted Biomass) made from water hyacinth close to the Tapi area in Surat .Total Bacterial and Fungal Counts: The greatest bacterial and fungal counts were found in the composted biomass (5.3×10^6 CFU/gm and 5.8×10^4 CFU/gm, respectively), indicating improved microbial activity, breakdown, and nutrient enrichment. Lower microbial activity was seen in the burned biomass, which may be because prolonged exposure to high temperatures lowers microbial survivability. The greatest actinomycetes count (6.3×10^4 CFU/gm) was found in composted biomass, which is essential for the decomposition of organic waste and the production of humus. The count of burned biomass was much lower (4.3×10^3 CFU/gm), suggesting a lower level of microbial diversity. The maximum number of nitrogen-fixing bacteria (6.5×10^5 CFU/gm) was found in composted biomass, indicating increased nitrogen availability. Burnt biomass exhibited a high decline (2.5×10^4 CFU/gm), most likely as a result of bacterial loss brought on by heat. Composted biomass had the greatest P solubilising count (4.0×10^4 CFU/gm), which is essential for plant phosphorus absorption. Only dry biomass and composted biomass had phosphorus solubilizers. The absence of P-solubilizing bacteria in the burned biomass indicates a decrease in phosphorus bioavailability. K-MB, or potassium-mobilizing bacteria: Composted biomass was better in potassium release because it contained the greatest K mobilising bacterial population (1.7×10^4 CFU/gm).Potassium mobilising activity was absent from burned biomass, suggesting little ability to improve soil fertility .Composted Biomass is the best vermicompost type for increasing soil fertility out of the three since it showed the largest microbial diversity and NPK-related bacterial numbers. The least efficient material for recycling nutrients is burned biomass, which has far less microbial activity. In NPK enrichment, dry biomass performed worse than composted biomass, although maintaining moderate microbial populations. [13]

RESULTS AND DISCUSSION

After the analysis of above mentioned results our vermicompost from water hyacinth is extremely good in quality as compared to chemical and organic fertilizers for best reproduction and cultivation of crops and plants. Efficiency of proposed vermicompost and its interaction with soil, plants and microbes will be established after this research work.

Saving the Tapi River and fresh water for the population of Surat. To make new way of direction in water hyacinth and its problem facing by Surat Municipal corporation and fulfil the concept of sustainable growth in future perspectives in smart city criteria. Vermicompost will be easily available to farmers with value for money concept. Recycling from nature with minimal use of resources.

Pot study and agricultural study of vermicompost in selected local crops to check the effect in plants.

CONCLUSION

By using various composting methods, water hyacinth, an invasive aquatic weed, may be efficiently transformed into nutrient-rich vermicompost. According to the research, vermicomposting improves the water hyacinth's physicochemical characteristics and nutritional condition, making it a useful organic amendment. The most advantageous kind of vermicompost for use in agriculture is Type 3, which has the greatest NPK and micronutrient content. In addition to creating nutrient-rich organic fertiliser, this research shows that vermicomposting may be a successful strategy for controlling invasive aquatic plants like water hyacinth. Vermicompost enhanced with cow dung had the greatest NPK levels of the three formulations evaluated, making it the most advantageous for boosting soil fertility. Although there were notable differences in pH, electrical conductivity, organic carbon, moisture content, and C/N ratio, the physicochemical investigation verified that all three varieties of vermicompost enhanced soil-quality indices. These results highlight how important it is to include water hyacinth into composting procedures in order to promote sustainable agriculture in the Tapi area. In addition to helping with waste management, vermicomposting improves soil health and production by turning an ecological annoyance into a useful resource. Further investigation of vermicompost quality and effects on agricultural crop study has been carried out and different parameters like anatomy, physiology, biochemical objectives will be published in different title of research work.

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