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PRODUCTION OF ALGAE-BASED BIOFERTILIZER USING BIO EXTRACTED NUTRIENT SOLUTION

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Abstract

This study explores a sustainable and eco friendly method for producing algae based biofertilizer utilizing bio extracted nutrient solutions derived from organic waste materials. The nutrient medium was prepared using ethanol extracted potassium from musa paradisiaca (banana peels) and nitrogen from azadirachta indica (neem leaves), both collected from local solid waste sources. Algal biomass was sourced from Alapuram Lake, Dharmapuri, and cultured using the extracted nutrients. Growth was monitored over a 30-day period, with periodic measurements of Ph, turbidity, color and dry weight to assess algal development. The optimal growth was observed on the 15^{th} day with p H 7.4, Turbidity 33.4 NTU, and temperature 29.5 C. the final dry algal biomass was processed into powdered biofertilizer, achieving 14.53 g from an initial 9.9 g dry weight. The results confirm the viability of utilizing plant waste derived nutrients for algae cultivation and biofertilizer production, offering a low cost and environmentally sustainable, alternative to chemical fertilizers. This project highlights the potential for integrating waste valorization in modern agriculture.

Key words: Biofertilizer, algae, Nutrient extraction, Neem leaves, banana peels, organic waste, sustainability.

1. Introduction:

The increasing global demand for sustainable agricultural practices has highlighted the importance of bio fertilizers as an eco friendly alternative to chemical fertilizers. Among various bio fertilizer sources, algae have emerged as a promising source due to their ability to enhance soil fertility and plant growth while reducing environmental harm (Ammar et al,. 2022). Algae are rich in essential nutrients such a nitrogen, phosphorous and potassium, which are vital for plant health. Due to its benefits many small scale and large scale sectors develop algae at huge scale for various purposes. At the peak of its demand and competence, the algae are grown with chemicals for its rapid and bulk growth (chatterjee. A, 2017). Algal blooms affect the lives of organisms that live in ponds, lakes, streams, rivers etc. The excessive use of chemical fertilizers has raised concerns over soil degradation, water pollution, and ecosystem imbalance. Biofertilizers, particularly those derived from algae, offer a sustainable solution by enhancing nutrient cycling and promoting healthier plant growth. Algae-based fertilizers not only improve soil structure but also increase microbial activity, which is crucial for long-term soil health. Furthermore, the integration of organic waste materials boosts the nutrient value of the biofertilizer. This holistic approach supports both agricultural productivity and environmental conservation.

Even though its harm, it provides essential nutrients and act as soil conditioners..Hence, it was selected as raw material for algal based biofertilizer. The waste such as shredded *azadirachta indica* and the *musa paradisiaca linn* peel was taken for the nitrogen and potassium extract (godlewska.k et al., 2021). In the study, an attempt had been made to investigate the effect of bio extracted nutrient solution on the algal growth. The potential analysis had been made by analyzing the algal growth with applying varying dosage of bio extracted nutrient solution for the period of 30 days. The qualitative parameters had been observed.

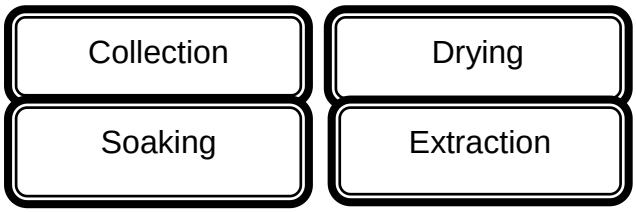
2. Materials and methods

2.1 Materials

Equipment included a hot air oven, ph meter, turbidity meter, porcelain mortar and pestle, whatman filter paper, weighing balance and white plastic culture containers.

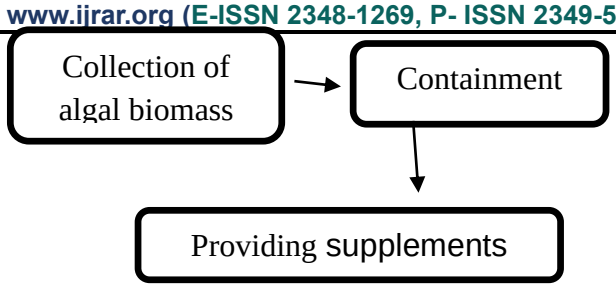
2.2 Bio Nutrient Extraction

Neem leaves and banana peels were dried, powdered, and soaked in ethanol at a ratio 1:10 ratio. Neem extract provided nitrogen rich nutrients while banana peel extract was high in potassium (kattubwe et al,. 2020) (sriraj. P et al., 2022). The p H of the potassium extract was 8.43 and the nitrogen extract was 5.49, confirming successful extraction.



2.3 Algal Collection and Culturing

Algae were collected from Alapuram Lake. Fresh samples were cultured in water supplemented with 2ml each of nitrogen and potassium extracts on the 10^{th} and 20^{th} day of the 30- day cycle. Environmental factors such as sunlight, aeration, and temperature were maintained naturally.



2.4 Biofertilizer Preparation

The grown algae were dried in hot air oven and powdered. The final dry weight of cultured algae was 14.53 g, compared to 9.9 g initially. Neem and banana powder were also used as carrier material to test future soil application. (Gajalakshmi.S et al., 2004)

Cultured Algal Biomass Dried in oven

Grinded biomass grinding process

3. Results And Discussion

3.1 Nutrient Extraction

246 ml of potassium and 117 ml of nitrogen solution were extracted from 25.24g of banana peel and 12.14 g of neem leaves, respectively.

3.1.1 potassium extraction

Table 3.1 Parameters Observed in Potassium Extraction Process

Serial Number	Parameters	Values	Units
1	Initial pH	7.33	-
2	Final pH	8.43	-
3	Weight of Collected *musa paradisiaca linn*	26	Gram (g)
4	Grinded *musa paradisiaca linn*	25.24	Gram (g)
5	Obtained extracted solution	246	milliliter (ml)

The measured 246 ml of potassium nutrient solution had been extracted from 25.24 g of powdered banana peel. The obtained value of pH for the banana peel extraction is 8.43.

According to the study, the pH of banana peel is 9.91 and the pH of ethanol is 7.33. The range of extract varies between the ranges 8-11. Hence it is within the range. It would not cause any affect, when it applied into the soil.

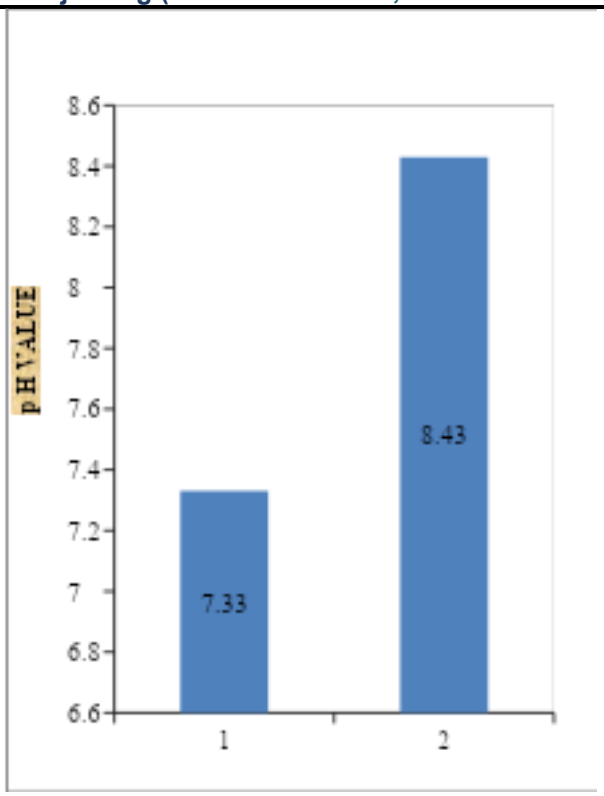


Figure 3.1 pH Graph for Banana Peel Extract.

4.1.2 Nitrogen Extraction Process

The neem extract range would be acidic in nature. The obtained pH Value was in acidic nature (<7). Due to the presence of ascorbic acid in neem leaves, the excess hydrogen ions exist in the neem leaves extracted solution. The decreased pH value is due to presence of excess hydrogen (H^+) ions. It ensured the extraction had been occurred.

Table 3.2 Parameters Observed in Nitrogen Extraction Process

Serial Number	Parameters	Values	Units
1	Initial p H	7.33	-
2	Final p H	5.49	-
3	Weight of collected *azadirachta indica*	15	Gram (g)
4	Grinded azadirachta indica	12.14	Gram (g)
5	Obtained extracted solution	117	Milliliter (ml)

The neem leaves were collected, dried and soaked in ethanol in 1:10 ratio i.e., 12.14 g in 120 ml of ethanol. The obtained extract amount was 117 ml from 12.14 g with pH 5.49.

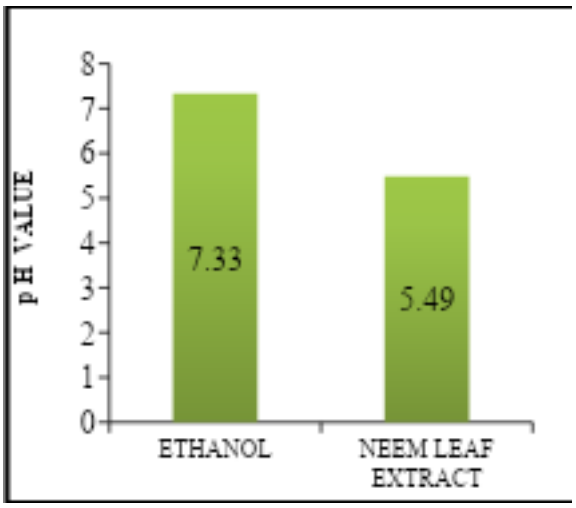


Figure 3.2 pH Graph for Neem Leaves Extract

3.2 Algal Growth Parameters

p H increased from 7.02 to 8.22; turbidity increased from 15.3NTU to 54.1 NTU; water color shifted from pale yellow to green. The optimal growth conditions were on day 15 at p H 7.4, Turbidity 33.4 NTU, a The algal growth was analyzed at below conditions,

Table 3.3 Growth Conditions of Algal Culture

Serial Number	Particulars	Conditions
1	Growth period	30 days
2	Light : dark	8:12 hrs
3	Aeration	Atmospheric air
4	Light	Sun light
5	Growth medium	Subsurface water
6	p H of growth medium	7.02
7	Turbidity of growth medium	15.3 NTU
8	Temperature	29.5 °C
9	Nutrient supplement	twice (10^{th}, 20^{th} day)
10	N	2 ml / 500 ml
11	K	2 ml / 500 ml
12	N:K	1:1
13	pH of Nitrogen Solution	5.49
14	pH of Potassium Solution	8.43

The observed pH values throughout the 30 days of algal growth period were given below.

Table 3.4 pH Values Observed during Growth Period

Serial Number	Day	pH Values
1	1	7.02
2	5	7.06
3	10	7.12
4	15	7.4
5	20	7.7
6	25	7.98
7	30	8.22

Here pH resulted as alkalinity i.e., 8.22 > 7.02 > 7.00

The pH, presence of hydrogen ions represents the algal growth by varying the pH value. A study states that, the pH level would increase after algal growth, because algae consume dissolved carbon dioxide, release oxygen and hydroxide alkalinity during photosynthesis. Due to the release of hydroxide ions, the pH range would increase.

The obtained pH value from algal growth analysis was 8.22 at 29.5°C. Initial pH was 7.02 (< 8.22). Hence alkalinity (>7) resembled. Here, the gradual increase in pH had been observed. This ensured the algal growth.

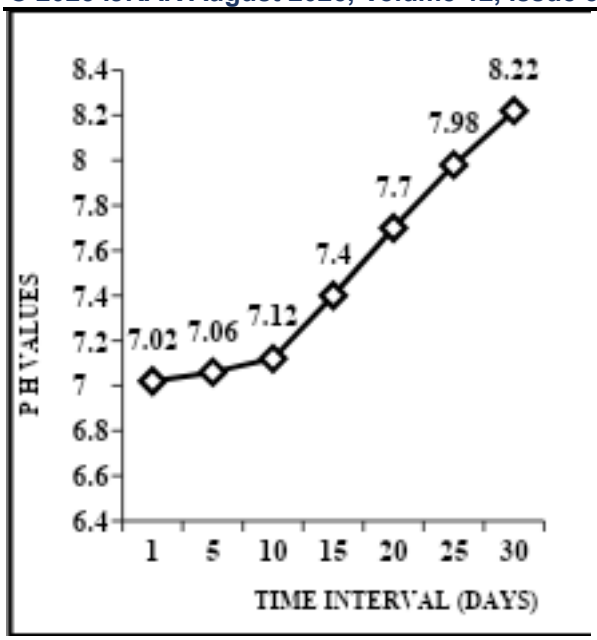


Figure 3.3 pH Graph of Observed Algal Growth

Serial Number	Day	Turbidity Values (NTU)
1	1	15.3
2	5	17
3	10	20
4	15	33.4
5	20	40.3
6	25	45
7	30	54.1

Table 3.5 Turbidity Values Observed During Growth Period

The algal growth makes the water turbid. Initial turbidity of growth medium was 15.3 NTU. Final turbidity of growth medium was 54.1 NTU.

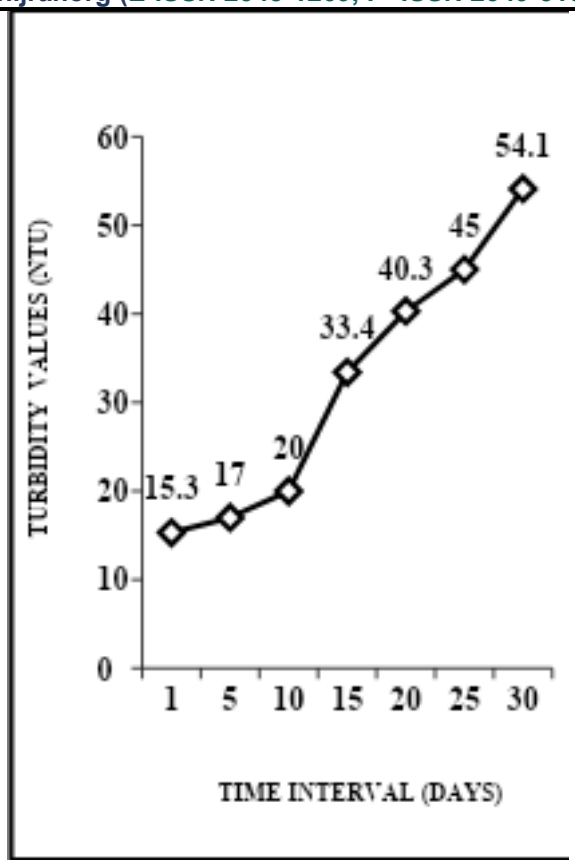


Figure 3.4 Turbidity Graph of Observed Algal Growth

4.2.3 Color Analysis

Generally, the presence of algal growth is the cause for green resemblance in the water body. The green color is due to the presence of chlorophyll in the algae for the photosynthesis process. Hence, the green color resembled in growth medium ensured the algal growth. The color difference had been visible during the growth period from white to yellowish green. This ensured algal growth.

3.3 Weight Increase

The dry biomass increased from 9.9 g to 14.53 g, demonstrating significant growth using the extracted nutrients.

Table 4.6 Weight Analysis of Algal Biomass

Particulars	Initial Weight (g)	Final Dry Weight (g)
Collected Algae	71.56	9.9
Cultured Algae	78.19	14.53

These findings align with previous research showing that neem extracts aid n nitrification inhibition and banana peels serve as rich potassium sources for fertilizer production (Gajalakshmi et al,. 2004; Katumbwe et al.,2020)

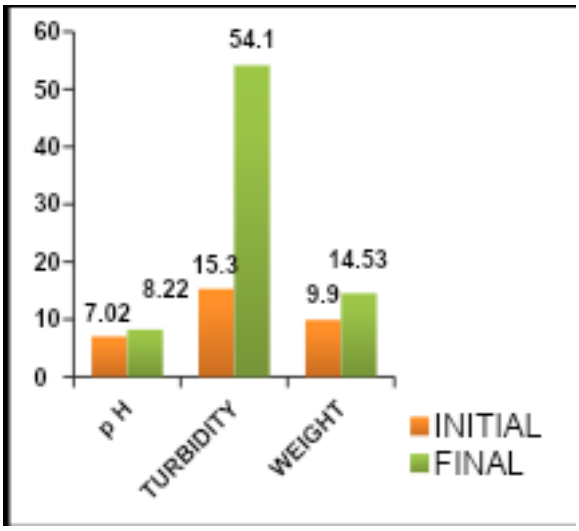


Figure 4.10 Overall Results - Graph

4. Conclusion

The experiment effectively demonstrated the use of ethanol – extracted nutrients from plant waste to culture algae, resulting in a functional biofertilizer. this method supports sustainable agriculture by reducing reliance on chemical fertilizers and reusing organic waste. The produced biofertilizer is rich in essential nutrients and environmentally safe.

5. Future Scope

- Testing biofertilizer quality and nutrient composition
- Applying biofertilizer to crops and measuring growth improvement
- Scaling the process for commercial applications

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