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SYNTHESIS OF NANO-FERTILIZER BY UTILIZATION OF BANANA PEEL EXTRACTION AND ITS EFFECTS ON THE GROWTH OF DIFFERENT PLANTS

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Abstract
Banana peel contains important nutrients that can be recycled into useful products used for different purposes. Banana peel is used to form a bio-stimulant Nano-fertilizer for agricultural purposes. Extract of Nano fertilizer from the banana peel is the main step for this study. The alkaline solution helps banana peel in the formation of Nano fertilizer. Nano-fertilizer extracts are subjected to physical and chemical analyses for characterization. The particle of fertilizer size range is between 18nm-54nm and the study shows that 39.9 nm is a major nanoparticle and it contains an average percentage of 36%. Nano-fertilizers increase the growth rate in plants. Fourier transform infrared spectroscopy (FTIR) inspection is used for the recognition of polymeric, inorganic, and organic materials. It used infrared light for sample scanning. Changes and errors in the characteristics sequence of the absorption band show an alteration in the composition of Nano- fertilizer. The synthesized Nano fertilizer from banana peel contains tryptophan, urea, proteins, citric acid, chelated potassium, amino acids, and chelated iron. Synthesized Nano fertilizer applied to pea, chili, and tomato plants. The study aims to observe the germination process in plants increases or decreases with increasing doses of banana peel extract for crops and to evaluate the effects of Nano fertilizers on pea, chili, and tomato plants. The obtained Nano bio stimulant shows great germination of different crops. \

Keywords – Nano fertilizer, Nano bio stimulant, Banana peel, FTIR, Growth Evaluation.

1 Introduction

Nanobiotechnology is an advanced approach to resolving multiple issues in various fields. Its scope has now spread its wings to other applied sciences with wide application in almost every aspect of life [1]. Currently, Nano fertilizers are being developed which are not only cost-effective but environment friendly leading towards sustainable agriculture [2] [3].

Nano fertilizers are made with composites of nanoparticles which are useful for improving nitrogen efficiency by increasing the germination of seeds [4]. Nano fertilizers made from Musa paradisiaca L (Banana peel) are known to control the release of nutrients from fertilizer granules to improve nutrient efficiency. It helps in the growing processes and photosynthetic systems improving leaves area, root length, and shoot diameter [5]. Banana peels are often discarded due to no significant applications but they can be recycled into various biomaterials such as biopolymer, biofuel, or bioplastics [6].

Furthermore, banana peels play a vital role as an antioxidant that contains three basic elements like nitrogen, potassium, and phosphorous. Banana peel extraction contains 78% potassium, 0.6% iron, 52% protein, and 0.517 tryptophan [7]. Similarly, banana peels are used for the production of bioethanol by utilizing the yeast of saccharomyces cerevisiae [8]. Insects and pests such as aphids do not like banana peels which is why it is put in the ground around cauliflower and roses to prevent creeping pests [9].

Potassium is found in high concentrations in banana peels playing its role in building up plants, and thereby promoting plant vigor and the growing process. Banana peels contain 200 mg of potassium content of the fruit providing nutrients and also acting as a pest-repellent [10]. They also contain potassium hydroxide that breaks lignin and cellulose. Tryptophan is an amino acid that increases yield. It not only speeds up the physiological processes but also plant metabolism, increases the availability of nutrients, and provides water during water stress [11]. It builds up enzymatic activity and formation of IAA (indole-3-acetic acid).

2 Methodology

2.1 Aim of study

To determine growth rate of different plants by utilization of nano fertilizer prepared from banana peel extraction.

2.2 Extraction of banana peel

2.2.1 Synthesis of wet Nano fertilizer

Fresh banana peels were obtained and washed with tap water to remove any sort of impurities, dust and to make sure there is no fungus present on them. The weight of banana peels was 0.65 Kg and were cut into small pieces by using knife or scissor. The banana peels were added in a blender and slurry was obtained. The slurry was mixed with 20% solution of KOH mixed with the viscous slurry. The alkaline slurry was then subjected to boiling for 30 minutes. It was then cooled down and 2g urea and 5% solution of citric acid was added into it dropwise until the pH became 5. After that was stored in airtight bottle and then placed into refrigerator.

2.2.2 Synthesis of dry Nano fertilizer

Fresh banana with no scar were obtained and the peel pieces in incubator at 55 until peels dry. The banana peels of 7.73 g were blended with tap water at high speed. The slurry obtained was mixed with 20% of KOH solution mixed. The alkaline slurry was subjected to 30 minutes. After that a 2g urea and 5% solution of citric acid until the pH became 5. Then form brown filtrate or brown sludge by vacuum filtration of the cold slurry. When the clear filtrate is obtained, it was heated at 45 C and stirring at 300 rpm.

2.3 Characterization of fertilizers

The obtained fine powder (alkaline filtrate) extracted from banana peel was added into a closed vessel at optimum pressure and temperature and treated with concentrated nitric acid. The extracted content was determined by atomic spectroscopy using the flame method. The proteins, other elements and tryptophan were analyzed and measured.

2.4 Growth Analysis

The effect of different elements (Nano fertilizer, plant manure and urea) on chili, pea and tomato plant was monitored. Tomato seeds incubated at 37 C were selected for seedling and were kept in moist form to produce seedling. Dry seeds of chili and peas were selected for planting. The plants were planted in separate pots and were compared with control. To check the effect of growth on these plants 0.01 g urea, 5ml Nano fertilizer and small amount of manure was added weekly.

2.5 Determining the wavelength of Nano particles

2.5.1 Spectrophotometer analysis

In order to determine wavelength of nano particles, 3ml wet Nano fertilizer was taken in petri dish and covered with aluminum foil. A small hole was left on the foil to avoid the growth of fungi. It was then incubated at 50 C for 2 days until it was completely dry. The dried Nano fertilizer was crushed into powder with pestle and vessel. 0.01 g of dry Nano fertilizer was mixed in three cuvettes with water and a separate cuvette filled with distill water as a control. The optical density (OD) was measured by comparing with the control sample referred at zero wavelength.

3 Results

3.1 Preparation of Nano fertilizer

The dried banana peels which were initially cut into small pieces and then place in the incubator at 30^oC for two days. The resulting dried crunchy solid become crunchy solid, which was ground in the pestle and vessel. It becomes a dark brown color semi-solid nano fertilizer.

3.2 Root Sprouting analysis

Nano fertilizer containing plants showed first root development after 3^{rd} week of plantation. After 4^{th} week of plantation, the plants containing urea showed first roots. The plant manure and control sample plants produced their first root after 5^{th} week of plantation.

Figure 1. Root sprouting of chili, tomato and pea seeds.

3.3 Evaluation of Fruiting

Pea plants took approximately 12 to 13 weeks for its proper growth, development of flowers and fruits. The growth of pea plant may vary depending on different variety of peas. In our study, it was observed that pea pods became mature within 17 to 20 days after their flowering phase.

3.4 FTIR analysis

The graph represents various ranges of wavelengths of nano fertilizer. In 4000 to 3000 cm-1 wave length represent presence of O-H, C-H and N-H bonds. The wavelength range between 3000 to 2000 cm-1 indicate the presence of Nitrile carbons containing triple bonding. In 2000 to 1500 cm-1, various double ate were formed between carbon- oxygen, carbon-carbon and carbon-nitrogen. Various peaks in this range indicate strong bonding of nanoparticles with urea which helps the formation of nano particles. In 1500 – 500 range, the single bond of C-C, C-N and C-O are present. The presence more double bonds show great structure formation with urea as a nano particle extracted from banana peels.

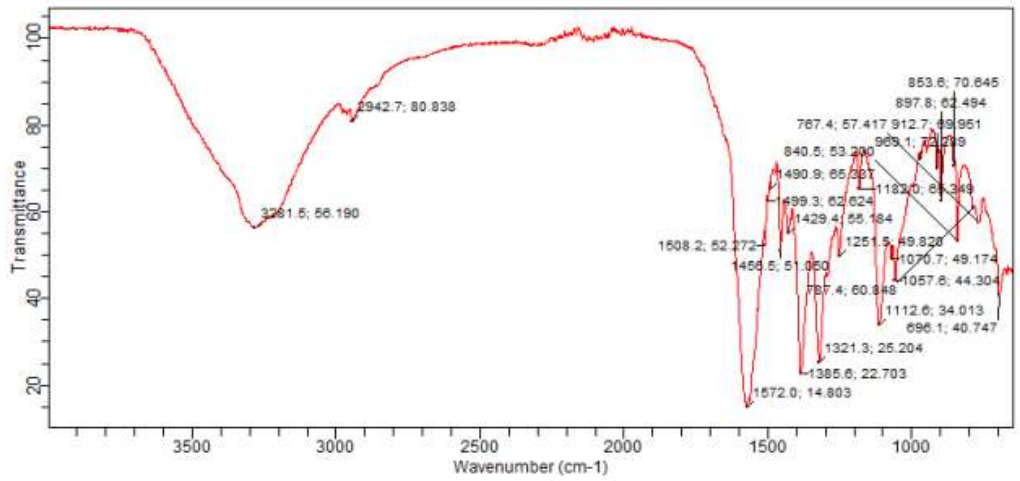

Figure 2. FTIR Analysis – the figure shows that the various ranges of wavelength obtained after experimentation.

3.5 Spectrophotometer analysis

Spectrophotometry revealed different wavelengths and absorbance rate of nanoparticles present in the nano fertilizer made from banana peels.

Table 1. UV- Vis Spectroscopy Analysis on Dry Nano fertilizer

Treatment	Wavelength (nm)	Absorbance
T0	200	0.128
T1	250	0.140
T2	300	0.196
T3	350	0.202
T4	400	0.209
T5	450	0.217
T6	500	0.224
T7	550	0.227
T8	600	0.235
T9	650	0.241
T10	700	0.239
T11	750	0.231
T12	800	0.221

Table 2. UV- Vis Spectroscopy Analysis on Wet Nano fertilizer

Treatments	Wavelength	Absorbance
T_0	200	0.015
T_1	250	0.020
T_2	300	0.083
T_3	350	0.091
T_4	400	0.095
T_5	450	0.105

T_6	500	0.109
T_7	550	0.112
T_8	600	0.215
T_9	650	0.125
T_{10}	700	0.117
T_{11}	750	0.095
T_{12}	800	0.075

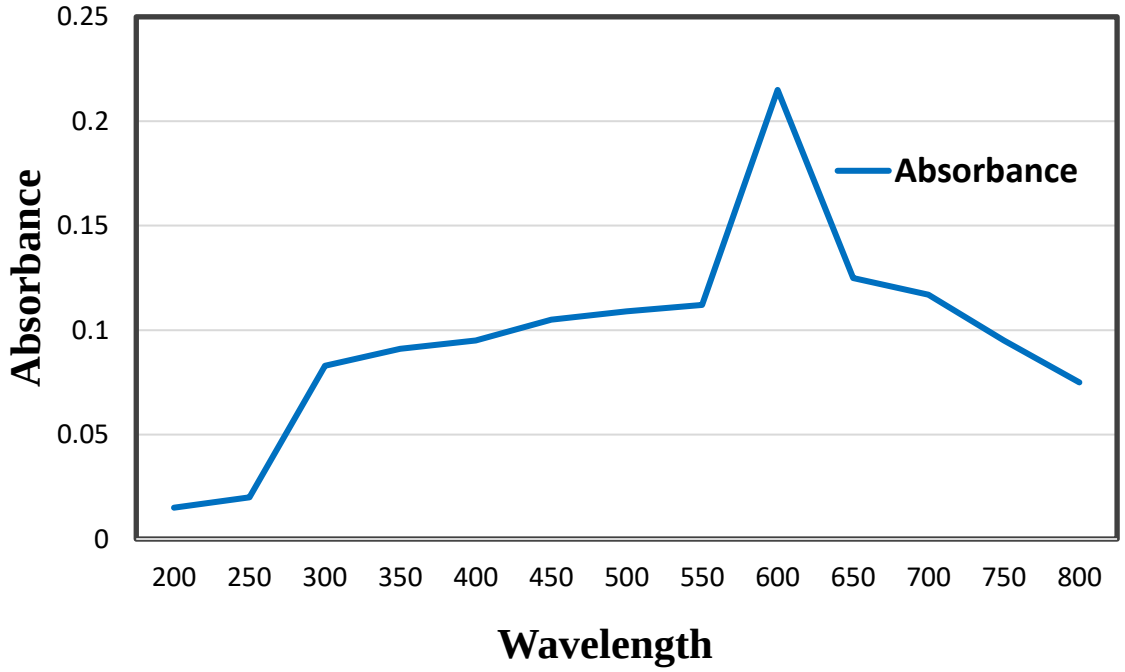

Figure 2. UV-Vis Spectroscopy Analysis on Wet Nanofertilizer.

Figure 3. Microscopic Analysis of fertilizer.

4 Discussion

4.1 Characterization of banana peel extraction

Nano fertilizer formulated from the banana peel, utilizing KOH as extracting agents under control optimum conditions. Citric acid reacted with elements forming a citrate mineral and urea utilized as a transporter for that citrate mineral in the Nano form. Similarly, it identified that an alkaline medium enhances the cellulose solubility during the digestion process of banana peels, which results in emancipating the micronutrients of total protein and tryptophan withdrawal that increases the greatest value on using 30 g of KOH. However, concerning changes in extraction efficiency and economic viewpoint, 15 g KOH was selected as the most favorable value.

Table 3. Effect of KOH dosage on tryptophan and total protein removal

No. Sample	Tryptophan mg/l removal	Potassium hydroxide g/kg dry peel	Tryptophan extraction Efficiency % extract	Total protein g/l extract	Protein extraction efficiency %
1	120	6	25	1.9	36.53
2	219	9	41.99	3.9	63.46
3	496	12	95.57	4.9	94.23
4	499	17	96.15	4.96	95.38

Table 4. Composition of banana peel extricate by alkaline extraction

Components	Concentration g/ kg dry banana peel
Protein	54
Iron	0.8
Potassium	80
Tryptophan	0.520

Potassium hydroxide is used as an extracting agent that helps banana peel to make nano fertilizers at optimum conditions. Potassium hydroxide helps to enhance potassium levels from banana peel. It converts the chelating agent to Nano chelating bio-stimulant fertilizers that increase the germination process. Nano fertilizer contains Nano formulations (Nanomedicine) of nutrients which deliverable to plants and allow homogeneous absorption. The effectiveness of nano fertilizer depends upon intrinsic and extrinsic factors.

5 Conclusion

Nano fertilizer extracted from banana peels has many significant roles in the field of agriculture. Nano fertilizer extracted from banana peels shows excellent germination productivity in 1st week for pea, chili, and tomato plants. That is why, it is recommended as an organic promoter for the germination of seeds and its seedling growth functioning by utilizing nanobiotechnology to move the normal extract of banana peels to Nano form affixed the progressive importance for this secure extraction and its beneficial effects as a growth promoter. Based on the pilot scale results gained in this study, future study on an industrial scale has to be achieved with support by professors, biochemists, botanists, and agriculture engineers taking into understanding the seed varieties, soil types, water irrigation, and economics of Nano fertilizers.

6 Conflict of Interest

The authors declare that they have no conflict of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

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