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Research Article

Establishment Of Nano Hydroxyapatite by Wet Chemical Process Characterization and Kinetic Study

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ABSTRACT

Nano fertilizer are new materials produced by means of nanotechnology. Plant nutrition is a crucial factor in the agriculture sector to maintain soil fertility and enhance crop productivity. It can serve slow release fertilizer supplying essential nutrient to plants. Nano Hydroxyapatite particle were synthesized using Helianthus annuus and banana peel powder by wet chemical Technique. n-HAP can be synthetically prepared from biowaste not only from the economical point of view but also it is very beneficial for environment. The prepared nano-hydroxyapatite powder was characterized by using different spectroscopy method (FTIR,XRD,SEM) and study their efficiency on okra plants .The data suggesting that n-HAP were able to enhance the growth of okra plants in comparison with traditional phosphorus fertilizer.

KEY WORDS: Helianthus annuus(sun flower), Musa sapientum (banana peel powder), nano particle, Okra plants(lady finger), nanofertilizer

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INTRODUCTION

Hydroxyapatite is a natural form of calcium formula n-HAP $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$. Nano-hydroxyapatite holds promise as an innovative approach in medicine as well as agriculture it can serve slow release fertilizer, gradually supplying essential nutrients like Calcium and Phosphorus to plants. It's nanoscale structure enhances nutrient uptake efficiency, promoting their plant growth and improved crop yield (volume-2). Nano-hydroxyapatite a nanoscale of calcium and phosphorus, exhibits excellent biocompatibility and bioactivity. It's an attractive candidates for soil amendment and nutrient management in agriculture (13).These nanoparticles exhibit very low toxicity, biocompatibility and naturally available degradation products in soils. Resent research trends have focused on altering synthesis pathway to

keep materials at the nano scale due to the benefits of nanomaterial application and their economic significance(11).Synthesizing HA from chemical sources in the form of phosphoric acid and calcium hydroxide has been achieved(14). Green synthesis uses ecologically friendly ingredients in nanoparticles, such as bacteria, fungi and plants extract-medicated synthesis offers an environmentally friendly production technique and has several applications in various research disciplines.

The hypothesis is that nano-sized particles can move in the soil and reach plant root through soil water flow created by transpiration (15). Nano Hydroxyapatite synthesized through green methods offers several benefits research have explored using biowaste sources to obtain n-HAP. These biowaste materials serves as a

suitable and ecofriendly alternative to conventional reagents(2). Green synthesis avoid toxic chemicals and expensive reagents by replacing synthetic chemical reagents with a green template can be formed efficiently and with controlled shape and size. Hydroxyapatite synthesized from chemical precursors such as calcium

and phosphorus (12). Nano hydroxyapatite is readily explained because materials with smaller sizes are more reactive and to the significantly larger exposed surface area.(14,15).Nanohydroxyapatite used as a multifunctional and sustainable from natural products for biomedical, Industry, Agricultural (34)

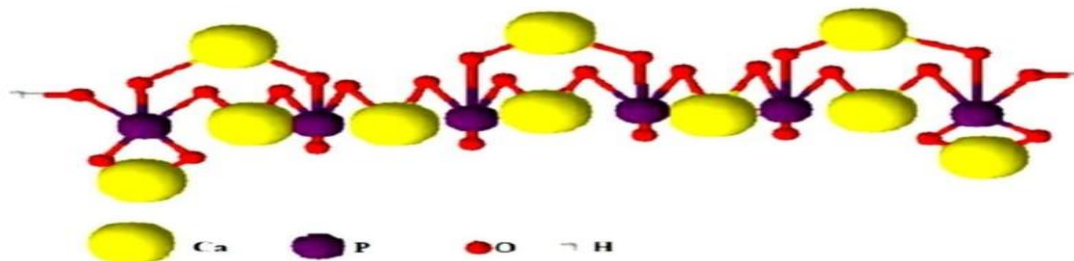


Figure 1- Structure of nanohydroxyapatite (Ref – 32)

MATERIAL AND METHOD

Hydroxyapatite nanoparticle were synthesized by wet chemical technique. In this study nano hydroxyapatite was synthesized with the help of sunflower seed by wet chemical process first sunflower seeds purchased from local market and it washed with normal water and then distilled water after that seeds in ethanol whole night

next day crushed seeds and again soaked than filtered this solution and used filtrate used for next step. Filtered divided into two parts –In first part added calcium hydroxide and phosphoric acid drop wise and In second part banana peel also added and then steering for further 24 hours to aid the development stage under continuous stirring.

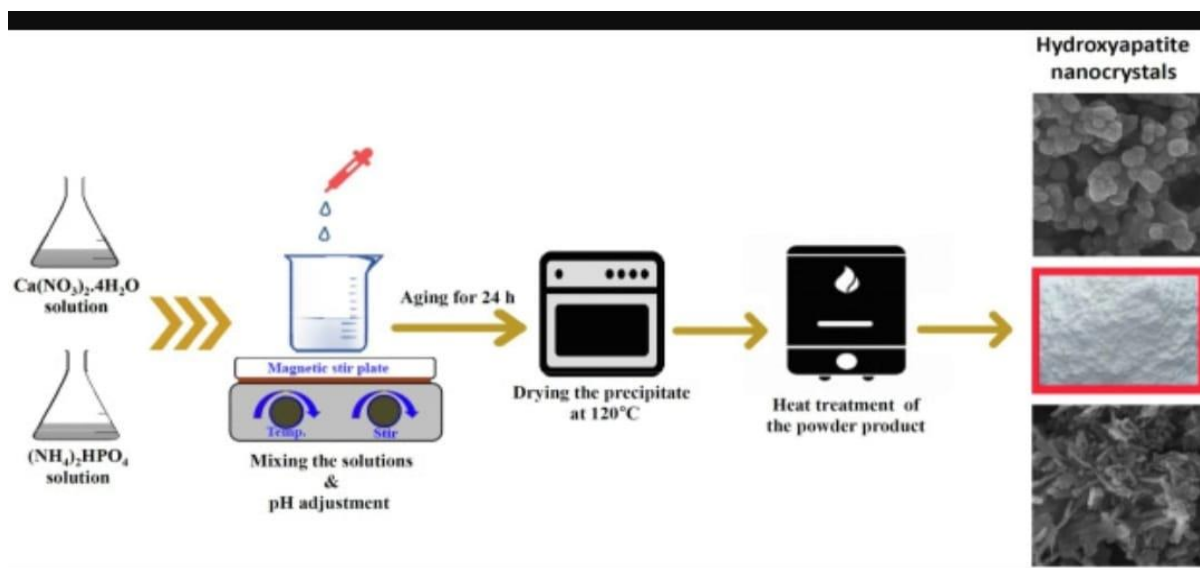
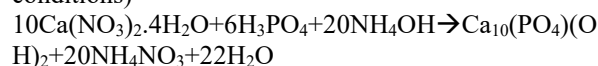


Figure 2 : preparation method of nano Hydroxyapatite (ref. 35)

In this reaction does not have any byproduct except water. Thus the need for frequent washing of the product is eliminated which makes product easy. In another study, priyam et al. reported the Ca/P ratio of 1-58 in the biologically synthesized HAP nanoparticles (28). Levinskas et al. reported the amounts 1.66% and 0.86% for Ca/P ratio and carbon di oxide respectively, in commercial HAP nanoparticles (24). In recent days, the synthesis of nanohydroxyapatite has been done using natural sources as a capping agent. This is more

advantageous than conventional method because it can show positively impact the environment without using expensive chemicals.(34)(multifunctional and sustainable hydroxyapatite from natural products for industrial applications- A comprehensive review which is shown in figure(3) (facile solution based synthesis off impurity free hydroxyapatite nanocrystals at ambient conditions)



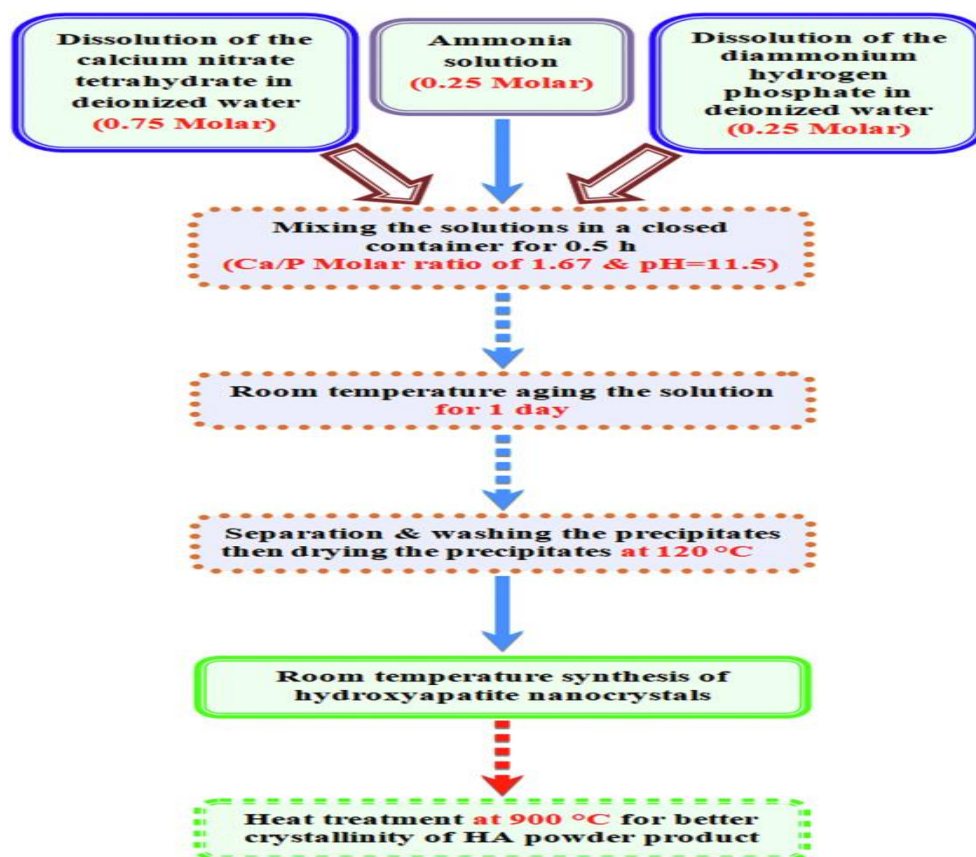


Figure 3- flow chart of preparation method of nanohydroxyapatite (35)

MOLECULAR STRUCTURE OF HYDROXYAPATITE-CHARACTERIZATION UV-VISIBLE SPECTROSCOPY

The UV-Visible spectrum showed a maximum absorbance peak at 200-400 nm for pure Hydroxyapatite. (Ref no 12). This peak indicates successful synthesis and can be used to quantify the concentration of hydroxyapatite in the sample.

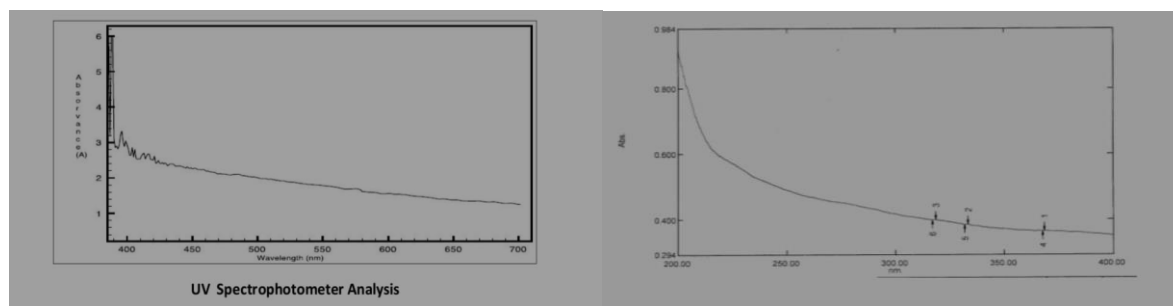


Fig.4- UV Spectra of HAP powder extracted from sunflower seeds

FOURIER TRANSFORM SPECTROSCOPY

FTIR is a powerful Technique used analyzed the vibrational modes of molecules. When applied to nano particles, it provides valuable information about it's structure and composition. The FTIR spectrum of n-HAP reveals characterization absorption bands corresponding to specific functional group. The

functional group included alcoholic group, phosphoric group, carbonate group, further confirming successful synthesis. PO_4^{3-} group exhibit peaks around 563cm^{-1} , 1017cm^{-1} , 1445cm^{-1} . CO_3^{2-} group are also observed in the spectrum. FTIR spectroscopy confirms the formation and purity of synthesized nanoparticles.

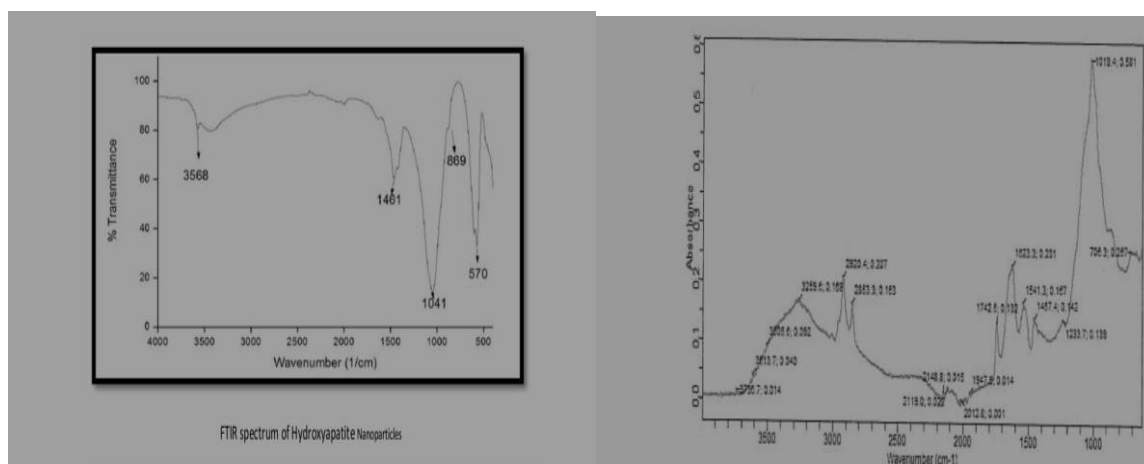


Figure 5- FTIR spectra of nano Hydroxyapatite

XRD SPECTROSCOPY

XRD spectroscopy is a valuable technique for analyzing the crystalline phase and structure of materials including

nanohydroxyapatite. XRD analyses confirmed that the shape of the synthesized nanoparticles was and exhibited a polycrystalline nature.

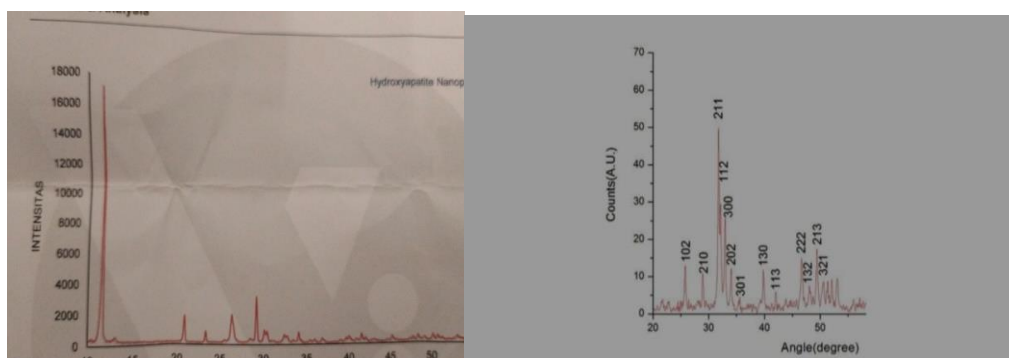


figure 6- XRD image of n-HAP prepared by sunflower seeds

SCANNING ELECTRON MICROSCOPY(SEM)—

SEM is a powerful spectroscopy used to analyze the surface morphology and composition of nano

hydroxyapatite . SEM provide the detailed image of the surface of nHAP , revealing features like particle size, shape and the presence of any agglomerates.

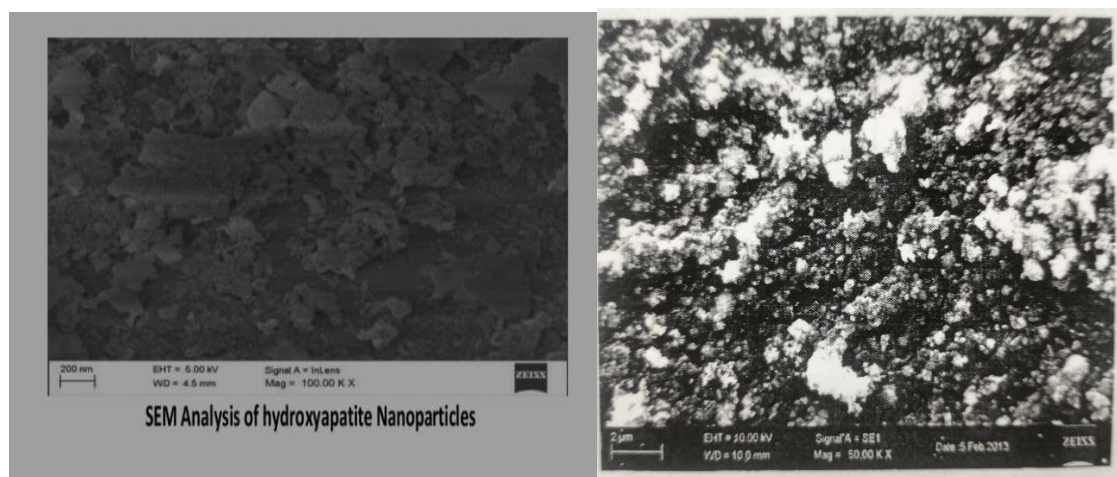


Fig 7- SEM spectroscopy of nano hydroxyapatite

EFFECT OF NANOHYDROXYPATITE ON OKRA PLANT POT EXPERIMENT



**Fig 8- comparative study of okra plant showing under different treatments: water without fertilizer (W) ,
synthetic fertilizer with sunflower seeds (S), synthetic fertilizer with banana peel and seeds (B)**

COMPARATIVE STUDY OF NANO HYDROXYPATITE:-

A comparative study using a plant observation testing experiment involves growing plants in controlled conditions to observe and measure various factors

affecting their growth. Root and shoot competition by using separate pots and saw the impact of root and shoot. The comparative study is done on the okra plant and saw the positive effects on plant.



Figure 9- comparaative study of shoot,leaf and fruit with and without n-HAP

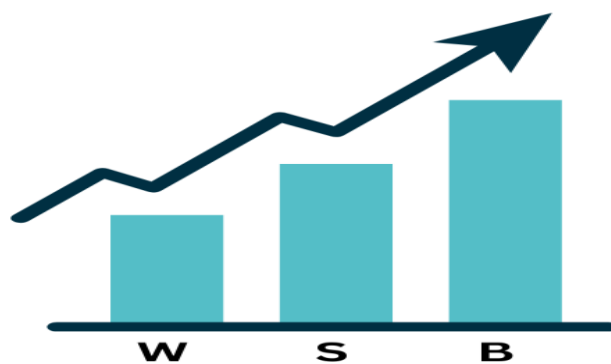


Figure 10- fertilizer effects of nanohydroxyapatite on okra plant

TABLE- showing the effect of nano hydroxyapatite on okra plant

	With n-HAP	Without n-HAP
Leaf length	15.5 cm	10.2 cm
Thickness of stem	1.5 cm	0.8 cm
Length of plant	90 cm	75 cm
Size of fruit	14.5 cm	10.4 cm
Size of flower	5 cm	3 cm

CONCLUSION

Nano Hydroxyapatite has been synthesized using the wet-chemical technique. The formation of nHAP was confirmed by Fourier transform infrared spectroscopy, x-ray diffraction. The pot experiment provides insights into the potential benefits of n-HAP on okra plant. It enhanced plant growth due to improved nutrients availability. Studies indicate that n-HAP can significantly enhance the growth and yield of okra by improving phosphorus availability in soil. There is a notable increase in the number of fruits and overall yield of okra plants and n-HAP shows more significant results with bio-organic matter. It's an ecofriendly conventional sustainable agriculture practice. Its other benefits will be known through field experiment.

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