International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 6 ǁ 2022 ǁ PP. 534-540

"Green Synthesis and Characterization of Cobalt Nanoparticles from *Pisonia Alba* Leaf"

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Abstract

Cobalt oxide nanoparticles have wide applications in several sectors due to their high resistance to corrosion as well as oxidation, ecofriendly nature, cost effectiveness and nontoxic potential. A facile, eco-friendly green synthesis of Cobalt oxide nanoparticles using Pisonia alba *leaf extract was reported. For instance, the use of biological materials such as plants is usually safe. Plants also contain reducing and capping agents. The characteristics of the CoNPs were determined by various analyses, including X-ray diffraction (XRD), Fourier-transform infrared (FTIR), Field emission scanning electron microscopy (FeSEM), Energy dispersive X-ray spectroscopy (EDX) and Dynamic light scattering method (DLS). Characterization techniques confirmed that the formation of nanoparticles and also they stabilized the nanoparticles.*

Keywords: *Green synthesis,* Pisonia alba, *Cobalt oxide nanoparticles, Characterization,*

Date of Submission: 26-05-2022 Date of acceptance: 08-06-2022

I. Introduction

Nanotechnology deals with particles of a size ranging from 1 to 100 nm, their synthesis strategy, and manipulation. This knowledge domain naturally commingles all the fields of natural sciences together with chemistry, physics, biological sciences, engineering, materials science, and computational sciences for the formulation of nanostructures [1]. Metal and metal oxide nanoparticles (NPs) have received substantial research attention due to their exceptional electrical, optical, magnetic and catalytic properties. These have enabled their broad use in diverse industrial, medical, agricultural and environmental applications, with further uses constantly under development. Traditional synthesis methods for pristine metal and metal oxide NPs include reducing and stabilising chemical agents that are toxic to humans and to other species in different trophic levels[2]. Conventionally, nanomaterials are synthesized using either chemical or physical methods which include sol process, micelle, chemical precipitation, hydrothermal method, pyrolysis, and chemical vapour deposition [3]. This study was designed with a simple, cost-effective, and environmentally synthesis method of CONPs at ambient conditions using *Pisonia Alba* leaves as a reducing and stabilizing agent.

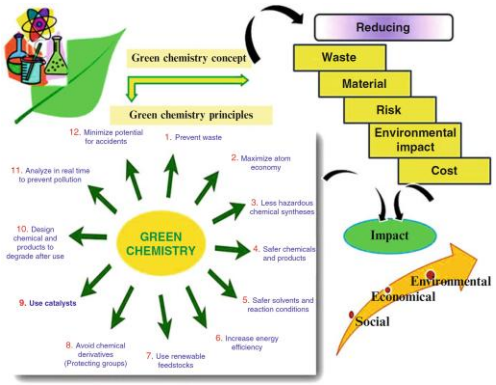

Figure 1: Schematic exemplification of green chemistry combination in metal nanomaterials cloning (4)

II. MATERIAL AND METHODS

1.1 Preparation of Pisonia Alba leaf exact

Pisonia Alba fresh and healthy leaves were collected from Veriyampatti near Vedasandhur in Dindigul district, and rinsed thoroughly first with tap water followed by distilled water to remove all the dust and unwanted visible particles cut into small pieces. The leaves *Pisonia alba* weighed 50g and added 150 ml of distilled water boiled for 10-15 minutes at 80°c in heating mental. The leaves extract was allowed to cool at room temperature and then filter using whatmann filter paper (5).

1.2 Synthesis of Cobalt Nanoparticles

For the synthesis of Cobalt oxide nanoparticles 1Mm of aqueous solution of cobalt nitrate was prepared. Adding 80ml of aqueous leaf extract and 20ml of cobalt nitrate 1mM solution was added in the beaker. It can be centrifuged at 1850 rpm in the magnetic stirrer for 1 hour. After 50 mins it can be settle and filter in the whatmann filter paper and dired in the oven. A cobalt nanoparticle was characterized by UV-visible spectrometer, FTIR, XRD, FESEM, EDAX, and Particle size analyzer (6).

1.3 UV-Vis Spectroscopy

UV-Vis spectroscopic analysis was carried out on Shimadzu UV 1800. Cuvette of path length 10 mm was used. The measurements were carried out as a function of reaction time at room temperature.

1.4 X-Ray Diffractometry

XRD measurements of the reduced CoNPs were recorded on XRD instrument operating at a voltage of 50kV and current of 1800 mA with Cu-Kα radiation λ = 1.540 A° with $20min^{-1}$ scanning rate to determine the crystalline phase and material identification. The samples were taken in lids and put under instrument for analysis.

1.5 Fourier transform infrared (FTIR) analysis

Perkin-Elmer spectrometer FTIR Spectrum ranging from 600 to 4000/cm at a resolution of 4/cm was used for the analysis. The sample was mixed with potassium bromide crystals. Thin sample disc was prepared by pressing with the disc preparing machine and placed in FTIR for the analysis of the nanoparticles as well as for the synthesized CoNPs.

1.6 Scanning electron microscopy and Energy-dispersive X-ray analysis

SEM analysis SEM analysis was done using Hitachi S-4500 SEM machine. Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid, extra solution was removed using a blotting paper and then the film on the SEM grid were allowed to dry under a mercury lamp for 5 minutes. Energy-dispersive X-ray analysis (EDAX) is a technique used for the measurement of nanoparticles by SEM. In this technique, the nanoparticles are analyzed by activation using an EDS X-ray spectrophotometer, which is generally present in modern SEM.

III. RESULTS AND DISCUSSION

1.7 Ultraviolet–visible spectroscopy

The UV-Vis spectrum of aqueous component of *Pisonia alba* leaf extract with 1mM aqueous cobalt nitrate solution was observed as shown in Fig. 1. The UV-Vis spectra showed the appearance of a single and strong band absorption peaks centered at about 346 nm respectively, thus indicating that the nanoparticles are isotropic in shape and uniform in size. This band is called the surface Plasmon resonance. There is significantly shift in the absorption peak of cobalt surface Plasmon resonance suggesting the formation of smaller cobalt nanoparticles.

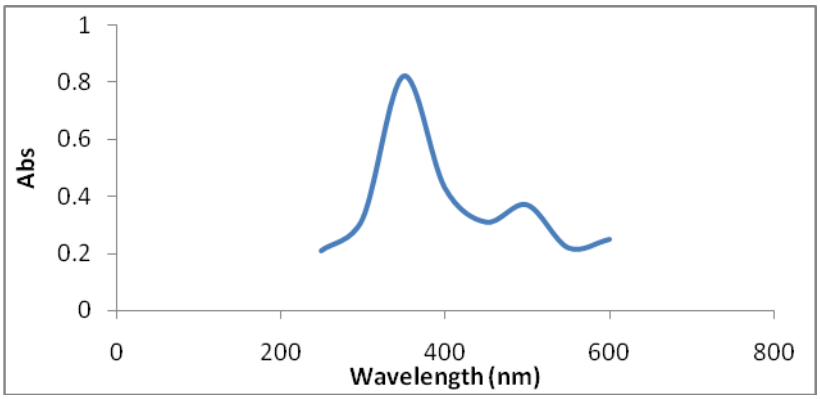

Fig.1 UV- Vis of cobalt nanoparticles using *Pisonia alba*

1.8 Fourier-transform infrared spectroscopy

The results of FTIR analysis of this study show different stretches of bonds shown at different peaks. The FTIR analysis was carried out between 3896.21cm^{-1} and 424.34cm^{-1} to identify the functional groups responsible for stabilizing the cobalt nanoparticles. FTIR spectra result shown in Fig.2 represents the silver nano particles from the leaf extract. FTIR spectrum of the leaf extract, which clearly shows peaks at 3896.21 cm^{-1}, 3857.63 cm^{-1} and 3819.06 cm^{-1} corresponds to the O-H stretching of hydroxyl groups. 3348.42 cm^{-1} can be due to O-H stretching in alcohols and phenolic compounds [7]. The band at 2978.09 cm^{-1} corresponds to C-H stretching vibrations of alkanes. C-H bond of alkyl group is showed peak at 2885.51 cm^{-1} [8]. This is typical of S-H vibrations, coming from L- cysteine, a primary of constituent of proteins is showed peak at 2360.87 cm^{-1}. The presence of heterocyclic compounds such as alkaloids and flavonoids in plant leaves are signaled by the bands at 1627.92 cm^{-1}, 1465.90 cm^{-1}. The peak value of 1365.60 cm^{-1} indicates the presence of alkyl halide groups. 1148.10 cm^{-1} corresponds to C-N symmetric stretching vibration. A small broad band at 1080 cm^{-1} may be inactive of the C-O stretching vibrations of ester, which could probably arise from the carboxylic acids. The C-H bending vibrations arising from the phenyl rings lead to the absorbent band at 817.82 cm^{-1} [9]. 424. 34 cm^{-1} which were assigned to the C-O stretching in carbonyl group [10]. These functional group plays a very important role in this cobalt nanoparticles synthesis. FTIR showed the structure, the respective bands of the synthesized nanoparticles, and the stretch of bonds.

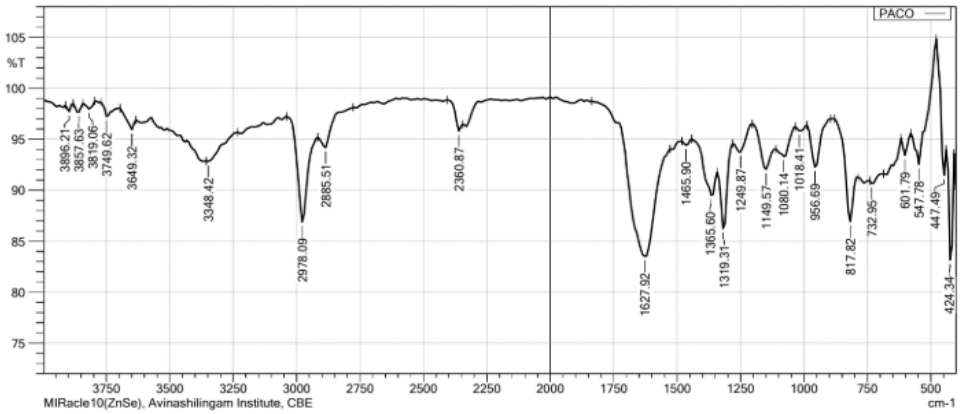

Fig.2 FTIR of cobalt nanoparticles using *Pisonia Alba*

1.9 X-ray diffraction

The powdered sample was used for XRD Analysis in order to confirm the presence of Cobalt nanoparticles. The XRD study has thus confirmed that the resultant particles in the prepared sample are cobalt nanoparticles having monoclinic structure. Relative intensities and Peak positions 2θ values of 19.59^0, 18.91^0, 16.44^0, 15.11^0 can be described to the (102), (210), (002), and (110) reflection planes of a monoclinic [11]. The synthesized cobalt nanoparticles are calculated from the width of the XRD peaks, and the Debye-Scherer equation is used to determine the average grain particle size of the nanoparticles. $D = K \lambda / \beta \cos\theta$ where D is the crystalline size of nanoparticles, λ is the wavelength of the X ray source (1.54 nm) used in XRD, β is the full width at half maximum of the diffraction peak, K is the Scherer constant with a value is 0.9, and θ is the Bragg angle. These peaks are due to the constituents present in *Pisonia Alba* extract. Generally, the broadening of peaks in the XRD patterns of solids is attributed to particle size effect. The broader peaks represent small size particles and that reflect the effects of experimental condition on the nucleation and crystal growth. The careful observations of peaks in the graph revealed that they are closed to the values which mean exactly cobalt Nanoparticles were produced by the reaction between cobalt nanoparticles and leaf extract of *Pisonia Alba* [12].

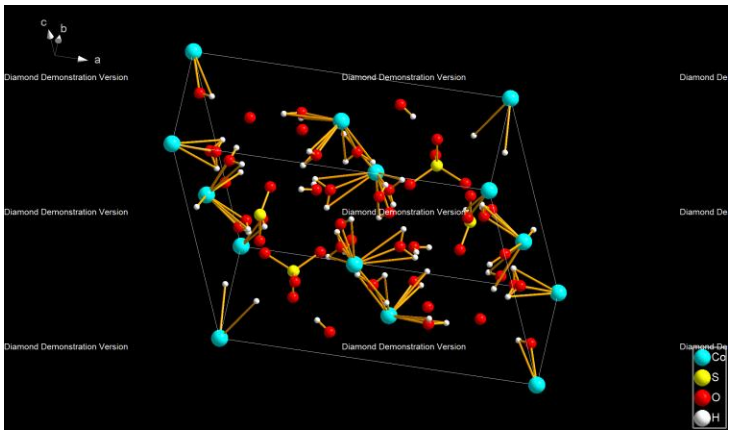

Fig.3 Crystal structure of XRD using PACo

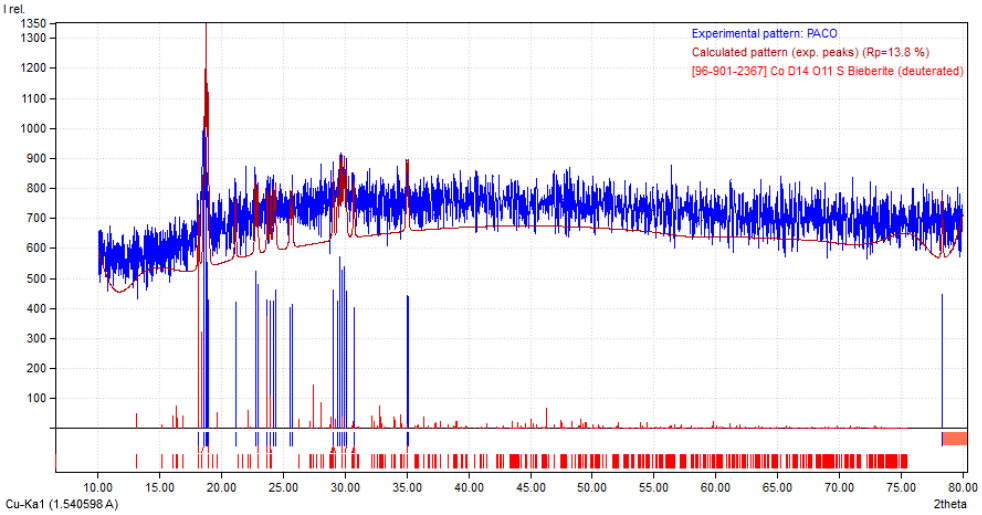

Fig.4 XRD spectrum of synthesized cobalt nanoparticles using *Pisonia Alba* plant extract

Table 1 : Miller indices (hkl) and corresponding diffraction

S.No	Diffraction	H	K	L
1	13.5545	1	0	0
2	6.7772	2	0	0
3	5.8566	1	1	0
4	5.5291	0	1	1
5	5.4164	-1	0	2
6	5.3857	-1	1	1
7	5.2706	0	0	2
8	4.8893	1	1	1
9	4.8191	-2	0	2
10	4.6889	2	1	0
11	4.6064	-2	-1	1
12	4.527	1	0	2

1.10 Energy Dispersive X-ray Spectroscopy

Energy – dispersive X-ray spectroscopy study was used to carry out the elemental analysis Cobalt nanoparticles. The purity and composition of the prepared particles were analyzed by EDAX. Fig.5 shows the EDAX spectrum of Cobalt Nitrate nanoparticles from plant extract method. EDAX spectrum not only identifies the elements corresponds to each of its peak, but the type of X-Ray to which corresponds well. Table 2 According to the atomic % and weight% of elements, Cobalt nanoparticles reduced by *Pisonia alba* have the weight and atomic percentage of cobalt 39.52%, 14.05 %. Maximum peaks around 127.4 keV correspond to binding energies of cobalt ions [13]. The peaks also reveals the percentage of elements present in the synthesized sample which clearly indicates the prepared cobalt nanoparticles contains. The higher a peak in a spectrum, the more concentrated the element is in the spectrum. The EDAX spectra is shown in Fig.5.6 which confirms 20% Cobalt element. There were other EDAX spectrum peaks for C and O suggesting that they are mixed precipitates present in the leaf extract [14].

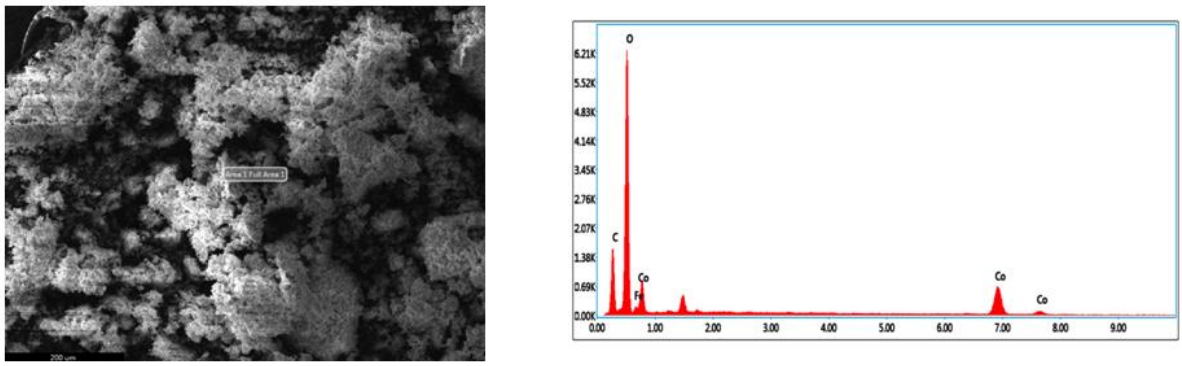

Fig. 5 EDAX of cobalt nanoparticles using *Pisonia alba*

Table.2 EDAX analysis of Cobalt nanoparticles

Element	Weight %	Atomic %
C K	18.18	31.72
O K	41.04	53.75
Fe K	1.25	0.47
Co K	39.52	14.06
Total	99.99	100

1.11 Scanning electron microscope

The SEM images of the Cobalt nanoparticles are shown in Fig.6. The Cobalt nanoparticles are formed in the form of white cloudy masses between colored grey masses of the sample. In the present study, the histogram of the particle size ranges from 5 to20 µm. This result strongly confirms that *Pisonia Alba* leaf extracts might act as a reducing and capping agent in the production of cobalt nanoparticles (16).

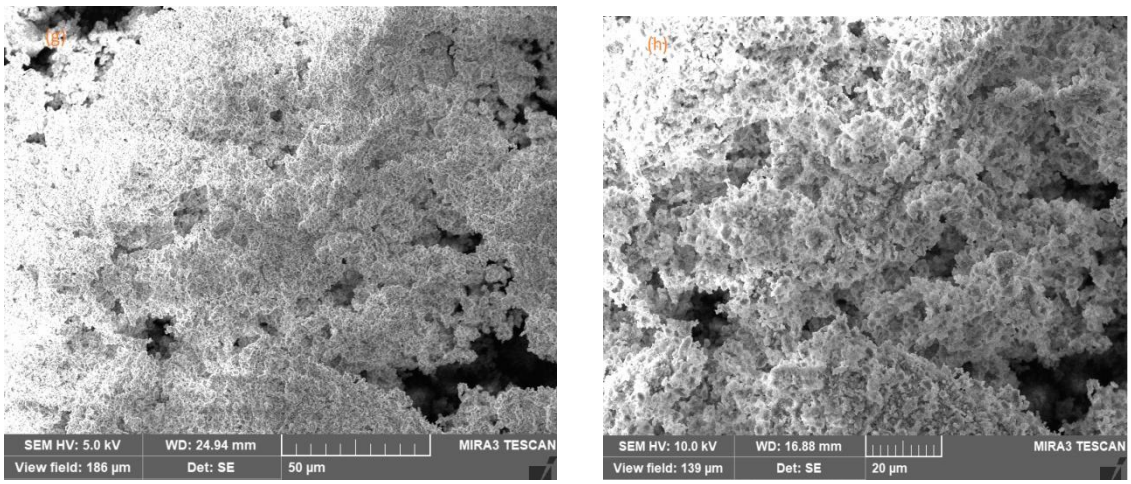

Fig. 6 FESEM images of cobalt nanoparticles using *Pisonia Alba*

1.12 Particle Size Analysis

Total concentration of Cobalt nanoparticles synthesized by *Pisonia alba* was found to be Intercept is 0.669. The size of Cobalt nanoparticles analyzed shows the "Z" range average values of about 1233 d. nm, with particle distribution rate of about 1.000 The size of the synthesized Cobalt nanoparticles is about 773.4 d. nm and its width is about 119.7 d. nm.. PLS technique studied the size distribution aspects of the cobalt nanoparticles were shown in Fig.7 (17). A measure of the zeta potential value describes the degree of stability of the colloidal solution bearing the cobalt nanoparticles. The value was found to be centered at−9.47mV and width 9.88 mV, a negative value with a high magnitude. This directly results in a highly stable colloidal solution as the like charges repel each other, there by denying the process of particle clustering. The fact that the zeta potential values were negative implied that the capping mechanism of phytochemical components was present in the leaf extract. The high negative zeta potential value may be ascribed to a shielding effect contributed by the bio-organic macromolecules resulting from the plant extract (12).

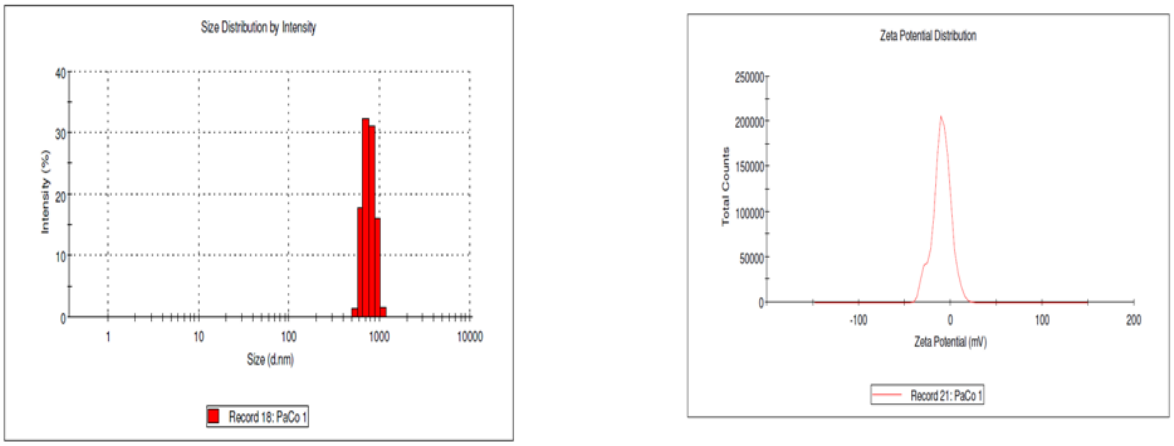

Fig.7 Particle Size Analyzer of cobalt nanoparticles using *Pisonia alba*

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