GREEN SYNTHESIS OF NICKEL NANOPARTICLES BY USING PLANT LEAF EXTRACT AS REDUCING AGENT

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ABSTRACT: *In the present work total reducing strength or phenolic compounds in leaf extract of Conocarpus erectus was determined in various solvents [water (59 ± 8 µg/g), ethanol (158 ± 5 µg/g) and methanol (296 ± 9 µg/g)] and then nickel nanoparticles (Ni NPs) were synthesized by using only methanol extract of Conocarpus erectus leaf as reducing agent because of its higher values of total phenolic compounds. Characterization of the green synthesized Ni NPs was performed by SEM (Scanning Electron Microscope) and XRD (X-Ray Diffractometer) techniques. The size of Ni NPs was estimated in the range of 30-90 nm. The usage of plant extract for the preparation of Ni NPs makes the process cost effective, non-toxic and green method.*

Keywords: Nickel Nanoparticles, *Conocarpus erectus*

1. INTRODUCTION

There is a variety of applications of Nickel nanoparticles (Ni NPs) such as automotive catalytic converters, a node of solid oxide fuel cells or conductive electrolytic layer of proton exchange membrane fuel cells, magnetic fluid and catalyst, coatings of plastics, nanowires, nanofibers and textiles, propellant and sintering additive etc. [1]. Several in-solution methods (liquid-phase reduction methods) are relatively simple, less expensive quicker to implement and do not require special equipment [2, 3]. Recent years Biological (or green) approach using plants or plant extracts and microorganisms for the syntheses of metal nanoparticles have recently been advised as substitutes to hazardous (chemical) methods [4].

Phenolic compounds like tannins, flavonoids and phenolic acids are considered to be involved in redox activities so they are key performer to the reducing or antioxidant activity of medicinal plants, fruits or vegetables. The phenolic compounds because of their redox activities behave as hydrogen donators, reducing agents, singlet oxygen quenchers and also metal chelating agent [5]. In plant extracts there are numerous types of phenolic compounds. They are highly reactive compounds and get involved in redox reactions. The presence of total phenolic substances within the plant extract could be liable for metal ions reduction and creation of the respective metal's nanoparticles [4].

Conocarpus erectus is the species of family Combretaceae. It is an evergreen tree and grows on coastal areas of hot regions of the world [6]. Its (*Conocarpus*) various extracts were reported a large variety of total phenolic compounds [7, 8].

The aim of present work is to synthesize cobalt nanoparticles by using leaf extracts of plant (Conocarpus erectus) having higher values of total phenolic compounds because to the best of our knowledge through literature it was the first time to use plant leaf extract (*Conocarpus erectus*) for the green synthesis of nickel nanoparticles.

2. MATERIAL AND METHODS

All reagents such as Nickel sulphate and Methanol which were used throughout the research work were of analytical grade supplied by Merck (Germany) and Sigma-Aldrich (USA). Equipment were Analytical balance (Sartorius, Germany), SEM analyzer (Hitachi S4160, Japan) XRD analyzer (Karaltay, DX-2700 MIN), Magnetic stirrer/Hot plate (MS-H-Pro+), vacuum filtration assembly (Thomas 4595D45), Thermostat/incubator (Seimens), Spectrophotometer (Tomos), grinder (West point).

2.1. Preparation of extract of samples

Sample (*Conocarpus erectus*) was obtained from the Main Campus of NED University Karachi and they were shad-dried for one week and then they were grinded. 100 g of shade-dried leaves were grinded to form powder then it was added to 500 mL methanol, ethanol and distillated/deionized water in 1L flask and mixed vigorously. The preparation of plant extract was performed by using hot plate/magnetic stirrer at 50¬° C for 1 h. The acquired plant extract was filtered by vacuum filtration assembly.

2.2. Determination of total reducing strength or total phenolic compounds

Total reducing strength or total phenolic compounds in all plant extracts were determined as described by singleton *et al.* [9] with the help of spectrophotometer. Briefly 0.5 mL of extract added with 10 % Folin-Ciocalteu's reagent (2.5 mL in equal voume of 7.5 % $NaHCO_3$). Blank was prepared by adding methanol (0.5 mL), 10 % Folin-Ciocalteu's reagent (It was dissolved in water and 7.5 % $NaHCO_3$ in equal volumes of 2.5 mL). The reaction mixtures were incubated at a temperature of 45° C for 45 minutes in an incubator/thermostat. The absorbance of solution was noted at 765 nm wavelength using spectrophotometer. Standard solution of gallic acid was used as standard.

2.3. Green synthesis of nickel nanoparticles

The nickel nanoparticles were prepared in a 250 mL conical flask in which 50 mL cent molar solution of nickel sulphate was mixed with 10 mL of the plant extract (100 g of dried leaves powder of was added to 500 mL methanol, ethanol and deionized/distillated water in 1L flask) along with vigorous shaking on a hot plate till the appearance of light blue colour.

2.4. Characterization of Ni NPs Characterization

The external appearance and size of produced Ni NPs were characterized by using SEM (Scanning Electron Microscope) and X-Ray Diffractometer (XRD).

3. RESULTS AND DISCUSSION

3.1. Total phenolic compounds

Leaves extracts (water, ethanol and methanol) of *Conocarpus erectus* were investigated for total phenolic compounds and it

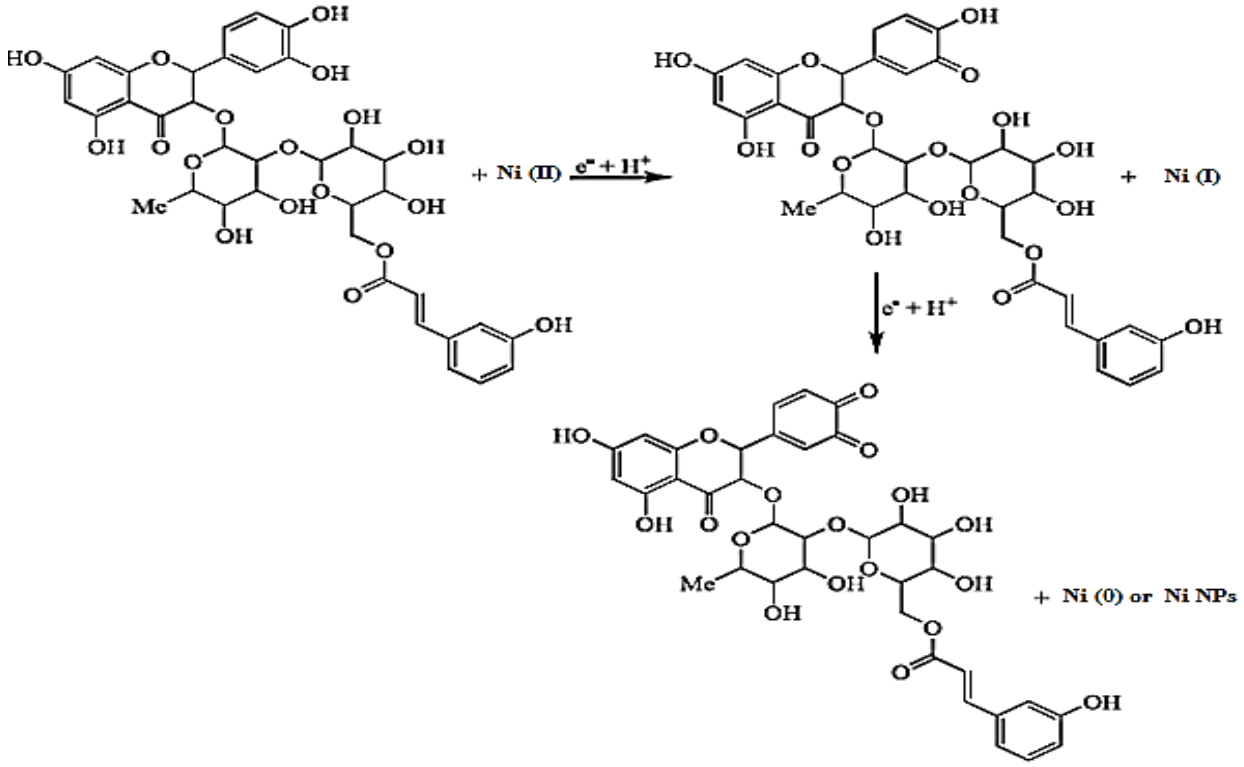

Fig. 1. Scheme/Mechanism for the formation of Ni NPs by phenolic compounds

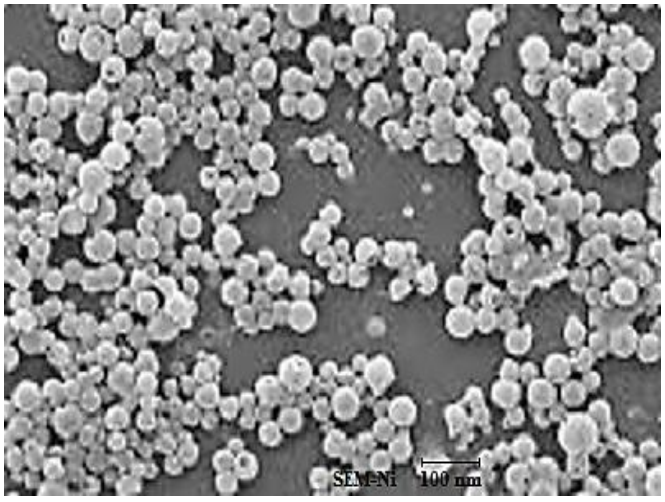

Fig.2. Scanning Electron Microscope Image of Green synthesized Ni NPs by *Conocarpus erectus*

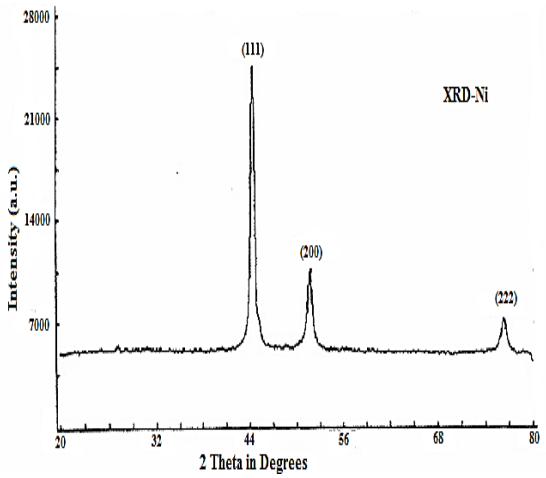

Fig. 3. XRD of Green synthesized Ni NPs by leaf extract of *Conocarpus erectus*

was found that the highest quantities were present in methanol extracts (296 ± 9 µg/g), followed by ethanol extract (158 ± 5 µg/g) while in water extract very low amounts of total phenolic compounds were observed (59 ± 8 µg/g). As methanol leaf extract of *Conocarpus erectus* contained higher values of phenolics so in the present study it was used for the green synthesis of Ni NPs.

El-Sayed *et al.* [8] have reported that the total phenolic compounds were higher in ethyl acetate fraction of fruits and flowers (303.45 and 301.15 mg/g GAE respectively) whereas they were lower (186.21 and 181.61 mg/g GAE) in leaves and stem. On the contrary our results shows the methanol extract of leaves contain higher values which might be due to environmental effect and choice of solvent [10]. Our selection of leaves extract as raw material for the green preparation of nickel nanoparticles is only due to the abundance and availability of leaves throughout the year.

In the present work our main focus is on the synthesis of Ni NPs using reducing properties of total phenolic compounds inside the plant leaves according to the scheme/mechanism (Fig. 1). Of course, the effect of other phytochemicals inside the plant is also possible [4].

3.2. SEM analysis

The SEM analysis is helpful in determining the structure of the Nanoparticles (or reaction products) that were fashioned. The SEM image (Fig. 2) disclosed a number of discrete and spherical Ni NPs. The SEM image of Ni NPs also revealed that spherical shaped nanoparticles were fashioned with the diameter range 30-90 nm. Similar types of images for Ni NPs were also reported by various researchers [1, 2, 3].

3.3. XRD analysis

The powdered sample was used for XRD Analysis in order to confirm the presence of Ni NPs (Fig. 3). The three characteristic peaks for nickel 2 θ = 44.6°, 51.9° and 76.8°, which is related to Miller indices (111), (200) and (222), respectively, were witnessed, showing that the nickel nanoparticles are face-centered cubic (FCC) nickel (PDF #04-0850) [11]. The XRD plot also shows that the (111) reflection is the highest intensity for the peaks. After comparing the XRD peaks pattern to the JCPDS database (PDF #04-0850), the pattern matches a random powder arrangement for nickel [11].

4. CONCLUSION

It was concluded that methanol extract of *Conocarpus erectus* leaves contained higher value of total phenolic compounds (296 ± 9 µg/g). It is also concluded that extract of *Conocarpus erectus* leaves can be utilized as a good reductant for the non-toxic or green synthesis of metal (Ni) nanoparticles.

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