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Biosynthesis of Nickel Nanoparticles Using Leaf Extract of Coriander

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Abstract

Nickel nanoparticles has been synthesized using nickel chloride as a precursor and coriander leaf extract as a reducing agent and stabilizing agent at room temperature under ordinary condition. The progress of the reaction was monitored most probably observing change in colour of obtained solution. The synthesized nickel nanoparticle was confirmed by UV-Vis, FTIR and powder XRD techniques. The size of nanoparticle was determined by using powder XRD and found to be 30.71 nm. The merits of this method are easily available material and inexpensive starting material, short reaction time, easy to carry out.

Keywords: ***Biosynthesis; Coriander leaf; Nickel chloride; Nanoparticle; Nickel***

Introduction

Synthesis of metal nanoparticles has gained significant interest in last twenty years because of their unusual properties and prospective applications in optical, electronic, catalytic, magnetic materials, thermal properties with corresponding bulk metals. In particular, magnetic nanomaterials show evidence of very large magnetoresistance, large coercivities, high curie temperatures and low saturation magnetization. Therefore, magnetic nanomaterial has attracted much attention in sensors, imaging, magnetic storage and ferro-fluids applications. In addition to magnetic properties, size-dependent melting properties of nickel nanoparticles also have been used to diffusion braze stainless steel at lower temperature and pressures [1].

A number of methods have been developed for the preparation of metal nanoparticles such as photo catalytic reduction, radiolytic reduction, sonochemical method, solvent extraction reduction, micro emulsion technique, polyol process and alcohol reduction [2]. Among the diverse kinds of metal nanoparticles, the preparation of some metal nanoparticles, such as nickel, copper and iron, are comparatively hard because they are easily oxidized. Nickel as an important transition metal, and nickel nanoparticles have wide ranging applications in the areas of permanent magnets, magnetic fluids, magnetic recording media, solar energy absorption, fuel cell electrodes, catalysts, biological activity [2]. Due to all these reasons the synthesis of Ni nanoparticles has attracted great focus of many scientists for its synthesis. Various methods were developed for the synthesis of nickel nanoparticles [3-18], many of these methods are accompanied by tedious process for isolation of nanoparticles, drastic reaction conditions, and use of expensive reagents, hence there is scope to develop new methods for synthesis of Ni nanoparticles.

The green synthesis as an eco-friendly pathway for nanoparticles synthesis. Here, we use coriander leaf extract for synthesis of Ni nanoparticles. Coriander (*Coriandrum sativum* L.) is spice crop which belongs to the family Apiaceae (Umbelliferae) is mainly cultivated from its seeds throughout the year [19]. A Constituent of coriander are phenolic acid including caffeic and chlorogenic acid and also contain essential oils like (E)-2-decenal, linalool, (E)-2-dodecenal, (E)-2-tetradecenal, 2-decen-1-ol, (E)-2-undecenal, dodecanal, (E)-2-tridecenal, (E)-2-hexadecenal, pentadecenal, and α-pinene [20]. The flavonoids include quercetin, keampferol, rhamnetin, apigenine and most of these compounds are known to suppress free radicals generated in the cell, when they are obtained through the diet [21]. Coriander has been reported to possess many pharmacological activities like antioxidant [22], antidiabetic [23], anti-mutagenic, anti-lipidemic, antispasmodic [24].

Materials and Methods

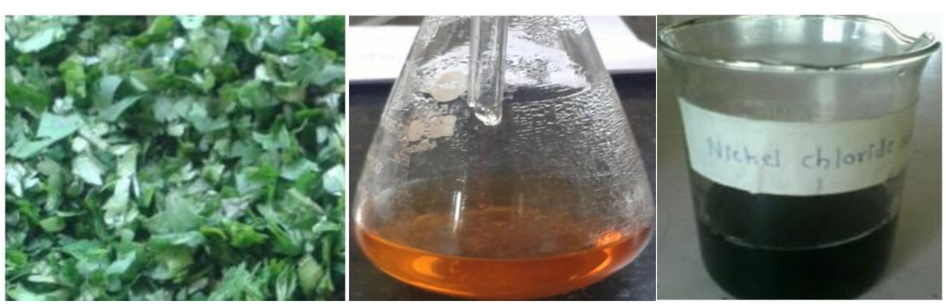
Preparation of coriander leaf extract

All the chemical and reagents used in this experiment were of analytical grade purchased from Loba Chemicals. The coriander leaves were purchased from Rajgurunagar vegetable markets, Pune, Maharashtra 410505, India. The coriander leaves were thoroughly washed and dried in shade. For preparing the plant broth solution, 20 gm dried leaves of coriander ware cut into small pieces and washed with distilled water. This was taken in a 250 ml beaker with 100 ml of distilled water and then boiled the mixture for 20 min at 80°C. The extract was filtered through Whatman filter No. 1 and then was stored at 5°C and can be used within a week.

Synthesis of Ni nanoparticles using coriander leaf extract

A volume of 10 ml of coriander leaf extract was added to 100 ml of 1 mm aqueous nickel chloride solution in a 250 ml Erlenmeyer flask. The colour of the solution changes from green to pale yellow after addition of coriander leaf extract and stirred the resulting solution for homogeneous mixing. The flask was kept at room temperature for overnight and Ni nanoparticles were separate out and settle at the bottom of mixed solution of nickel chloride and coriander leaf extract. The Ni nanoparticles thus obtained was purified by repeated centrifugation method at 5000 rpm for 15 min followed by re-dispersion of the pellet in deionized water. Then the Ni nanoparticles were dried in oven at 80°C. The progress of the reaction is shown in FIG. 1.

The pH of nickel chloride solution was 4.0, when we added coriander leaf extract to this solution, pH changes from 4.0 to 4.24. The pH of coriander leaf extract was 6.78. From this we confirmed that the capping between nickel and coriander leaf extract was taken place.



(a) **(b)** **(c)**

FIG. 1. **Steps for synthesis of nickel nanoaprticle. a) Coriander leaves; b) Coriander leaves extract; c) Nickel chloride solution 0.1 M, coriander leaves extract, and nickel nanoparticles settled at bottom.**

Equipment

UV-Vis spectral analysis was done by using a double beam spectrophotometer 2203 Systronics, in the range of 400 nm to 700 nm.

Fourier transform infrared spectrum was obtained using a JASCO FT/IR-6100 FT-IR spectrometer**,** at Department of Physics, Savitribai Phule Pune University, Pune, Maharashtra, India.

The XRD result was obtained using D8 advance diffractometer, Bruker AXS, at Department of Physics, Savitribai Phule Pune University, Pune, Maharashtra, India.

Results and Discussion

The synthesized Ni nanoparticles were characterized by UV-Vis, FTIR and XRD techniques.

UV-Vis spectroscopic analysis

The reduction of nickel chloride to pure nickel nanoparticle was monitored by using ultraviolet visible spectrophotometer. The absorption spectrum of pale yellow nanoparticle solution prepared with the proposed method showed a palsmon absorption band with a maximum of 560 nm and the spectra is shown in FIG. 2.

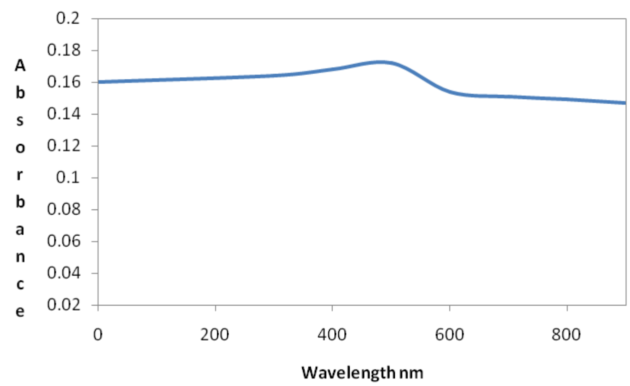


FIG. 2. **UV-Vis spectrum of nickel nanoparticles dispersed in deionized water at room temperature.**

Fourier transform infrared spectroscopic analysis

FTIR spectra of biosynthesized nickel nanoparticles were recorded to identify the capping and efficient stabilization of the metal nanoparticles by biomolecules present in coriander leaf extract. The FTIR spectrum of synthesized Ni nanoparticles using coriander leaf extract was shown in FIG. 3. The band at 3495 cm^{-1} corresponds to O–H stretching of alcohols and phenols. The band at 1565 cm^{-1} corresponds to N–H bend of primary amines. The peak at 1413 cm^{-1} corresponds to C–N stretching of aromatic amino group. The band corresponds to 1674 cm^{-1} corresponds to carbonyl group of flavonoids, phenolic acids etc. The band at 1219 cm^{-1} corresponds to C–O linkages of phenol, acid, flavonoids. The band at 500 cm^{-1} corresponds to nickel. Therefore, the synthesized nickel nanoparticles were surrounded by proteins and metabolites such as phenolic acid, carboxylic acid, flavonoids. From the analysis of FTIR studies we confirmed that phenolic compounds have the stronger ability to bind metal indicating that the phenols could possibly form the metal nanoparticles to prevent agglomeration and thereby stabilized the medium. This suggests that the biological molecules could possibly perform dual functions of formation and stabilization of Ni nanoparticles in aqueous medium.

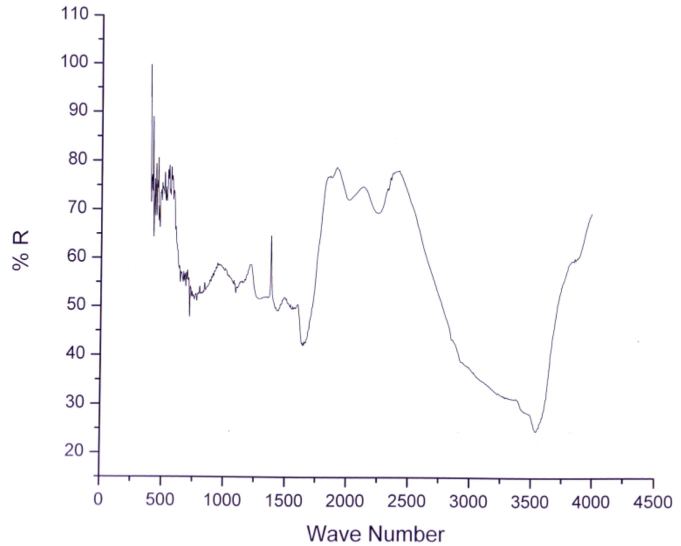


FIG. 3. **FTIR spectrum of synthesized of Ni nanoparticles using coriander leaf extract.**

X-ray diffraction analysis

XRD pattern of synthesized Ni nanoparticles using coriander leaf broth extract is shown in FIG. 4. The sample demonstrated a high crystallinity level with diffraction angles of 20.39°, 31.03°, 31.73°, 37.00°, 41.08°, 42.97° and 53.21° which correspond to the characteristic of face centered cubic of nickel lines indexed at (111), (211), (210) and (220). The diffraction angle observed at 20.39° which is related to the coriander leaf extract. The average size of the nickel nanoparticles was found to be 30.71 nm. The size of the NPs was determined using Debye-Scherrer equation, which may indicate a high surface area, and surface area to volume ration of the nanocrystals TABLE 1. The equation is written below:

$$D=k \times \lambda/\beta \times cos\theta$$

$$D=0.9 \times 1.54/((\pi/180) \times \beta \times cos\theta)$$

Where, D: grain size; K: constant (0.9 for spherical particle); B: full width at half maxima of peaks; θ: corresponding angle for peaks.

TABLE 1. **Calculated size of nickel nanoparticles for respective peak from XRD.**

Peak No.	**D in Å**
1	345.7738
2	293.575
3	443.52
4	271.8286
5	228.2608
6	302.8052
8	264.5543

Mean grain size of nanoparticle is 30.7187 nm.

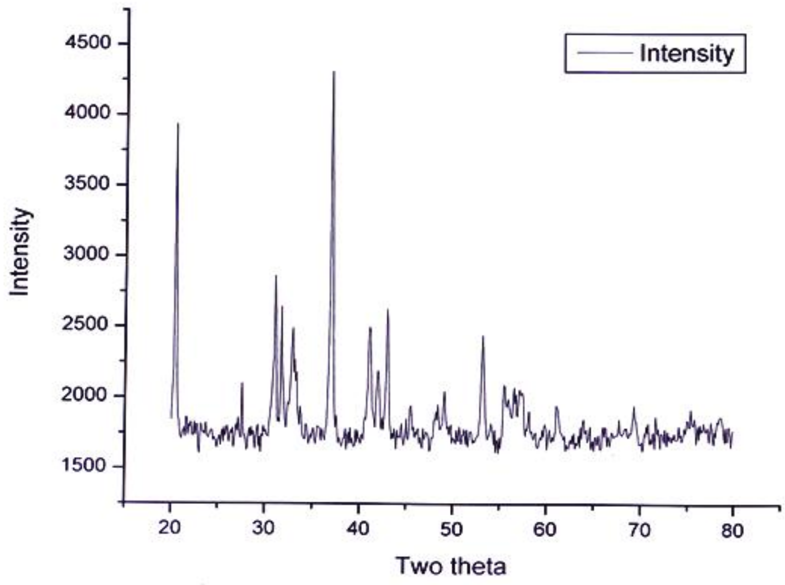


FIG. 4. **XRD pattern of Ni nanoparticles obtained from coriander leaf extract.**

Conclusion

In conclusion, here we report green and vegetable assisted synthesis of Ni nanoparticles using coriander leaf extract. The coriander leaf extract was found efficient for synthesis of nickel nanoparticle. This method has merits over other reported methods are easily available starting materials, inexpensive process, easy to carry out in any college level laboratory, reaction conditions are simple, avoid use of expensive, hazardous and toxic reagent and pollution free. The size of prepared nanoparticle is very small compare to other reported methods. Study of the biological and catalytic activity of this nanoparticle is underway in our laboratory.

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