

## Using Cobalt and Nickel Oxide Nanoparticles for the Conversion of Solid kitchen waste into Biofuel

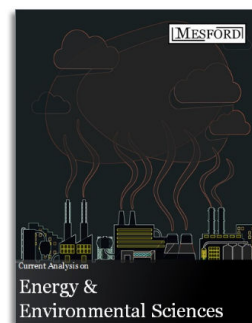
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### Abstract:

Here we are describing the novel approach for the synthesis of cobalt oxide (Co<sub>3</sub>O<sub>4</sub>) and nickel oxide (NiO) nanoparticles by using bread fungus and coriander leaves at room temperature. We used Cobalt Nitrate hexahydrate [Co(NO)<sub>3</sub>.6H<sub>2</sub>O] and Nickel Chloride (NiCl<sub>2</sub>) as a precursors. All nanoparticles were in Nano size and ranging from ~16 and ~18 nm respectively. The X-Ray diffraction (XRD) pattern reveals the formation of Cobalt oxide [Co(NO)<sub>3</sub>.6H<sub>2</sub>O] and Nickel oxide (NiO) nanoparticles, which shows crystallinity. Scanning electron microscopy (SEM) images reveal that the particles are spherical in shape, uniformly distributed and no agglomeration occur. Fourier Transform Electroscop (FTIR) graphs shows the bonding of Cobalt Oxide and Nickel Oxide. These Nanoparticles may have a promising role in the conversion of solid waste or organic matter into biofuel and biogas as well as Char can be produce.

**Publication History:** Received: 05 October 2018 | Revised: 25 January 2019 | Accepted: 28 January 2019

### Keywords:

Cobalt oxide, Nickel Oxide NPs, Bread Fungus, Coriander leaves, Green Synthesis, Kitchen waste, Biofuel.

## INTRODUCTION

Nowadays there is a requisite to figure out how to manipulate the size of nanoparticles and form the group into regularly ordered particulate materials for application into different device making utilization of the special physical properties that emerge due to nanometric crystallite sizes similar to the quantum impacts (Minelli 2004). In different areas of physics, chemistry, optics and material sciences, nanomaterials have a wide ranging applications. Due to quantum size effect, other than the novel properties revealed by metallic nanoparticles, their synthesis convention represent some major environmental issue. So swiftly new applications of nanoparticles and nanomaterials are emerging (Verma et al. 2010). Moreover indicates that inorganic nanoparticles are very enormous materials due to their high surface area. At nano size thought pores of plasma membrane proteins, it is easy to enter in cells. Aside from this, they have potential properties for detecting and location of different natural analytes. For example, the presence of semiconductor metal zinc oxide nanoparticles (< 30 nm) in the natural framework have capacity to adjusted biological properties. Zinc oxide nanoparticles have potential applications in different zones including optical, piezoelectric, attractive and gas detecting and

furthermore they show high catalytic productivity, strong adsorption ability, high isoelectric point (9.5), biocompatibility, and quick electron exchange energy for bio-sensing purposes (Rotello 2008).

Till now most of the physicochemical synthetic methods are heavily in the use of organic solvents and agents which are toxic reducing in nature. Due to the higher reactivity such chemicals possess high environmental and biological risks. With the expanding enthusiasm for minimization or end of such sorts of unsafe chemicals, the advancement of natural, biomimetic and biochemical methodologies is desirable. Consequently, biological approach has favorable circumstances over physicochemical techniques on account of its clean, non-toxic chemicals, ecologically kind solvents, and easy to use nature (Albrecht et al. 2006). The utilization of naturally benevolent materials like fungi or the synthesis of silver nanoparticles offers various advantages of eco-friendliness and compatibility for pharmaceutical and other biomedical applications as they do not utilize lethal or toxic chemicals for the synthesis protocol (Bhainsa et al. 2006). Among the various sorts of metal nanoparticles, the arrangement of some metal nanoparticles, for example, nickel, copper and iron, are nearly hard in light of the fact that they are effectively oxidized.

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Nickel as a critical progress metal, and nickel nanoparticles have boundless applications in the zones of changeless magnets, attractive liquids, attractive account media, solar energy absorption, fuel cell electrode or energy unit terminals, catalysts biological action (Hsieh 2002). Chemical synthesis methods prompt to the presence of few toxic chemicals which absorbed on to the surface that may have unfavorable impact in the field of medical applications. Green synthesis of nanoparticle is an alternative of physical and chemical method and it is environment friendly and cheap method. Nanoparticles are synthesized at achievable temperature having low pH cost effective and environment friendly. By keeping these views in mind nanoparticles have been synthesized by different methods. Among those methods plants extracts considered to be the best one. Nanoparticles can be made by those materials which have enzymes in them (Irvani 2011). Here we report a novel method for the synthesis and characterization of cobalt oxide and nickel oxide nanoparticles synthesized by *Rhizopusnigricans* fungus and leaves extract of Coriander. XRD, FTIR and SEM revealed that the cobalt and nickel oxide nanoparticles are uniformly distributed without any sign of agglomeration and spherical in shape ranging from ~14nm and 18nm respectively in size.

## EXPERIMENTAL

### Green Synthesis of Cobalt Oxide Nanoparticles by Using Bread Fungus

Bread and Cobalt Nitrate Hexahydrate ( $\text{CoNO}_3 \cdot 6\text{H}_2\text{O}$ ) was purchased from local market and Sigma Aldrich respectively. Initially fungus was grown on the bread by two different methods. One is we put the dry bread into the dark for 7 days and the other is dip pieces of bread in water and then put it in dark. We observed that fungus on wet bread grown faster. After that 200 ml of water is taken into the beaker of 500 ml and added 5.82 gram metal salt ( $\text{CoNO}_3 \cdot 6\text{H}_2\text{O}$ ) and place the beaker on to the hot plate for stirring through magnetic stirrer. Concentration of our salt solution is 0.1M. When all the salt was dissolved in water, a reddish solution is formed in which we start added bread fungus till the solution become dark green and keep it on stirring for 3 hours. Place solution in dark for three days and then filter it through whatman filter paper. The filtrate was kept into the oven for a night at 80 °C till we got a jelly like solution and then place it in vacuumed furnace (GSL-1100X) at 500 °C for 3 hours then the calcined sample was ground into fine particles which are the Cobalt Oxide nanoparticles.

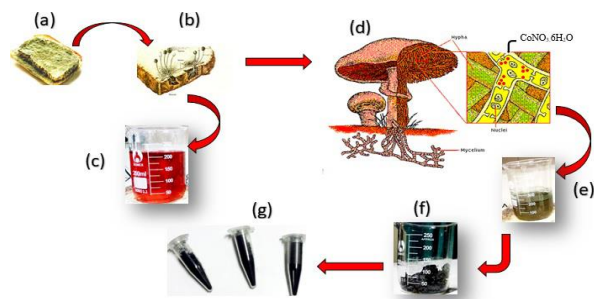


Figure 1. Mechanism of Green synthesis of Nanoparticles.

### Green synthesis of Nickel Oxide Nanoparticles by Using Coriander Leaves

Initially Nickel chloride ( $\text{NiCl}_2$ ) was purchased from scientific store and coriander leaves from vegetable market. Fresh coriander leaves washed with distilled water and placed into the sunlight for 3 days so that all moisture from the leaves removed. For synthesis of Nickel Oxide Nanoparticles 0.2 M solution of Nickel chloride was prepared in 240 ml of distilled water and placed it on to the hot plate for stirring till all the metal salt dissolved in solvent. It took 30 minutes. After that we put 10 grams of dried shaded coriander leaves into the solution and keep it on stirring for 3 hours. Kept the solution in dark for 3 days and then filter it through whatman filter paper and place it into the oven to get jellyish solution at 70 °C. Place that jellyish solution into the vacuumed furnace (GSL-1100X) at 500 °C for 3 hours and after that remaining powdered form was grinded and get the fine nanoparticles of Nickel oxide.

### Production of Biofuels from Solid Kitchen Waste

We purchased round bottom flask from local market and kitchen solid waste is collected. We weighted flask and waste. Weight of flask is 110.301 g and weight of waste is 219.70 g. Round bottom flask of 250 ml filled with solid kitchen waste. Cobalt oxide and Nickel oxides NPs (0.1% of both) added in flask having waste in it. After that we put flask in furnace with U. shaped tube. One end of tube was in flask while other end was outside the furnace for collecting of liquid Bio-oil. Set the temperature of furnace at 450 °C for 2 hours. We noticed that liquification starts as temperature passes through 180 °C. This liquid called Bio-oil collected in beaker. Methane gas is also produced and nature of the gas is confirmed by burning matchstick in this gas which gives blue and yellow flame. This shows the gas is methane (natural gas). For obtaining Bio-diesel from bio-oil reflux process is done in which we took 20 ml of alcohol in a beaker with 1g of Potassium hydroxide (KOH) and reflux for one hour. Moreover, we put 10 ml of bio-oil in it and again reflux it for 2 hours. Filtered it with whatman filter paper and resultant is our biodiesel.



Figure 2. Experimental setup of Gasification for biofuel.

## RESULT AND DISCUSSION

### XRD Analysis of Cobalt and Nickel Oxide Nanoparticles

Powdered sample of Cobalt Oxide ( $\text{Co}_3\text{O}_4$ ) was used for XRD analysis. XRD pattern of Cobalt Oxide nanoparticles synthesized by green route method is shown in fig 3.

We Obtained 6 peaks of Cobalt oxide nanoparticles. Relative intensities and peak positions of six peaks at  $2\theta$  values (31.233, 36.866, 38.519, 44.857, 59.456 and 65.270) degrees corresponding to ((200), (311), (222), (400), (511) and (440)) planes of cobalt oxide nanoparticles, were matched to values from JCPDS 01-080-1533. Crystal structure of Cobalt Oxide nanoparticles is cubic as  $a=b=c=8.0968$ . Where a, b and c are lattice constant. By using sheerer  $D=0.94\lambda/\beta\cos\theta$  formula (Yuanchun et al. 2008) average crystallite size is 14.43nm.

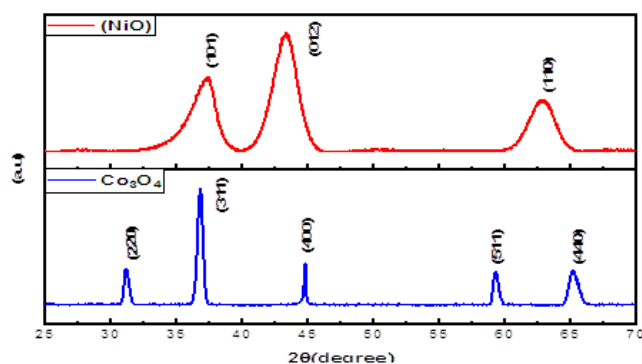


Figure 3. XRD Pattern of Cobalt and Nickle Oxide.

For the analysis of nanoparticles of Nickel oxide (NiO) we used powder sample. XRD patter which we get is shown in fig 2.

Three peaks were obtained from the XRD analysis of our sample with relative intensities and peak position at  $2\theta$  values  $37.22^\circ$ ,  $43.66^\circ$  and  $62.73^\circ$  corresponding to (101), (012) and (110) planes of NiO. These values matched also to the values from JCPDS 00-044-1159 which shows the presence of NiO nanoparticles. Crystal structure of obtained nanoparticles is cubic as  $a=b=c=4.180$  where a, b and c are lattice constant. Average particle size of NiO nanoparticles as calculated by sheerer formula is 18.15 nm.

### SEM Analysis of Cobalt and Nickel Oxide Nanoparticles

Morphology and size of Cobalt oxide and Nickel oxide nanoparticles via green route was determined by Scanning Electron Microscope as shown in Figures.

Figure 4. Confirm us the particles of Cobalt oxide in nanometer range. Similarly it also confirm us that the nickel oxide nanoparticles are also found in nanometer range. Average particle size calculated of  $\text{Co}_3\text{O}_4$  and NiO nanoparticles are 18.66 and 17.01 respectively.

Both images reveal that the morphology of Cobalt and Nickel oxide NPs are spherical in shape and there is not considerable

amount of agglomeration with homogeneous size distribution in both specimen.

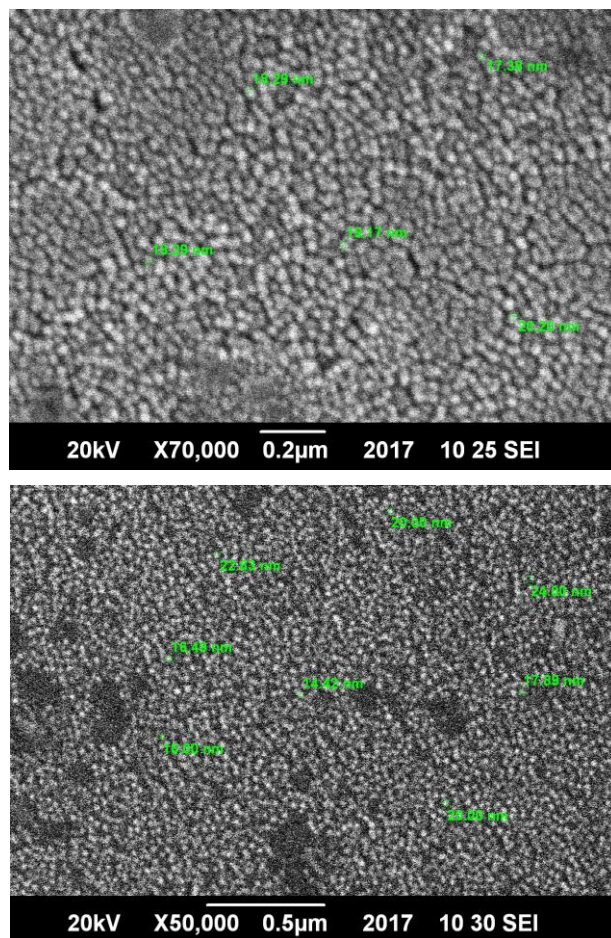


Figure 4: SEM images of Cobalt Oxide and Nickle Oxide.

From SEM we concluded that via Green route synthesis of Cobalt and Nickel Oxide we achieved well dispersed homogeneous and controlled size nanoparticles.

### FTIR Spectrum of Cobalt Oxide's and Nickel Oxide's nanoparticles

FTIR Spectra of both Cobalt and Nickel oxide nanoparticles were recorded in solid phase using KBr pallet technique. The spectrum was achieved in range  $4000-400\text{ cm}^{-1}$  as exhibited through figure. The Characteristic peak of Cobalt Oxide is formed at  $585\text{ cm}^{-1}$  which identifies to the stretching vibration of Co-O bond and gives the confirmation of the formation of  $\text{Co}_3\text{O}_4$  (Gopal et al. 2015). The spectrum also shows the peak at  $3710\text{ cm}^{-1}$  which shows the OH bonding. The C-O stretch is located with a sharp peak at  $1043\text{ cm}^{-1}$  as shown in fig 5.

The characteristic peak of NiO is formed at  $415\text{ cm}^{-1}$  which identifying the bonding of Ni-O (Pramod and Vasudeo 2016) The spectrum also shows the very little sharp peak at  $3460\text{ cm}^{-1}$  which indicates the -OH bonding. The C-Cl stretches is located with a little peak at  $1152\text{ cm}^{-1}$ . Peaks at  $1408\text{ cm}^{-1}$  and  $1740\text{ cm}^{-1}$  shows the stretching of C-O and C=O respectively as shown in figure 6.

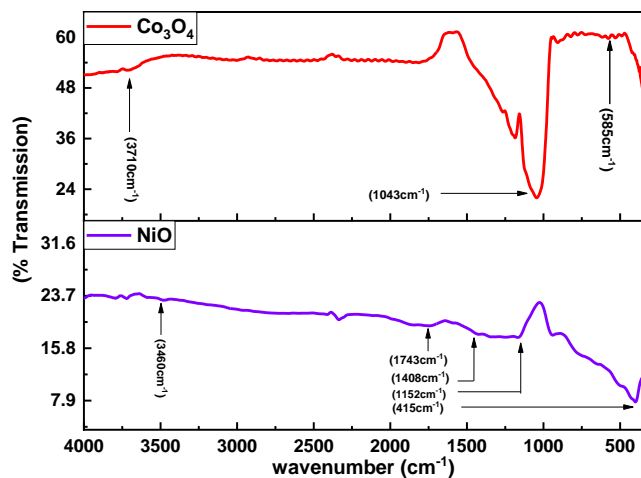


Figure 5. FTIR Spectrum of Cobalt Oxide and Nickel Oxide.

There are different very small peaks of functional group and very sharp peak of NiO bonding by which we can say that our required nanoparticles are very pure and having very less impurities.

#### FTIR Spectrum of Biodiesel

FTIR spectrum of biodiesel obtained from solid kitchen waste is achieved in the range of 4000-400  $\text{cm}^{-1}$  as exhibited from the figure 6. The characteristic peak of required Methyl ester is formed at 1650  $\text{cm}^{-1}$  which shows the C=O bonding. The spectrum also shows a broad peak at 3416  $\text{cm}^{-1}$  which is of –OH bonding. No other functional group had such a broad and intense bond at high wave number. Other peaks obtained at 2919  $\text{cm}^{-1}$  and 1050  $\text{cm}^{-1}$  show the asymmetric CH<sub>2</sub> stretching and C-O stretch respectively. Peak obtained at 717  $\text{cm}^{-1}$  indicates the conversion of bio-oil into Biodiesel which is basically the rocking of CH<sub>2</sub> (Mahmood et al. 2011).

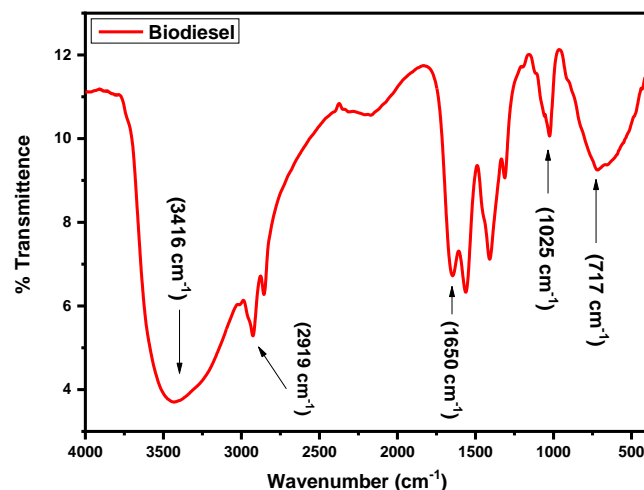


Figure 6: FTIR Spectrum of Biodiesel

## CONCLUSION

$\text{Co}_3\text{O}_4$  and NiO nanoparticles were successfully synthesized by green route methodology. X-ray Diffraction pattern confirms the formation of Cobalt and Nickel Oxide Nanoparticles with grain size 14.43 nm and 18.15 nm respectively and there is no sign of impurities. Scanning electron microscopy revealed the homogeneous distribution of nanoparticles with no agglomeration. The successful formation of bonds between Cobalt-Oxygen and Nickel-Oxygen is identified within the figure print region. FTIR of biodiesels show the bonding of C=O at 1650  $\text{cm}^{-1}$  which confirms the formation of required methyl ester. This method has worth as it is easy to carry out in laboratory, cheap and starting materials are easily available. These nanoparticles of Cobalt and nickel oxide then used as a catalyst for carrying out gasification of solid kitchen waste and transesterification process which becomes more efficient and took much less time and temperature. It yields high quality of biodiesel that is ecofriendly and more efficient. Methane gas and Char were also obtained as a by-product. This work is absolutely oriented towards the effective utilization of waste. This use of solid waste as a source of Biofuel will add green energy technology in existing environment which is sustainable and renewable energy.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest

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