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Rambutan (*Nephelium lappaceum* L.) peel extract assisted biomimetic synthesis of nickel oxide nanocrystals

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ABSTRACT

We report sustainable novel simple green synthetic strategy to synthesize NiO nanocrystals. This is first report on sustainable biosynthesis of NiO nanocrystals employing *Nephelium lappaceum* L., peel extract as a natural ligation agent. Green synthesis of NiO nanocrystals was carried out via nickel–ellagate complex formation using rambutan wastes. Successful formation of NiO nanocrystals was confirmed. Possible mechanism of NiO nanocrystals formation using rambutan extract was proposed. Prepared NiO nanocrystals were coated on cotton fabric and their antibacterial activity was analyzed.

1. Introduction

Design of wide range alternative routes of synthesizing biocompatible nanoparticles with minimizing chemical hazards to health and environment, and also reducing waste and preventing pollution has now been routinely applied. Due to increasing environmental concerns, attempts have been made to develop nanoparticle synthesis using plant extracts. Synthetic methods based on naturally occurring biomaterials provide an alternative means for obtaining industrially required nanoparticles. Green chemistry principles drive researchers to develop synthetic strategies whereas enzymes [1], microorganisms [2] and plant extracts [3–4] play major role in nanoparticles formation. Plant extract based synthetic strategy is the best eco-friendly alternative method to synthesize nanomaterials compared to other biological and traditional methods.

Generally, nickel oxide (NiO) nanoparticles with uniform size and well dispersion are desirable in super capacitors [5], magnetic [6], electrochemical performance [7], photocatalyst [8], antimicrobial [9] and water treatment [10] applications. Various methods to prepare NiO nanoparticles include chemical precipitation [5], solvothermal [6], thermal-decomposition [7], precipitation–calcinations [8] and microwave-assisted hydrothermal methods [10]. Though numerous methods are available for NiO nanoparticles synthesis, copious reactants, starting materials, tedious processes and complex apparatus are routinely used. During recent times several groups achieved success in Ag, Au and Pd nanoparticles synthesis using bacteria and fungi extracts and plant extracts like geranium leaves, lemon grass, neem leaves and aloe vera [11–13]. Even though success in above field has opened developing bio-inspired methods to synthesize metal nanoparticles, there is no reported literature for NiO nanoparticle synthesis using rambutan extract. Rambutan (*Nephelium lappaceum* L.) belongs to subtropical fruits and their residues consist principally of seeds and peels waste [14–15].

In present investigation, green chemistry route adopted NiO nanocrystals synthesis was carried out using rambutan peel waste and characterized comprehensively. To the best of our knowledge, it is the first report on NiO nanocrystals synthesis using rambutan extract. Synthesized NiO nanocrystals coated cotton fabric was characterized and their antibacterial activity was examined.

2. Materials and methods

Rambutan was collected from Ooty, Tamilnadu, India. Nickel nitrate [$Ni(NO_3)_2 \cdot 6H_2O$], citric acid, sodium lauryl sulfate and ethanol were purchased from Merck chemicals Ltd., India. Bleached cotton fabric was purchased from Ayyappa textiles, Karaikudi. Double distilled water was used throughout the experiment. Manually separated rambutan peels were washed with running water and subsequently incised into small pieces and

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placed in a circulating oven at 50 °C until complete dryness. 3 g of finely dried rambutan peels was boiled with mixture of ethanol and double distilled water (1:2) for 10 min. Extract was filtered through Whatman No. 1 filter paper. 0.1 M of $Ni(NO_3)_2 \cdot 6H_2O$ was prepared in 50 mL and then 10 mL of rambutan extract was slowly added drop wise into the solution under magnetic stirring at 80 °C for 2 h to form nickel–ellagate complex. Nickel–ellagate complex formed after adequate time of stirring was collected by

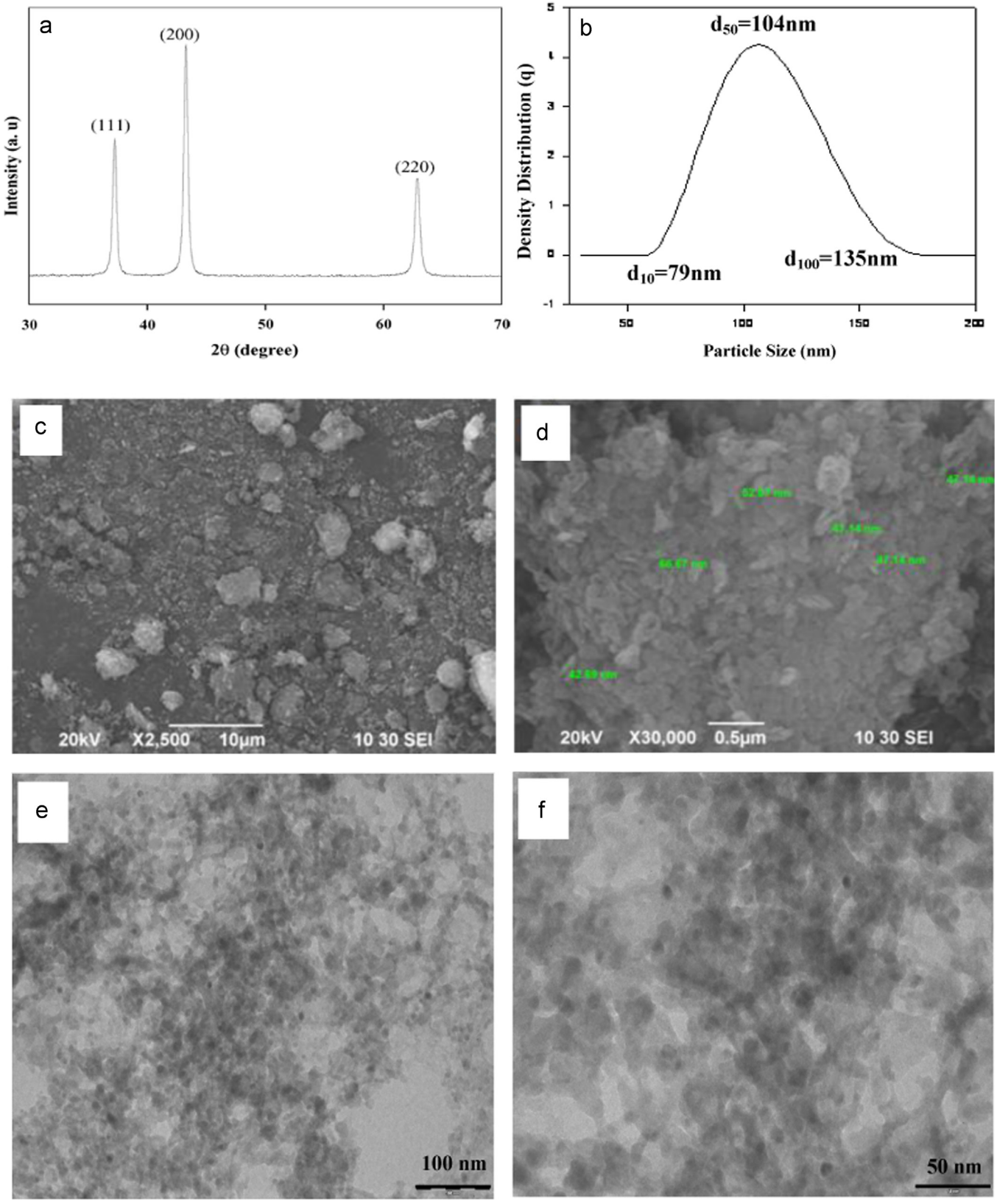

Fig. 1. NiO characterization (a), XRD (b), PSA (c, d) and SEM (e, f) TEM images.

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