University of Tikrit

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Department of Chemistry

A scientific essay:-

Green Synthesis of Metallic Nanoparticles Using Food and Agro Wastes

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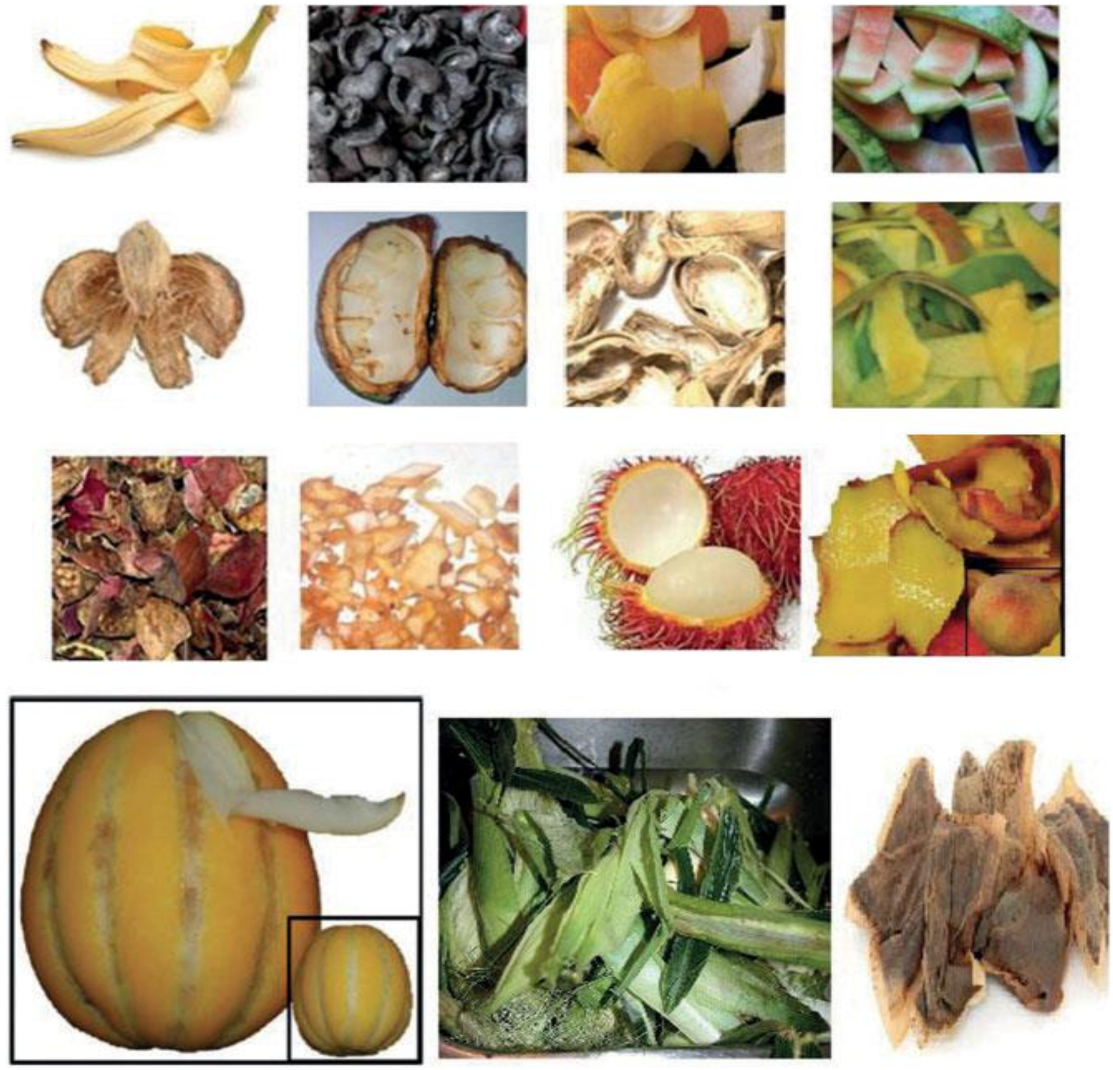
Green Synthesis of Metallic Nanoparticles Using Food and Agro Wastes

Utilization of food waste resources is a sustainable, effective and important eco-friendly method for managing plant wastes and biomass[1]. Nanoparticles have been successfully synthesized by using a variety of food wastes, including corn cob, Cocos nucifera coir, fruit seeds and peels, rice bran, wheat bran, and palm oil mill effluent [2]. Such food wastes are rich in biomolecules such as phenolics, flavonoids, and proteins. In the green synthesis of diverse metallic nanoparticles, food wastes can serve as bioreducing agents. In a laboratory study, food wastes used in the synthesis of silver nanoparticles include the extracts of kola seed shell [3] Figure exhibits some food wastes that are used for the biogenic synthesis of nanoparticles [4]

Different types of metallic nanoparticles have been successfully synthesized from food and agro-industrial wastes. Extracts from these wastes were usually used as reducing and stabilizing agents for nanoparticle synthesis with a widely diverse activities ranging from larvicidal, antioxidant, antimicrobial, and catalytic to cytotoxicity against cancer cells. Such food [4]

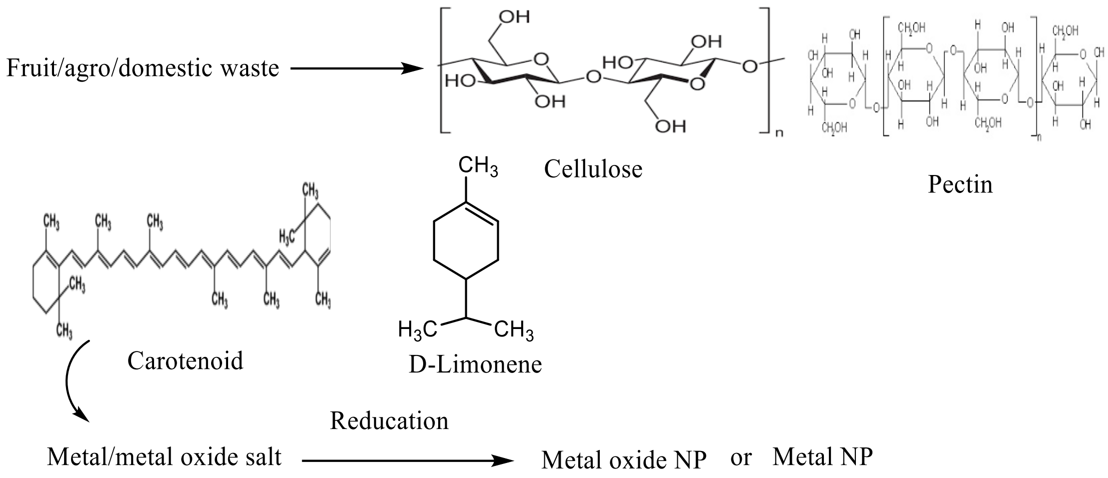


Peels of oriental melon (cucumis melo **Corn peels** **Tea waste**

Figure :Some food wastes that are used for the biogenic synthesis of nanoparticles. (Reproduced from (4)

and agricultural wastes are abundantly produced during the processing of agricultural wastes. They are often discharged into the environment as solid waste. Mostly, they are of poor nutritional value and may even contain antinutritional factors. This limits their value or applications as animal feeds ,Several biotechnological processes have been developed state fermentation, as renewable materials for the production of biogas [5] Further studies were conducted for the utilization of agro-wastes as sources of biomolecules in green nanotechnology. As a result, several agro-wastes have been documented for their relevance in through the simple procedure of hot water extraction of dried and ground agro-waste

materials. It is clearly evident that agro-wastes have been used extensively for the synthesis of different nanoparticles.
In this respect, the abundance of agro-wastes can be successfully employed on a large scale for the biogenic synthesis of nanoparticles. wastes extract [(6)]



Mechanism of nanoparticles formation in the presence of food and agro waste materials. (Reproduced from .

Zinc Oxide Nanoparticles (ZnO NPs) Using Food and Agricultural Wastes

Biogenic zinc oxide nanocrystals were synthesized by Yuvakkumar from rambutan peels. The process was as follows: zinc-ellagate complex was formed by reacting Zn (NO3)2·6H2O with rambutan peel extract for 2 h at 80 °C. The zinc-ellagate complex was then oven dried at 40 °C for 8 h followed by calcination in a muffle furnace at 450 °C for the purpose of obtaining zinc oxide nanocrystals. The synthesis of zinc oxide nanocrystals was facilitated by polyphenols through the p-track conjugation effect was confirmed by employing the standard characterization studies, including scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). This study showed that the cotton fabric coated with zinc oxide nanocrystals exhibited remarkable antibacterial activity against *E. coli* (18.5 mm) and *S. aureus* (23 mm), due to the increasing ZnO nanocrystals adsorption on the cotton surface.

[7] in which they synthesized ZnO NPs by using tea solid waste extract mixed with Zn acetate at 80 °C. The obtained precipitates were dried at 70 °C overnight to obtain ZnO nanoparticles. The green synthesized ZnO nanoparticles was confirmed by energy-dispersive X-ray analysis (EDXA), XRD, high-resolution transmission electron microscopy (HRTEM), scanning electron microscopy (SEM), and dynamic light scattering (DLS).

The average nanoparticles size was 19.5 nm. The determined zeta potential of the green synthesized ZnO nanoparticles was (–41.3) mV, which indicates good stability. Moreover, ZnO nanoparticles were also synthesized by Karnan and fruit peel extract acted as a natural ligation agent. The successfully prepared nanoparticles were characterized by UV-Vis absorption spectroscopy, UV-Vis diffuse reflectance spectra (UV-Vis DRS), HRTEM, XRD, field emission scanning electron microscopy (FESEM), and N2 adsorption-desorption isotherm. The photocatalytic activity of ZnO nanoparticles was further evaluated by photodegradation

of methyl orange (MO) dye under UV light. The result depicts around 83.99% decolorization efficiency at 120 min of illumination. Besides the photo-decolorization, mineralization was also achieved. This mineralization has been confirmed by detecting the chemical oxygen demand (COD) [8].

Nickel Nanoparticles (NiNPs) Using Food and Agricultural Wastes

For the first time, a successful synthesis of nickel oxide (NiO) nanocrystals was achieved via nickel ellagate complex formation by using rambutan peels .In this method, the polyphenols in the extract facilitated the formation of nickel oxide nanocrystals from $Ni(NO_3)_2·6H_2O$. The cotton fabric coated with the synthesized NiO nanocrystals exhibited strong antibacterial activity of 35 and 25 mm against *S. aureus* and *E. coli*, respectively [9]

Palladium Nanoparticles (PdNPs) Using Food and Agricultural Wastes

Palladium nanoparticles (PdNPs) were synthesized using *Annona squamosa* aqueous peel extract [171]. In this investigation, 80 ml of 1 mm palladium acetate Pd(OAc)2 was reacted with 10 ml of aqueous extract at 60 °C for 4 h. The synthesized nanoparticles were characterized by X-ray diffraction (XRD), UV-Vis spectroscopy, and transmission electron microscopy (TEM). Spherical-shaped palladium nanoparticles were confirmed. The average particle size was 100 nm. The obtained results clearly indicated that these compounds containing OH as a functional group played a critical role in capping the synthesized nanoparticles. The results also highlighted the possibility of green pathways to produce Pd nanoparticles (10)

Meanwhile, the aqueous extract from watermelon rind was used as capping and reducing agents for Pd nanoparticles by Lakshmipathy *et al.* (11). The involvement of polyhydroxyl groups was established in the extract for the synthesis of palladium nanoparticles. The PdNPs were found to have an average size of 96.4 nm. The polydispersity index of 0.243 exhibited potential catalytic industrial applications by the Suzuki coupling reaction of aryl halide with phenyl boronic acid at room temperature (11) In a similar study, bioinspired Pd nanoparticles were synthesized using banana peel extract (BPE) as a nontoxic eco-friendly solid waste. In this study, the boiled, crushed, acetone precipitated, air-dried peel powder was employed to reduce Pd chloride. The PdNPs were characterized by using scanning electron microscopy-energy dispersive spectra (SEM-EDS), XRD, and UV-Vis spectroscopy. Studies of dynamic light scattering (DLS) revealed that the average nanoparticle size was 50 nm. In addition, Fourier transform infrared spectroscopy (FTIR) implicated the role of carboxyl, amine and hydroxyl groups in the synthetic process (12).

Platinum Nanoparticles (PtNPs) Using Food and Agricultural Wastes

Recently, synthesis of platinum nanoparticles (PtNPs) was studied by Dauthal and Mukhopadhyay using *Punica granatum* peel extract. The synthesized PtNPs were crystalline and spherical with a particle size range of 16–23 nm. The negative zeta potential of the platinum nanoparticles indicated high stability. Characterization using Fourier transform infrared spectroscopy (FTIR) analysis indicated that the hydroxyl and carbonyl functional groups present in polyphenolic compounds and the quinones of the peel extract were responsible for the capping and stabilization of the synthesized nanoparticles. These PtNPs displayed good catalytic activity by reducing the anthropogenic pollutant, 3-nitrophenol, by NaBH4. The presence of a hydroxyl group containing compounds was found to be responsible for the catalytic action of the rambutan peel extract in the formation of Pd and Ni metallic nanoparticles.[13]

Titanium Dioxide Nanoparticles (TiO2NPs) Using Food and Agricultural Wastes

Rice straw has been employed as a lignocellulosic solid waste material for the production of titanium dioxide nanoparticles. The investigators used a sol-gel method and further modification of the pore volume and size. The study showed that the decreased particle size enhanced the surface area that made TiO2NPs highly potential photocatalyst [14] In a similar study, the extract of *Annona squamosa* L. peel was successfully used for the formation of polydisperse, spherically shaped and 23 ± 2 nm sized titanium dioxide nanoparticles [15].

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