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Facile Green Synthesis and Characterization Copper Oxide Nanoparticles Using Albizia Amara Leaves Extract

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Abstract

Nanoparticles are the spearheads of the rapidly expanding field of nanotechnology. Development of the green synthesis has gained extensive attention as a reliable, sustainable and eco-friendly protocol for synthesizing a wide range of metal and metal oxide nanoparticles. The present study Green Synthesized Copper Oxide Nanoparticles using Albizia Amara Leaves. The synthesized copper oxide nanoparticles were characterized by Ultraviolet Vis spectroscopy (UV-Vis), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FT-IR), Scanning Electron Microscope (SEM), Energy Dispersive X-ray (EDX). The green chemistry approach used in the present work for the synthesize of copper oxide nanoparticles is simple, cost effective, and good alternative method.

Keywords: *Albizia Amara Leaves Extract, Copper oxide nanoparticles, Characterization,*

1. INTRODUCTION

Nanotechnology can be defined as the manipulation of mater through certain chemical and physical process to create materials with specific properties which can be use particular application [1]. A nanoparticle can be defined as a microscopic particle that has at least one dimension less than 100 nm in size [2]. Nanotechnology generally involves the application of extremely small particles that are used across all field of science including chemistry, biology, medicine and material science [3-4]. Nanoparticles are the spearheads of the rapidly expanding field of nanotechnology. Different types of nanoparticles with desired shape and size have been fabricated using various approaches like physical, chemical and biological techniques [5].

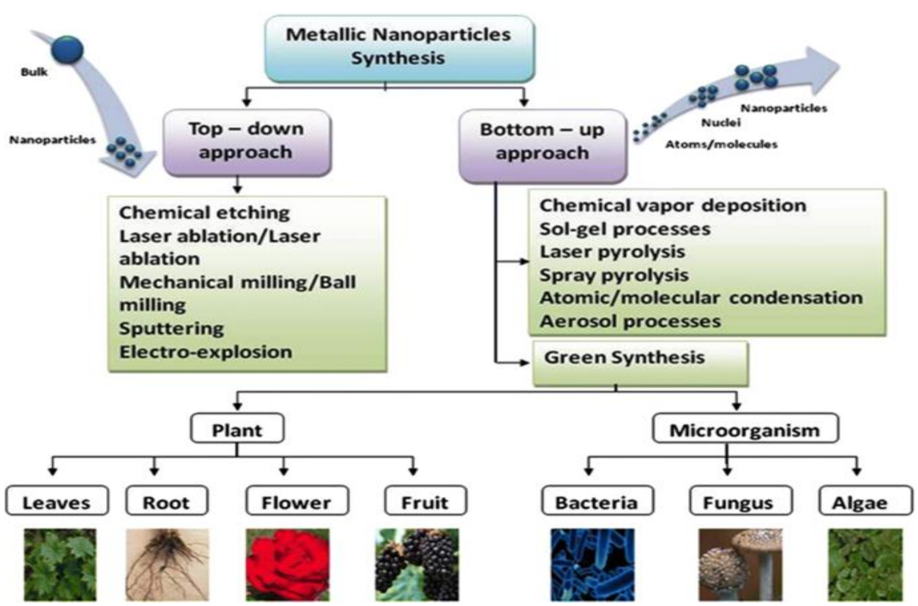

Fig. 1. Schematic diagram of synthesis of nanoparticles

The biological method which is represented as an alternative to chemical and physical methods, provides an environmentally friendly way of synthesizing nanoparticles. Moreover, this method does not require expensive, harmful and toxic chemicals. Metallic nanoparticles with various shapes, sizes contents and physio chemical properties can be synthesized the biological method actively used in recent years. Traditional methods are used from past many years but researches have proved that the green methods are more effective for the generation of NPs with advantage of less chances of failure, low cost and ease of characterization.[6]. In the green synthesis method in which nanoparticles with biocompatibility are produced these agents are naturally present in the employed biological organism. Synthesis can be done in one step using biological organism such as Bacteria, Actinobacteria, yeast, molds, algae, and plants (or) their products.

The plants are considered to be more suitable compared to microbes for green synthesis of nanoparticles as they are non-pathogenic and various pathways are thoroughly researched. The plants (or) plants extract, which act as reducing and capping agents for nanoparticle synthesis, are more advantageous over other biological process [7]. Because they eliminate the elaborated process of culturing and maintaining of the cell and can also be scaled up for large scale nanoparticle synthesis is preferred because it is cost-effective, environment-friendly, a single step method for bio synthesis process and safe for human therapeutic uses. different parts of plant materials such as extracts. Fruit, fruit peels, bark, root, leaves, and tubers [8]. Plants which have great potential for detoxification, reduction and accumulation of metals are promising fast and economical in removing metal-borne pollutants. Metallic nanoparticles having various morphological characteristics can be produced intra cellularly and extra cellularly. With the materials present in the plant extract such as sugar, flavonoid, protein, enzyme, polymer, and genie acid acting as a reducing agent take charge in bio induction of metal ions into nanoparticles [9-13].

Metal and metal oxide nanomaterials prepared from earth-abundant and inexpensive metals have attracted considerable attention because of their prospect as viable alternatives to the expensive metal-based catalysts used in many conventional chemical processes [14] Nanomaterial's exhibit activities which are different from those of the corresponding bulk materials because of their size and shape-dependent physicochemical and optoelectronic properties [15]. The catalytic activity of nanomaterials represents a rich resource for chemical processes, employed both in industry and in academia. The great interest in catalysis using nanomaterials has prompted the synthesis and investigation of a diverse range of highly functionalized nanoparticles (NPs), including metal oxide nanostructures [16-20]. Some of the distinguish reported types of nanoparticles includes photochromatic nanoparticles, polymer coated nanoparticles, metal oxide nanoparticles, FeO, CuO, MgO, ZnO, FeNPs, AuNPs, AgNPs, PdNPs [21-23].

Among the various metals like Cu based nanomaterials which are cheap and environmentally friendly are especially attractive in this context due to the high abundance of Cu in nature and the available simple and straightforward techniques to synthesize these nanomaterials. The present green method for the synthesis of CuO nanoparticles is simple, mild, and environmentally friendly. Green synthesis of CuO nonoparticles could also be extended to fabricate other, industrially important metal oxides.

In the present study copper oxide nanoparticles (CuONPs) were synthesized using *Albizia Amara* Leaves Extract.

2.MATERIAL AND METHODS

2.1 MATERIALS

All chemicals used were of analytical reagent without any further purification in addition to deionised water, copper chloride dihydrate ($CuCl_2.2H_2O$), Sodium hydroxide (NaOH), hydrochloric acid (HCl) and ethanol. Albizia Amara Leaves were collected from Ashok nagar in Chennai

2.2 METHODS

2.2.1 PREPARATION OF ALBIZIA AMARA LEAVES EXTRACT

The Albizia Amara Leaves were collected from Ashok Nagar, Chennai. The fresh leaves was washed several times with tap water followed by distilled water to remove the dust particles. The clean and fresh sources are dried in a shaded place at room temperature for 10 to 15 days and then the leaves were pulverized using commercial blender. The fine powdered was stored at room temperature for further use. In a 250 ml of conical flask 10 gm of leaves powder were taken and to this 100 ml of double distilled water is added and it is heated at 80°C for 30 minutes. Then the solution was filtered using Whatman filter paper and kept aside for further process. The obtained extract in pale brown colour and adjust the pH at 11 by adding 0.1M of sodium hydroxide solution.

2.2.2 PREPARATION OF COPPER OXIDE NANOPARTICLES

In a 250 ml conical flask, 50 ml of Albizia Amara Leaves extract was taken and to this 100 ml of 0.1 M $CuCl_2.2H_2O$ solution is added slowly at room temperature under static conditions. The colour change of the reaction was observed and the time taken for the changes was noted. The solution colour changes immediately from pale brownish to yellowish grey colour indicating the formation of copper oxide nanoparticles (CuONP). Further the solution is centrifuged and precipitated is extracted and dried in electrical oven for 24 hours at 100°C. The dried sample kept in muffle furnace for 4 hours at 500°C. the green synthesised CuONPs is formed at uniform particle size and stored for further characterisation and uses.

2.3 CHARACTERIZATION OF COPPER OXIDE NANOPARTICLES

2.3.1 UV-VISIBLE SPECTROPHOTOMETER ANALYSIS

Synthesized CuO nanoparticles were subjected to UV-Vis spectroscopy analysis, which confirms the formation of nanoparticles in the initial stage. The CuO nanoparticles synthesized were subjected to scan UV-Vis spectrophotometer in the range 190 nm - 800 nm using Elico SL210 UV VIS Spectrophotometer.

2.3.2. FT-IR SPECTROSCOPIC ANALYSIS

The plant extract and green synthesized CuO nanoparticles were characterized by FT-IR spectrometer. The spectroscopic technique is based on the analysis of peaks at certain wave numbers. FT-IR data indicates the presence of functional groups in the plant extract and synthesized nanoparticles. The FT-IR analysis carried out in the frequency range of 4000 - 400 cm^{-1} using Perkin Elmer instrument.

2.3.3. X-RAY DIFFRACTION ANALYSIS (XRD)

X-ray diffractometer (lakjdf) was used to study the average particle size and crystalline nature of the synthesized adsorbents. The diffraction pattern was obtained by using CuKα radiation with wavelength of λ=1.541A°. The scanning was done in 2θ value range of 4° to 80° at 0.02 min^{-1} and one second time constant.

2.3.4. SCANNING ELECTRON MICROSCOPIC (SEM)

The SEM analysis provide the details about surface morphology, porosity and particle size distribution of the adsorbents. The surface morphology of the synthesized CuO nanoparticles was recorded using Hitachi instrument

2.3.5. ENERGY DISPERSIVE X-RAY SPECTROSCOPY (EDX)

EDX is an analytical technique used for the elemental analysis of a adsorbent and it depends on the interaction between known source of X-ray excitation and the Adsorbent. The elemental composition of the adsorbent was determined with the help of elemental analyser (CE-440 elemental analyser).

3. RESULTS AND DISCUSSION

3.1. CHARACTERIZATION STUDY OF COPPER OXIDE NANOPARTICLES.

3.1.1. UV- VIS ABSORPTION SPECTROSCOPY FOR COPPER OXIDE NANOPARTICLES.

The Green approach for the formation of copper oxide nanoparticles using Albizia Amara Leaves extract was reported. Formations of copper oxide nanoparticle were confirmed by UV-vis spectrophotometry.

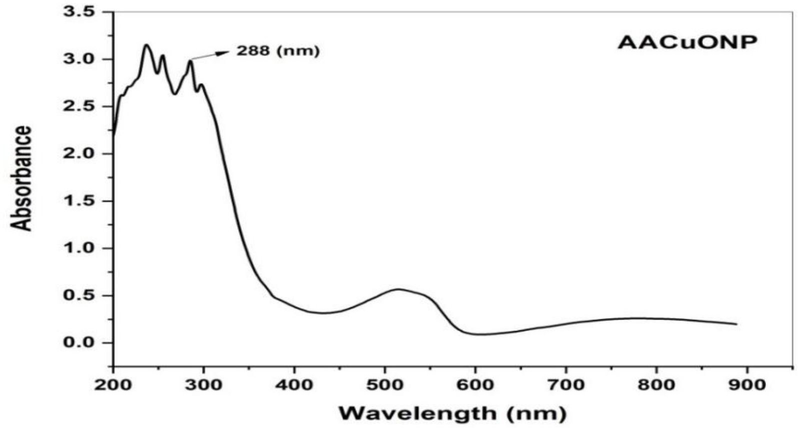

Fig 2. UV-visible adsorption spectrum of AA CuONPs

Fig 3. Shows the UV-Vis absorption spectrum of copper oxide nanoparticle. The adsorption spectrum was recorded for the sample in the range of 200 – 800 nm. The spectrum showed the absorbance peak at 288 nm corresponding to the characteristic band of copper oxide nanoparticle [24].

3.1.2. X-RAY DIFFRACTION

The x-ray diffraction (XRD) study was undertaken to Determine and confirm the crystalline structure of synthesized CuONPs.

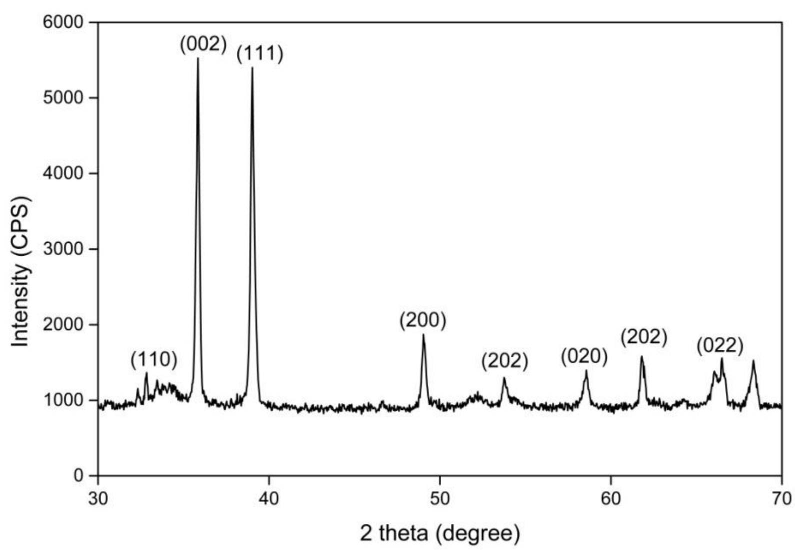

Fig 3: X-ray diffraction pattern of AA extract- mediated synthesized CuONPs

Fig (3) Shows the appearance of diffraction pattern at 2θ= 33.3, 35.4, 38.8, 48.7, 58.3, 61.8, 66.28 and 68.0 which are assigned to the planes (110), (022), (111), (200), (202), (020), (202), (022) respectively of monoclinic phase CuONPs. No characteristic peak due to any impurity was observed in the diffraction grams Suggesting the formation of pure crystalline CuO. The average size of the CuO was calculated by using the Debye-Scherer Equation (3) [25]. A sharp peak at 20=35.4 and 38.8 with the diffraction of the (022) and (111) plane indicates that confirmation of CuONPs. The average crystallite size in the samples of CuONPs is below 21nm.

$$D = 0.9\lambda / \beta \cos\theta \quad \text{Eq. (3)}$$

Where λ is the wavelength of the x-ray radiation (0.154nm), θ is the Diffraction angle and β is the full width at half maximum. The crystalline size have been 38.93 nm

3.1.3 FOURIER TRANSFORM INFRARED (FT-IR) SPECTROSCOPY.

FTIR spectroscopy analysis also revealed the possible biomolecules and functional group responsible for capping or stabilizing of the synthesized CuONPs were expressed in fig (4,5). Taking the spectrum of leaves Extract as control the involvement of different functional groups of Albizia Amara leaves extract in reducing and stabilizing process of nanoparticles synthesis was evaluated.

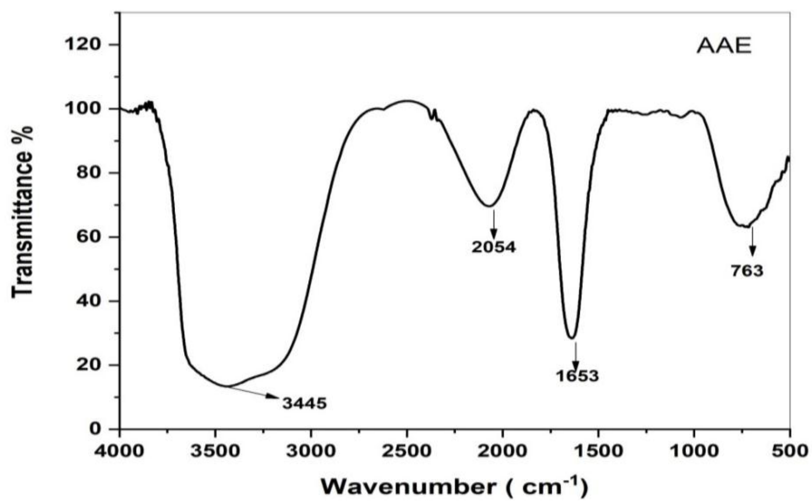

Fig 4. FTIR spectrum of AAL extract

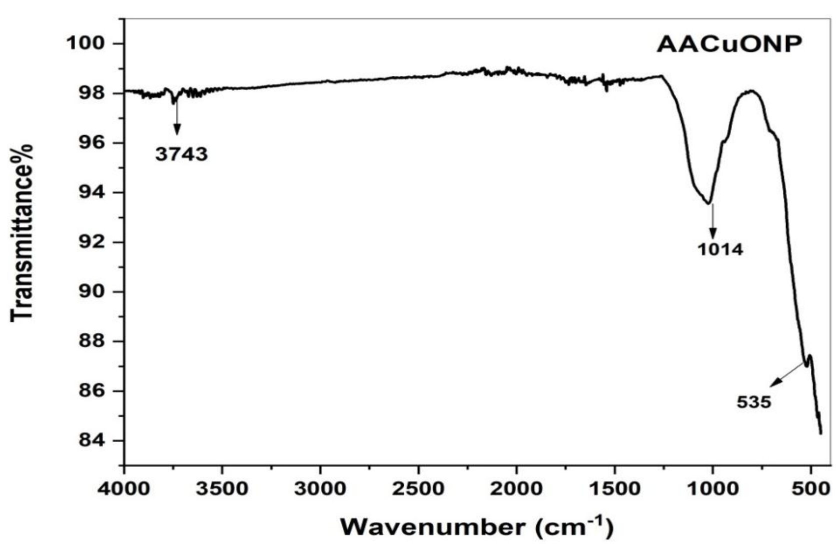

Fig 5 shows AA green synthesized CuO NPs

Absorbance bands at 3248, 2127, 1362, and 752 cm^{-1} were observed in the spectrum of Albizia Amara leaves extract. A broad band at 3248 cm^{-1} was due to the O-H stretching of alcohol compounds. The peaks at 1827 and 1363 cm^{-1} are Containing $-NH_2$ group and C=O groups of flavonoids [26-27]. 775 cm^{-1} is containing C-H bonds. FTIR spectrum of CuONP for the peak appeared at 3393, 1632, 1015, 709, and 562 cm^{-1}. The peaks at 3393, 1632 and 1015 cm^{-1} corresponding to hydroxyl group (-OH) Stretching, hydroxyl (-OH) bending and C-O stretching respectively. The Narrow bands at 535 confirm the formation of CuONPs.

3.1.4. SCANNING ELECTRON MICROSCOPE (SEM)

The morphology of CuO nanoparticles studied by SEM analysis. Fig (6) showa the surface morphology of the copper oxide nanoparticles was observed in the SEM image. It seems that the diameter of CuO nanoparticles range between 60-80 nm as calculated by image J programme [28].

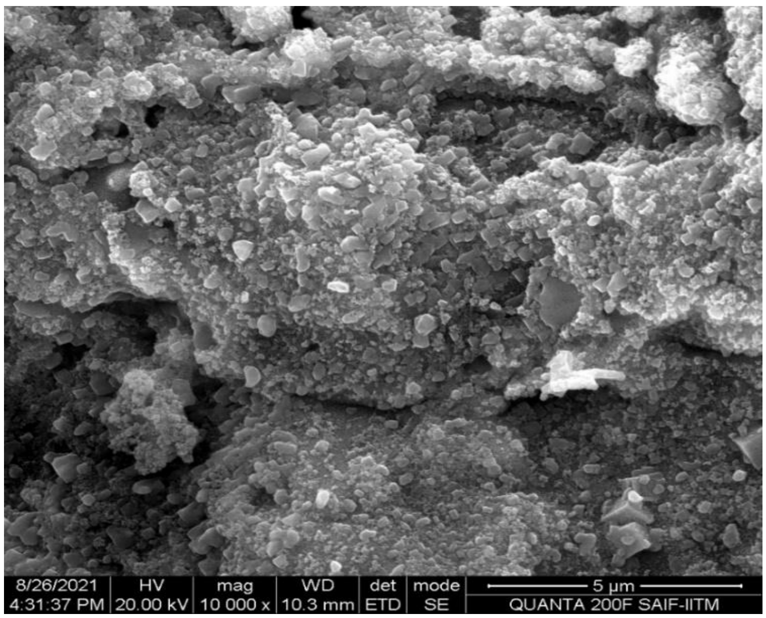

Fig 6. SEM image of Green synthesized copper oxide nanoparticles.

3.1.5. ENERGY DISPERSIVE X-RAY DIFFRACTIVE (EDX) ANALYSIS

The Energy Dispersive X-ray (EDX) study was carried out for the green synthesized CuO nanoparticles to know about the elemental composition. EDX confirm the presence of Cu and O signals of CuO nanoparticles as shown in table 1. The elemental analysis of nanoparticles yields Cu 78.07% and 21.93% of oxygen which process that the produce nanoparticles is in its highest purified form [29-30].

Table 1: EDX analysis for synthesized copper oxide nanoparticles.

S.NO	Element	Weight (%)
1.	Cu	78.07
2.	O	21.93

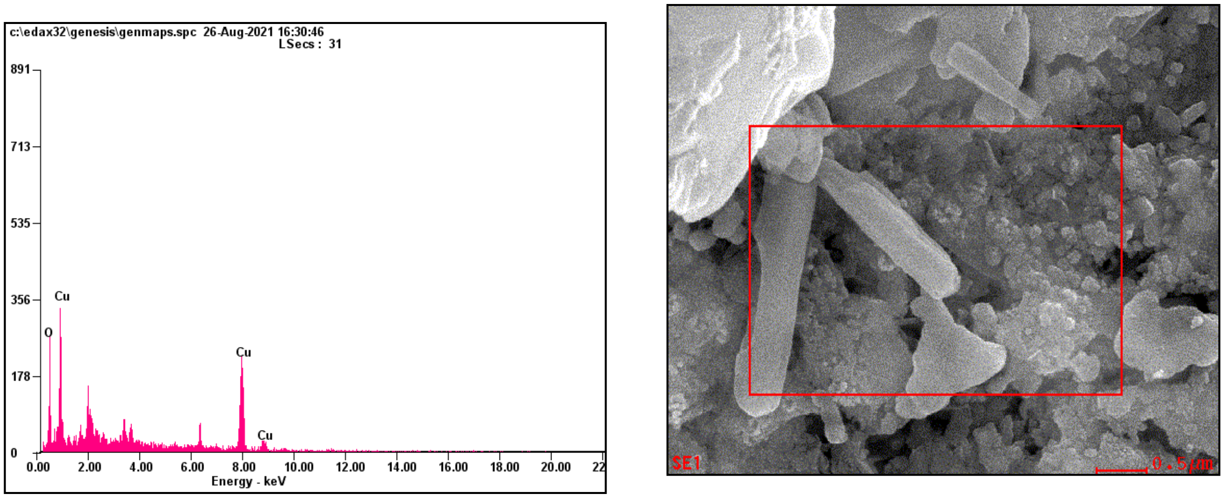

Fig 6. EDX spectrum of copper oxide nanoparticles

CONCLUSION

In this study, an eco-friendly and convenient green method from copper chloride dihydrate solution using Albizia Amara leaves extract was developed. The green synthesized copper oxide nanoparticles were confirmed by UV-vis, XRD, FT-IR, SEM-EDX. CuO nanoparticles prepared from above mentioned route are expected to have more extensive applications such as reducing, stabilizing and efficient antimycobacterial agent, chemical sensor and semiconductor etc. This process is an economical method for the preparation of Nano crystalline CuO with respect to energy, time, simplicity and can be used for large scale synthesis of copper oxide nanoparticles

REFERENCES

1. Environmental Protection Agency, "*Nanotechnology white paper*," USEPA 100/B-07/001, 2007.

2. K. N. Thakkar, S. S. Mhatre, and R. Y. Parikh, "Biological synthesis of metallic nanoparticles," *Nanomedicine,* vol, no. **2**, 257-262 2010

3. Chen, H.; Roco, M. C.; Li, X, Lin, Y.-L. Trends in nanotechnology patents. *Nat. Nanotechnol.* 2008, **3**, 123-125.

4. Altikatoglu, M.; Attar, A.; Eric, F.; Cristache, C.M.; Isildak, I. Green synthesis of copper oxide nanoparticles using Ocimum basilicum ectract and their antibacterial activity. *Fresenius Environ. Bull.* 2017, **25**, 7832-7837.

5. R. G. Chaudhuri, S. Paria Core / shell nanoparticles. Classes properties, nanoparticle mechanism, characterization and applications. *Chem. Rev.* **112** (4) (2012) 2373-2433.

6. Lee Jackson, dirty Old London: The Victorian Fight Against Filth (2014)

7. John Tarantino. "Environmental Issues". The Environmental Blog. Archived from the original on 2011,12,10.

8. Udiba U.U. Gauje, B., Ashade, N.O., Ade-Ajayi, F.A. okezie V.C., Aji B.M., and Agboun, T.D T., 2014. An assessment of the heavy metal status of River Galma around Dakace industrial layout, Zaria, Nigeria,. *Merit Research Journal Of Environmental Science and Toxicology* 2 (8): 176-184

9. M. N. Ahmed, R.N. Ram, Removal of basic dye from wastewater using silica as adsorbent, *Environ. Pollut.,* **77**(1992) 79-85

10. W. A. Al-Amrani, P.E. Lim C.E. Seng, W.S. Wan Ngah, Bio regeneration of azo dyes-loaded monoamine modified silica in batch system: Effect of particle size and biomass acclimation condition, *Chem Eng.j.* **251** (20140 175-182.

11. S. Mondal, Methods of dye removal from house effluent- An overview, Environ. *Eng. Sci*. **25** (2008) 383-396

12. V, Larrechi MS, Callao MP (2007) kinetic and adsorption study of acid dye removal using activated carbon. Chemosphere **69**: 1151-1158.

13. Gupta VK, Kumar R, Nayak A, Saleh TA, Barakat MA (2013) Adsorptive removal of dyes aqueous solution onto carbon nanotubes: a review. *Adv Colloid Interface Sci* 193-194: 24-34.

14. Hassan, A.A and Abdulhussein, H. 2015. Methyl Red Dye Removal from Aqueous Solution by Adsorption on Rice Hulls. *Journal of Babylon University*, **3**: 23

15. Mas Rosemal H. Mas Haris and Kathiresan Sathasivam (2009). The Removal of Methyl Red from Aqueous Solutions Using Banana Pseudostem Fibers.

16. Laxmi, V. 2014. Removal of malachite green dye from water using orange peel as an adsorbent. Master of Technology Dissertation, *National Institute of Technology*, India.

17. Ferdous, J. Zainal-Abedin, Hafizur-Rahman and M-Ali-Hossain. 2014. Decolorization of Methyl Red by Hog Plum Peel and Sunfix Red by Bacterial Strains. *International Journal of Chemical and Environmental Engineering*. **5**(1):66-68.

18. NEILSEN LF., MOE D., KIRKEBY S., GARBARSCH C. Sirius red and acid fuchsin staining mechanisms. *Biotechnic Histochem.*, **73**, 71, 1998.

19. ZOBIR BIN HUSSEIN M., YAHAYA AH., SHAMSUL M., SALLEH HM., YAP T., KIU J. Acid fuchsin-interleaved Mg-Al-layered double hydroxide for the formation of an organic-inorganic hybrid nanocomposite. *Mater. Letter*, **58**, 329, 2004.

20. Dash Bibek, "Competitive Adsorption of dyes (congo red, methylene blue, malachite green) on Activated Carbon", 2011.

21. M. Q. Zhu, L. Zhu, J. J. Han, W. Wu, J.K. Hurst, A.D. Li, Spiropyranbased Photochromic polymer nanoparticles with optically switchable luminescence *J. Am. Chem.Soc*. **128** (13) (2006) 4303-4309.

22. K. Ulbrich, K. Hola, V. Subr, A. Bakandritsos, J. Tucek, R. Zboril, Targeted drug delivery with polymers and magnetic nanoparticles: covalent and noncovalent approaches, release control, and clinical studies, *Chem Rev*. **116** (9) (2016) 5338-5431.

23. S. M. Dhoble, N.S. Kulkarni Investigation of in vitro and involve antifungal property of biological synthesized copper oxide nanoparticles against rhizoctonia solani a phytopathogen of soyabean (Glycine max L. Merrill) *Int. J. Eng. Sci*. **4** (5) (2018) 17-30

24. Azhar,S. S,Liew A.G., Suhardy, D., Hafiz, K. F, Hatim,M. D. I., 2005, "Dye Removal from Aqueous Solution by using Adsorption on Treated Sugarcane Bagasse", *American Journal of Applied Sciences* **2** (11): 1499-1503.

25. Long – Bao Shi, Pei-Fu Tang, Wei Zhang, Yan-Peng Zhao, Li-chang Zhang and Hao Zhang. Green synthesis of copper oxide nanoparticle using cassia auriculata leaf extraxt and vitro evaluation of their bio compatibility with rheumatoid arthrites macrophages. *Tropical Journal of Pharmaceutical Research*. January 2017; **16** (1): 185-192

26. R Chowdhury, N. Barah and M. H. Rashid, Facile biopolymer assisted synthesis of hallow SnO_2 babostructures and their application in dye removal, *ChemistrySelect,* 2016, **1**, 4682-4689.

27. Kavitha R. Francisca P. Anxilia A. Biosynthesis characterization and antibacterial effect of plants mediated silver nanoparticles from Adenanthera Pavonina Leaves. JETIR February 2019, vol **6**. (2)

28. D. Berra, S. Laouinia, B. Benhaouab, M. Ouahrania, D. Berrania and A. Rahald, "Green Synthesis of Copper Oxide nanoparticles by phoenix dactylifera leaves extract" Digest *Journal Nanoparticles and Biostructure*. vol.**13** 1231-1238.

29. Maruthupandy, M., Zuo, Y., Chen, J. S., Song, J. M. Niu, H. L. Mao, C. J. Zhang, S. Y. Shen, Y. H. 2017. Synthesis of metal oxide nanoparticles (CuO and ZnO Nps) via Biological template and their optical sensor application. *Applied Surface Science,* **397**: 167-174.

30. S. M. Yedukar C. B. Maurya, P. A. Mahanwar. A biological approach for the synthesis of copper oxide nanoparticles by Ixora Coccinea Leaf extract. *Journal of Material and Environmental Science.* **8** (4) (2007) 1173-1178.