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Green Synthesis and Characterization of Y_2O_3 nanoparticles

[1]Sanjay R. Kale*, [2]Dilip R. Thube

[1]Associate Professor, Department of Chemistry, Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati, 413 102, Dist. Pune. Maharashtra.

[2]Professor, Department of Chemistry and Research Center, New Arts Commerce and Science College, Parner, 414 302 Dist-Ahmednagar. Maharashtra.

Abstract: **In the present study, the Green synthesis of Yttrium oxide (Y_2O_3) nanoparticles was carried out using *Aegle Marmelos* (Bael) leaves aqueous extract as a precipitating and capping agent. The synthesized metal complex was calcined at 800°C. The produced nanoparticles (NPs) were characterized by using various instrumental techniques for its crystalline nature and surface morphology The XRD and SEM analysis confirmed the presence of cubic structure of agglomerated Y_2O_3 NPs with particle size ~ 35 nm. The EDX analysis identifies the presence of elements yttrium and oxygen. FTIR analysis gave the evidences for presence of Y–O–Y and O–Y–O metal oxide stretching in the range 450-550 cm^{-1}. The UV-visible spectroscopic analysis showed that for the scanned suspended metal oxide was in the UV range which is an indication of the formation of nano-sized material. TGA gave the thermal stability of Y_2O_3 NPs. This study confidently describes an eco-friendly; nontoxic, economical and effective green process to synthesis *Aegle Marmelos* leaves extract mediated Y_2O_3 NPs, which can be useful due to their remarkable properties.**

Index Terms: **Green synthesis; Aegle Marmelos; Yttrium oxide; nanoparticle; calcination**

I. INTRODUCTION

Nanosized inner transition metal oxides can be effectively synthesized using with different methodologies which include chemical, electrochemical, radiation and biological techniques. The synthetic methods involve use of toxic, hazardous chemicals which are harmful and can leads to increase the risks of bioaccumulation followed by bio magnifications. Therefore, it is need of time to develop an eco-friendly method to synthesize nanoparticles. Nowadays green route can be adopted in the synthesis of metal and metal oxide nanoparticles using plant material. The leaves extract mediated method is one of the environmentally conscious as it eliminates toxic chemicals formed as by-product in certain chemical reactions and removes use of organic solvents. Also it is much more superior over some physical, chemical or microbiological methods as it is environmentally friendly, of low cost and can be adopted for large scale preparations. An eco-friendly (green) approach by employing several plants such as Alfalfa [1], Aloe Vera [2] has been reported. Green synthesis of gold and silver nanoparticles has been reported [3] to obtain a wide range of sizes and shapes of NPs. During the green synthesis, the plant extract can act both as stabilizing and capping agents and the surface morphology and size of metal oxide nanoparticles are highly depends on the plant extract material [4].The metal and metal oxides nanoparticles have been considered as promising material that possesses remarkable antibacterial properties caused by their high surface area [5].To control and minimize the problems caused by the bacteria, Y_2O_3 NPs is one of the key materials which can act in a non-toxic way to environment. Therefore, in this study we use leaves extract of *Aegle Marmelos* plant to synthesize Y_2O_3 NPs and further applied for antibacterial activity. The *Aegle Marmelos* is a traditional plant also known as Beal belongs to Rutaceae family and have been used in medicine and medical applications to cure ophthalmia, catarrh, deafness, aggravations, diabetes and asthma throughout centuries in India. The leaves extract of *Aegle Marmelos* was used to synthesize ZnO nanoparticles [6] and Silver nanoparticles [7] for their antimicrobial activity had been reported. Biosynthesis of Y_2O_3 nanoparticles using *Acalypha indica* leaf extract and their antibacterial study [8] has been reported. Green synthesis and characterization of Y_2O_3, CuO and $BaCO_3$ nanoparticles using *Azadirachta Indica* (Neem tree) fruit aqueous extract has been reported [9]

Yttrium oxide (Y_2O_3) is an important compound among rare earth oxides with controllable size and morphology which may have better sintering ability and unique luminescent property has been actively studied in the recent years for its applications in the field of transparent ceramics[10] luminescent devices [11] and humidity sensor [12] .Y_2O_3 is a well-known and widely used as a host material for various rare earth dopants in the field of biological imaging and photodynamic therapy[13], still there is no report found which give green and eco-friendly synthesis of Y_2O_3 NPs using aqueous leaves extract of *Aegle Marmelos* (Bael tree) as a precipitant and capping agent. The precipitation of yttrium hydroxides from yttrium nitrate solution takes place and the formed product after thermal decomposition and calcinations yields Y_2O_3. The synthesized pure Y_2O_3 NPs were characterized by using various instrumental techniques.

II. MATERIALS AND METHODS

Yttrium nitrate hexahydrate [$Y(NO_3)_3$ $6H_2O$] was purchased from Alfa Aesar and used further directly without purification. The leaves of *Aegle Marmelos* (Bael tree) were collected from own field, washed thoroughly with double distilled water and dried for ten days at room temperature.

Preparation of leaves extract by extraction process

The dried and finely cut leaves were grinded in mortar and pestle to obtained fine powder. About 30 gm powder was boiled to extract the phytochemicals in a 250 ml Erlenmeyer flask with 100 ml double distilled water for 60 minutes. Then the aqueous solution was taken for filtration using ordinary filter paper and through WhatmanNo.1 filter paper. The filtrate was collected and evaporated on water bath. The extract thus formed was stored in a refrigerator and used for further synthesis of Y_2O_3 NPs.