Study on Green Synthesis, Characterization and Anticancer Activity of Thorium Nanoparticles Using Tomato (Lycopersicon Esculentum) Extract

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Study on Green Synthesis, Characterization and Anticancer Activity of Thorium Nanoparticles Using Tomato (Lycopersicon Esculentum) Extract

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Abstract: *In the present study, we experiment the reducing and capping activity of aqueous extract from tomato juice for the preparation of thorium nanoparticles. Structural and morphological studies of these nanoparticles were carried out by using UV-Vis spectroscopy, Transmission Electron Microscopy, Fourier infrared spectroscopy, X-ray Diffraction Analysis and anticancer activities. The average particle size of thorium nanoparticles was found in the range of 1.05nm to 1.67 nm. The use of tomato extract proves the process a non-toxic, cost-free and environmentally friendly green method of production of thorium nanoparticles.*

Introduction: *The subject nanotechnology deals with manufacturing, study and manipulation of matter at nanoscale in size range of 1-100 nm which may be called as nanoparticles [1]. Nanotechnology represents the design, production and application of materials at atomic, molecular and macromolecular scales in order to produce new nanosized materials [2].Nanotechnology is mainly concerned with synthesis of nanoparticles of variable sizes, shapes, chemical compositions and controlled disparity with their potential use for human benefits [3].Their unique properties contribute to their potential applications in various fields like biosensors, bioremediation of radioactive wastes, functional electrical coatings, synthesis of enzyme electrode and particularly in medicine such as delivery of drugs, antigen for vaccination and gene delivery for treatment or prevention of genetic disorder [4,5,6]. This has inspired the scientists to develop effective procedures for the synthesis of nanoparticles. In recent years, metal nanoparticles have received significant attention owing to their unique properties and practical applications [7]. The traditional chemical methods used to synthesize nanoparticles are expensive and often raise questions of environmental risk due to use of toxic, hazardous chemicals. Further, these synthetic methods normally use organic solvents because of hydrophobicity of the capping agents used [8]. Hence, the search for cleaner, nontoxic methods of synthesis has ushered in developing approaches that use biological systems [9.10].It is known that fruit mediated synthesis of thorium nanoparticles is much safer and environmentally friendly as compared to chemical synthesis. Here we report synthesis of thorium nanoparticles by using onion (Lycopersicon esculentum) extract. Through elaborate screening process involving number of fruits, we observed that tomato was potential fruit for the synthesis of thorium nanoparticles. The synthesized nanoparticles were characterized by, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Fourier infrared (FTIR) spectroscopy, X-Ray Diffraction and anticancer activity.*

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I. Material and Methods

Red tomatoes (25 gms) (Lycopersicon esculentum) was collected from the local market Vijayapur and washed with double distilled deionizer water. The skin was removed from the tomato and whole was squeezed to get the juice. This was dissolved in distilled water and filtered using wattman filter paper. Thorium nitrate (0.1M) was used as precursor for the synthesis of thorium nanoparticles.

Characterization of thorium nanoparticles

TEM Analysis of Thorium Nanoparticles: Transmission electron microscopy (TEM) is a microscopy technique where by a beam of electrons is transmitted through an ultra-thin specimen, interacting with the specimen as it passes through. An image is formed from the interaction of the electrons transmitted through the specimen and the image is magnified and focused onto an imaging device. Transmission electron microscopy measurements were performed on Jeol/JEM 2100 model 1200EX instrument operated at an accelerating voltage at 200 kV.

Fourier Transform Infrared: Dried powder of the ThNPs was subjected to analyze the presence of possible functional groups for resulting in formation of ThNPs using Fourier transform infrared (ATR schimadzu Japan) spectroscopy.

X-Ray Diffraction Analysis: To determine the nature and size of the synthesized ThNPs, X-ray diffraction (XRD) was performed using on Xpert Pro MPD, which was operated at a voltage of 40 kV and current of 40mA with Cu-Kα radiation.

Anticancer Activity: A 375 cells were subcultured in DMEM (Gibco) by adding 10% fetal bovine serum (FBS), penicillin (100 IU/ 100ml), and streptomycin (100 µg/ml) and incubated at 37 ^{0}C in a CO_2 incubator (5%). Stock suspension of ThNPs (1mg/ml) in DMEM (added with 10% FBS) was diluted to concentrations (5-40 µg/ml) for morphology of cells, cytotoxicity, comet tests. For each experiment, the suspension of ThNPs was freshly prepared, diluted to suitable doses and instantly exposed to the cells. Culture medium without Th NPs served as the control in each experiment

HRTEM Analysis of Thorium Nanoparticles and SAED Pattern: TEM is one of the most commonly used methods for the determination of the shape, size and morphology of nanoparticles [11, 12]. The morphology and size of the particles were determined by the HRTEM images shown in fig.1and 2. The particles formed were spherical in shape. The Th Nps formed were in the range of 1.05nm to 1.67 nm. The more stable spherical shape and isotropic nanoparticles was formed by the action of large number of bimolecules ranged in the solution.

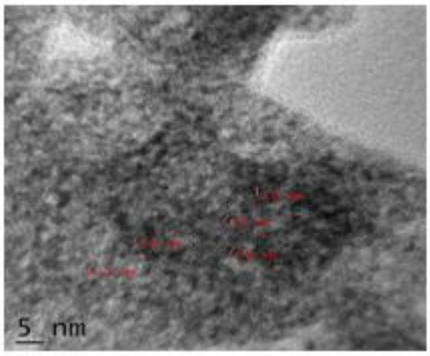

Fig.1

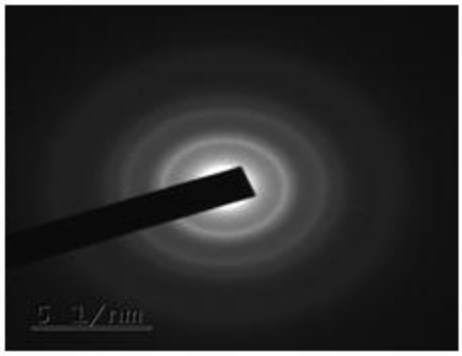

Fig.2

Fourier Transform Infrared of ThNPs

FTIR spectrum (Fig.3) used to analyze the functional group present in fresh tomato extract. The Thorium nanoparticle was confirmed in the FTIR spectrum after synthesis. The peaks at 1450 cm^{-1}, 1600 cm^{-1} and 1605 cm^{-1} shows the symmetric stretching vibration of –COO [13], stretch vibration of C=C [14] and the reduction of thorium ion to thorium nanoparticles. The peaks at 2350 $cm^{-1,}$ 3380 cm-1 represents the asymmetric stretching for C-C [15], stretching vibration of C-H and water and OH absorption frequency [16].

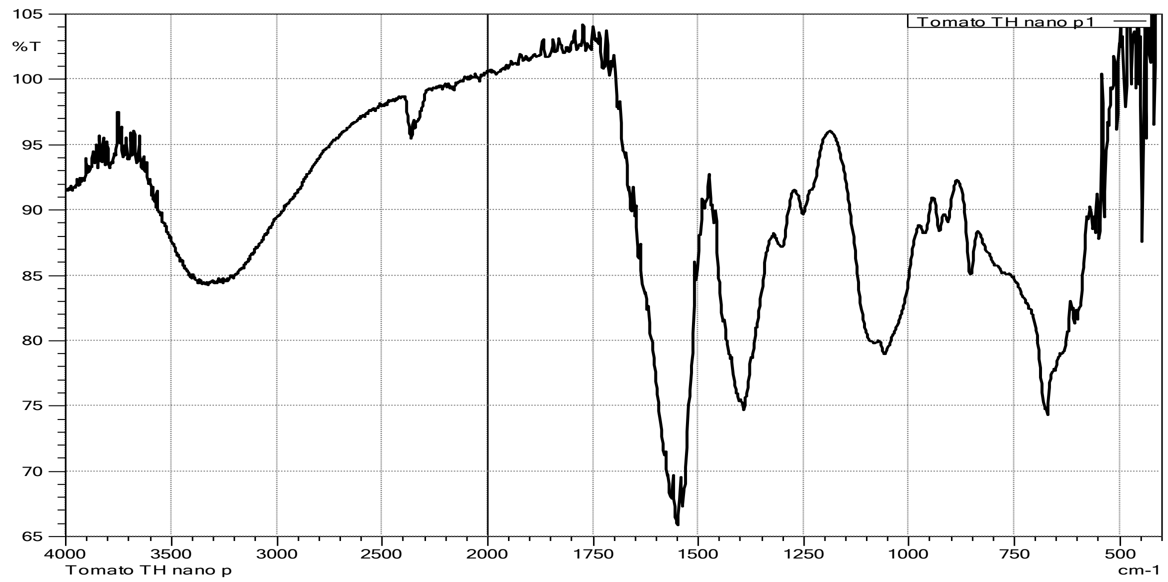

Fig.3

TG and DTA of ThNPS of Thorium

TGA and DTA spectrum of ThNps sample are given in Fig.4. In this thermo gravimetric and differential thermal analyzer were analyzed with the function of temperature. The weight loss of the material was calculated from TG curve. Bellow 120^{0}C the weight loss was observed due to water evaporation. After 120^{0}C to 410^{0}C the weight loss occurred due to the weight loss occurred due to the evaporation of inorganic material in the sample. Then the weight loss was happened due to the evaporation of surface unreacted organic and other materials of the sample. The total weight loss was calculated as 3.5 % from room temperature to 800^{0}C. The DTA spectrums displays two endothermic peaks descend between 10^{0}C to 280^{0}C and between 310^{0}C and 480^{0}C [17].

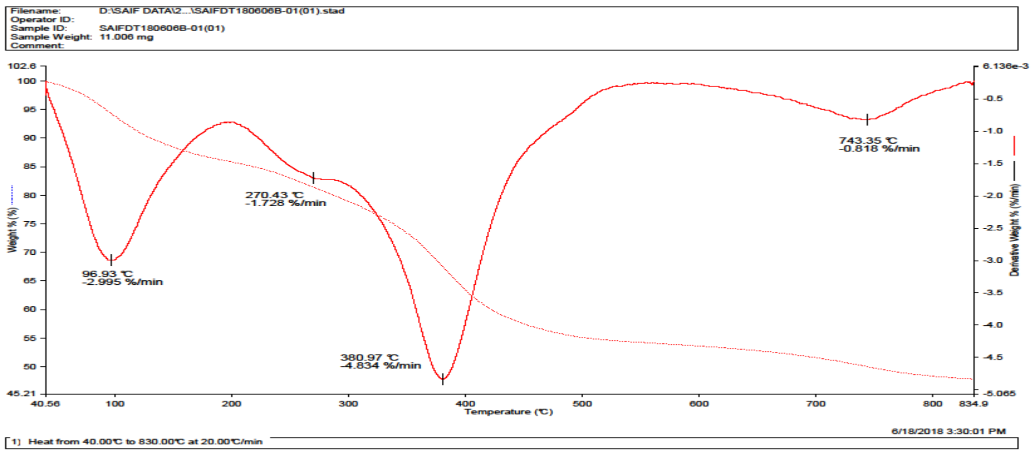

Fig.4

X-Ray Diffraction Analysis:

Fig.5 illustrates the powder X-ray diffraction patterns of the Th Ns sample. It is well known that the PXRD peak intensities, peak shapes and peak positions, which reflect the extent of crystallanity of Th NPs. The characteristic peak corresponding to the (100), (110), (111), (200) and (210)located at 2θ: 6.754°, 7.185°, 8.387°, 13.53°, 14.62°, 19.25°, 25.442° and 46.17° respectively which shows that sample is simple cubic structure. The absence of extra peak clearly tells the purity of the sample. The average crystalline was obtained from Scherer formula. The average crystalline size of the Th NPs calculated is around 15.67nm.

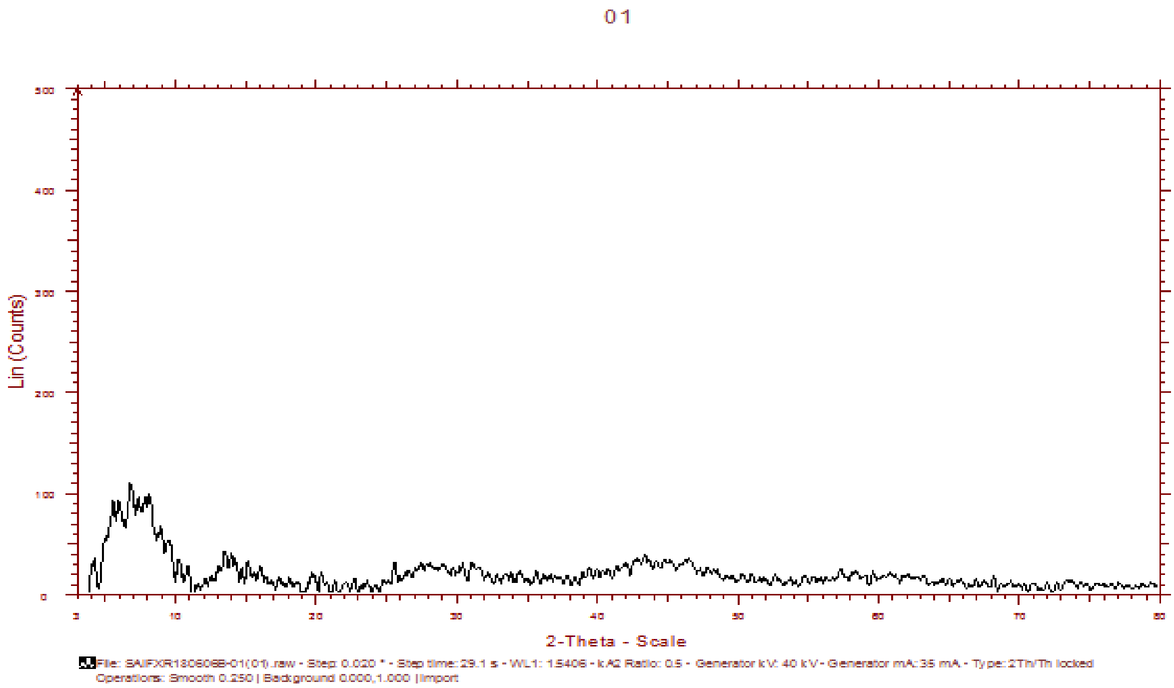

Fig.5

Anticancer activity: The MTT results demonstrated concentration dependant cytotoxicity in A 375 cells after exposure to ZnO nanopaticles (Fig.6). The MTT reduction observed after 24 hours of exposure to nanoparticle concentrations of 1000, 500,250,125 and 62.5 µg/ml was 61.6, 77.4, 80.4, 86.9 and 96 % of exposure. Nair et al reported that the cytotoxicity of Th NPs in cancerous cells is related to size, with smaller nanoparticles having greater toxicity. The Th NPs suppressed the proliferation of cancer cell line by inducting apoptosis after entering in to cells and the activity is dose dependant [18].

Table.No.1 Anticancer activity

S.No	Cell Line	Concentration (µg/ml)	Cell Viability (%)
1		1000	61.6
2	Human Melanoma[A 375]	500	77.4
3		250	80.4
4		125	86.9
5		62.5	96.0

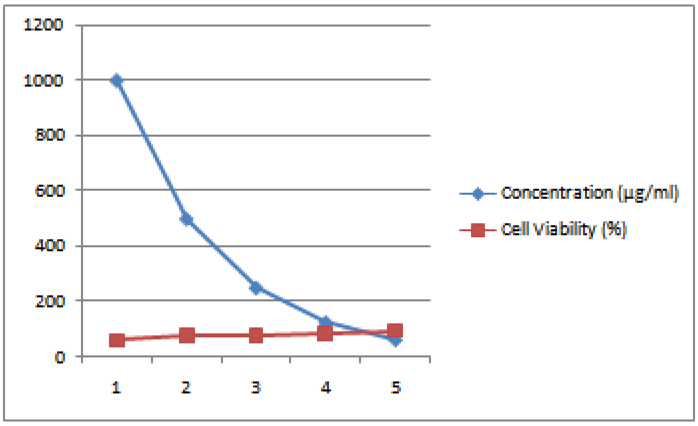

Fig.6. Percentage cell viability due to exposure of Th NPs to human melanoma A 375 cell lines

II. Conclusions:

The green synthesis of tomato fruit extract was shown to be eco-friendly and produced nanoparticles are fairly uniform in size and shape. Taken together the results show that, effect of ThNPs on melanoma cell line A 375 is concentration or dose dependant.

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