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Effect of Gamma irradiation in biosynthesis of Silver nanoparticles by Date-Palm Fronds *Phoenix dactylifera* L.

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ABSTRACT

The research was focused on the study of the effects different gamma irradiation doses 20, 40 and 60 KGy in biosynthesis of silver nanoparticles by aqueous extract of Date-palm fronds. Gamma Radiation doses were used as a reducing agent for silver ions while aqueous extract was used as a bio reducing, capping and stabilizer agents for synthesis of Silver nanoparticles. The results of UV. spectrophotometer showed that the highest absorption were recorded at wavelengths 422, 460, 447 and 460 nm at Gamma radiation doses as well as the control treatment respectively. The results of XRD were showed to the nanoparticles nature of the silver particles produced by aqueous extract of Date-palm under exposure to different Gamma radiation doses and reduced crystalline size of the nanoparticles was observed by increasing gamma radiation doses. Images of the electron microscopy (SEM) and (EDX) energy diffused X-ray detector, the nanoparticles are almost spherical and have a diameter of 26.75, 22.41, 16.83 and 31.36 nm when exposed to the gamma radiation doses mentioned above, as well as aqueous extract of date palm, respectively. The results indicated the importance of gamma radiation in synthesis of silver nanoparticles as reducing agent and with good nanomaterial's proprieties with increase of gamma radiation doses, in addition to the importance of aqueous extract of date palm as bio reducing, capping and stabilizer agents for silver nanoparticles and thus the possibility of synthesis of silver nanoparticles by ecofriendly method and it using in Different applications.

Keywords: Silver nanoparticles, Gamma ray, Date Palm, Synthesis

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INTRODUCTION

Nanotechnology has been described as one of the fastest development technologies in the world and has been called the next technology revolution in various fields because of its great advantages. (1) Nanotechnology is concerned with the study of the composition, properties and synthesis of nanomaterial's ranging in size from 1-100 nm as well as applications in various industrial, medical and agricultural fields (2). The use of Gamma rays in the synthesis of nanomaterial's in aqueous medium is an important method. The use of Gamma rays in manufacturing leads to many advantages and including good nanostructures and stability of manufactured nanoparticles as well as being safe and inexpensive methods compared to other chemical and physical methods (3). biological methods of nanomaterial's by microorganisms have attracted great interest in recent years as they are ecofriendly , low cost-effective methods, as and easily of synthesis(4), but it was found that the use of plant extracts is better in obtaining manufacturing rates faster, and more stable compared to the use of microorganisms (5). Silver nanoparticles are one of the most important nanomaterial's that have attracted interest in nano applications (6) their wide application in the destruction of environmental pollutants (7) and their use in the control of insect and pathogenic infesting plants (8) and their importance as Nano sensors to detect toxins and pesticide residues at low concentrations. In addition to its importance in the therapy of cancer and its effects on many pathogens of humans and animals (10). This study aimed to study the effect of different doses of Gamma rays on the biosynthesis of silver nanoparticles by aqueous extract of Date-Palm fronds and to determine the properties and specifications of Synthesed silver nanoparticles.

MATERIALS AND METHODS

Preparation of silver nanoparticles under irradiation conditions by Gamma rays

The aqueous extract of Date-Palm fronds was prepared according to the method described in (5). silver nanoparticles were prepared under the influence of different doses of Gamma rays as a reducing agent using gamma cell- 900 cell and source Co 60 with a capacity of 2.8 Ci at 30 Gy / hr. in physics department College of Science University of Baghdad . Aqueous solution of silver nitrate Prepared at a concentration of 50 mM as a standard solution. Aqueous extract of palm fronds and silver nitrate solution were exposure to different doses of Gamma rays separately and included 20, 40 and 60 KGy while the control without radiation treatment. The silver nitrate solution also treated and heating , stirring by (magnetic hot plate stirrer) at a temperature of 50 ° C, during which the occurrence of color changes of the solution, which indicates a reduction process and the formation of silver nanoparticles. Similarly, the steps were repeated for the preparation of silver nanoparticles without irradiation as a control treatment for comparison. For the purpose of purifying the silver nanoparticles and obtaining a nanoparticles, the centrifuge of the nanoparticle was carried out at a rotation speed of 4000 rpm for one hour, then the precipitated part was taken and placed in a glass petri dish and then placed in a heat oven (60 ° C) for drying for 2-1 hours, then collect the silver nanoparticles powder and store in incubator in opaque glass bottles at 25 ± 2 ° C until use.

Study of some properties of prepared silver nanoparticles

The optical properties of silver nanoparticles, silver nitrates and extracts were determined by UV-VIS spectrophotometer. The functional groups that make up the aqueous extract of date palm fronds were identified and the functional groups were identified in the silver nanoparticle solution to determine the materials contribute in the reduction, capping and stabilizer of nanoparticles by the Fourier transform infrared (FTIR) device. The XRD diffraction device was used to determining the crystal size of the silver nanoparticles. Scanning electron microscope (SEM) was used to determine the structural ,shape and size properties of the nanoparticles As well as the ratios of components in each sample determined by X-ray energy dispersed device (EDX) attached to the scanning electron microscope.

RESULTS AND DISCUSSION

Reduction of silver ions and formation of silver nanoparticles

The addition of aqueous extract of palm fronds treated with irradiation to the solution of silver nitrate treated with radiation also led to the occurrence of color changes ranging from yellow and then stabilized to brown within 15 minutes (Fig. 1) which indicates the occurrence of reaction and a reduction of silver ions and the formation of silver nanoparticles. The same applies to the reaction of aqueous extract and non-irradiated silver nitrate, whereas the silver nitrate solution has not changed in comparison. Ultraviolet spectroscopy showed that the highest absorption was recorded at wavelengths 422, 460 and 447 nm when the silver nanoparticles solution was treated with radiation doses 20, 40 and 60 KGy respectively, while the highest absorption at wavelength 460 nm was recorded in the control treatment. Absorption for aqueous extract of palm fronds at a wavelength of 277 nm while highest absorption of silver nitrate was recorded at a wavelength of 221 nm (fig. 2,3,4). The mechanism of reducing silver ions to nanoparticles by Gamma rays has been discussed by many researchers if it is found that the exposure of the aqueous solution of the reactants to certain doses of Gamma rays leads to radiolysis decomposition of the water and the formation of free radicals as well as the presence of electrons in the aqueous solution and therefore free radicals and electrons They are powerful reducing agents that reduce silver ions to nanoparticles(3). The date palm aqueous extract is very rich in the secondary compound such as phenols, ketones, aldehydes, carboxyl groups and aromatic groups which will also acts as biological reducing , capping and stabilization of silver nanoparticles (5).

Fig. 1: Stages of the synthesis of silver nanoparticles

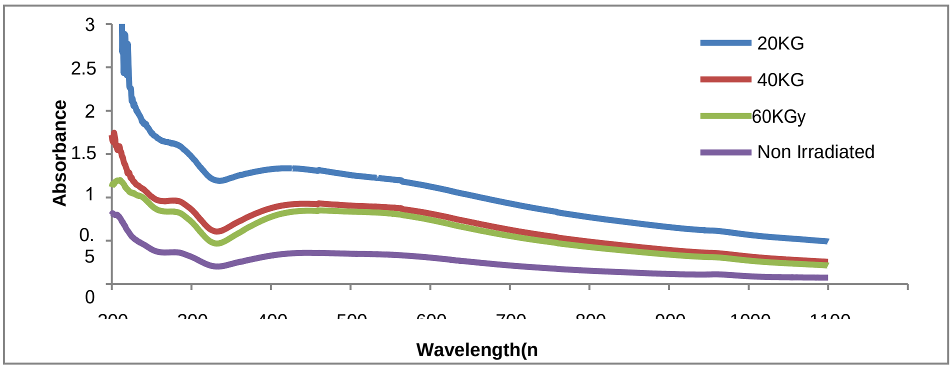

Fig. 2: UV vis.spectrophotometer of silver nanoparticles synthesized by aqueous extract of date palm fronds under gamma irradiation conditions

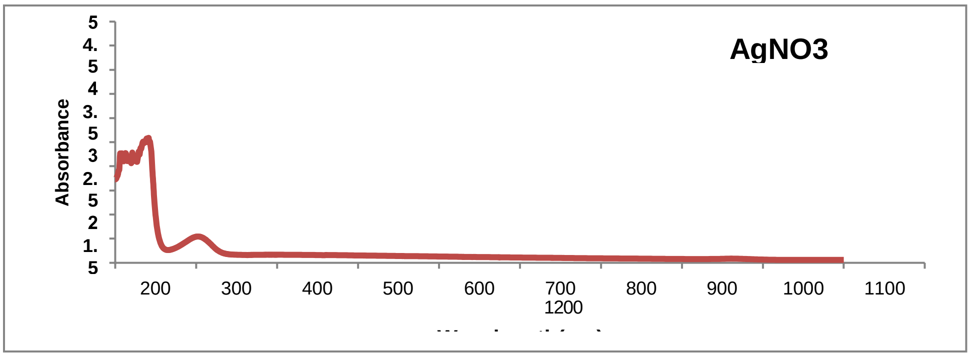

Fig. 3: UV VIS.Spectrophotometer of silver nitrate

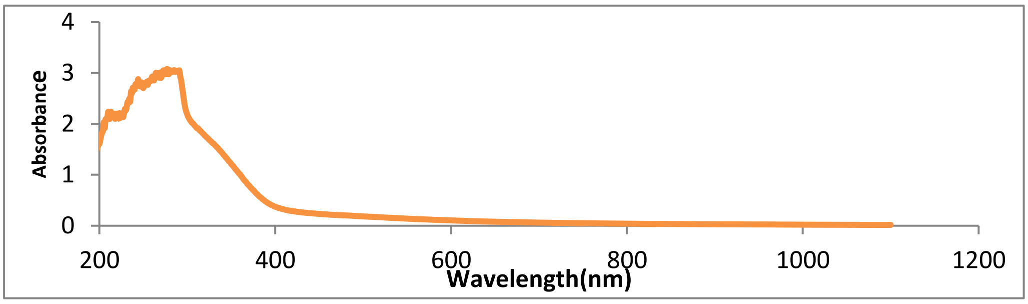

Fig. 4: UV VIS.Spectrophotometer for aqueous extract of date palm fronds

Infrared spectroscopy of aqueous extract of palm leaves and prepared silver nanoparticles

Fourier transform infrared (FTIR) of the palm frond aqueous extract (Fig. 5) showed that the extract is rich in several functional groups according to the elasticity values at wavenumbers. The elasticity at wavenumber (619.11-825) indicates the presence of aromatic groups. The wavenumbers of 1062-1201 indicate the presence of alcohol groups, while the wavenumber 1708 represents the presence of dihydric and ketone groups. There are also carboxylic groups at wavenumber 1444 and 2609. At the wavenumber, 3176, 3483 and 3556 the presence of amide groups as well as the presence of alkyl groups at the wavenumber of 2875. This abundance of active groups can have a significant role in the reduction, capping and stabilization of silver nanoparticles. In infrared spectroscopy for silver nanoparticles powder prepared by aqueous extract of date palm fronds, carboxylic, ketone, dihydro, aromatic, phenolic and amide groups are the most effective groups contributing to the process of biological reduction, capping and stabilization of prepared nanoparticles. The wavenumber indicated in (Fig. 6) the importance of these groups in reducing silver ions and converting them to nanoparticles.

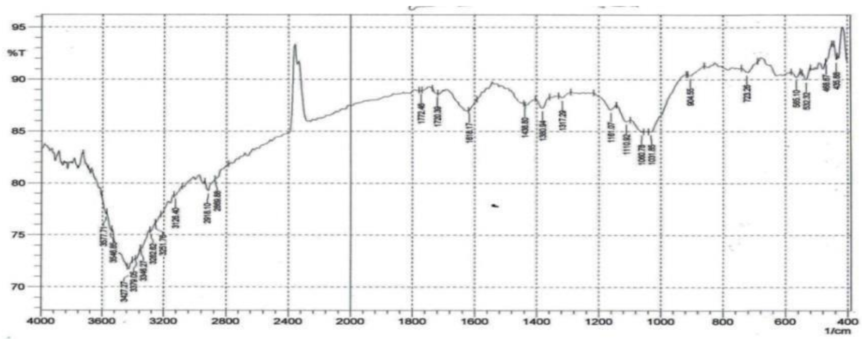

Fig. 5: FTIR for aqueous extract of date palm fronds

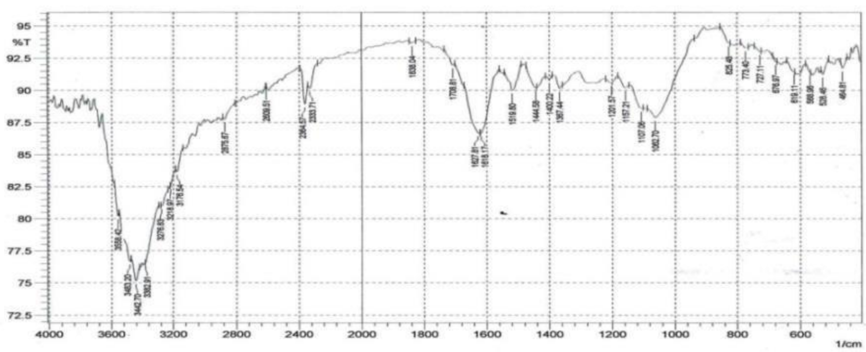

Fig. 6: FTIR for synthesized silver nanoparticles

Determination of the crystal size of silver nanoparticles by X-ray diffraction

X-ray diffraction test (XRD) (Fig. 7) showed a strong peak at surface 111 and angle 32. The examination also showed two other peaks at surfaces 200 and angle 46 as well as at surface 220 and angle 67 which corresponds to the spherical shape of the crystals. An average of 43.33 nm for silver nanoparticles manufactured by aqueous extract of date palm fronds without treated with Gamma rays. The examination showed the same peaks and angles at the silver nanoparticles prepared under the influence of different doses of Gamma rays. The crystal size were 33.25, 43.94 and 35.22 nm for Silver nanoparticles prepared by the aqueous extract of palm leaves under the influence of doses of radiation 20,40 and 60 KGy of gamma rays respectively fig (8, 9,10)

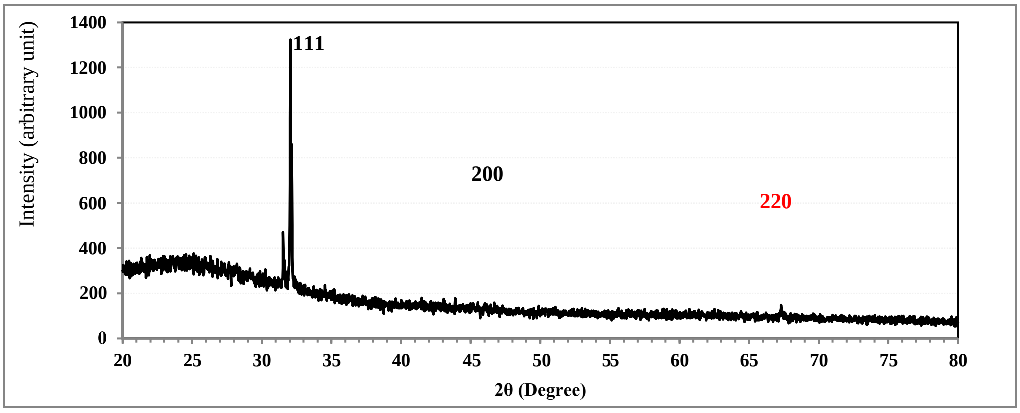

Fig. 7: XRD for silver nanoparticles synthesized by date palm aqueous extract

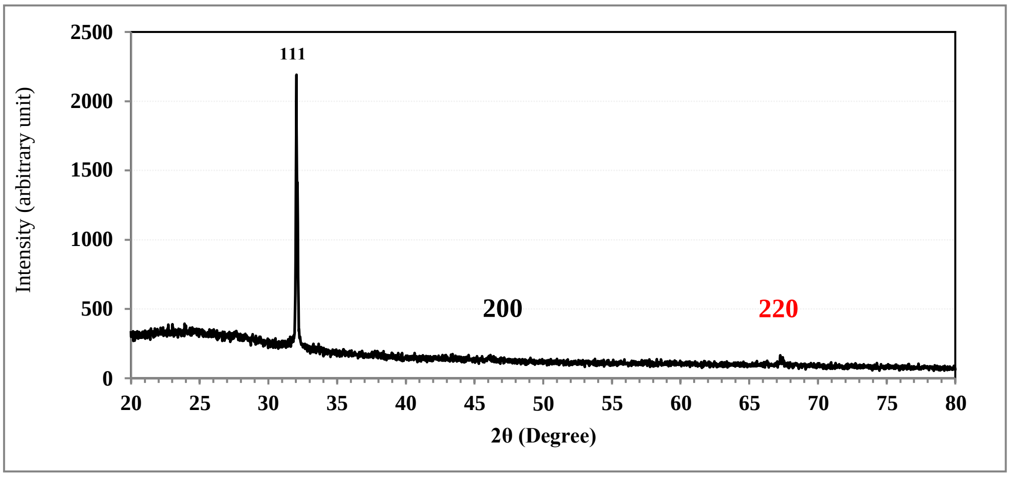

Fig. 8: XRD for silver nanoparticles synthesed by date palm aqueous extract at 20 KGy of Gamma radiation

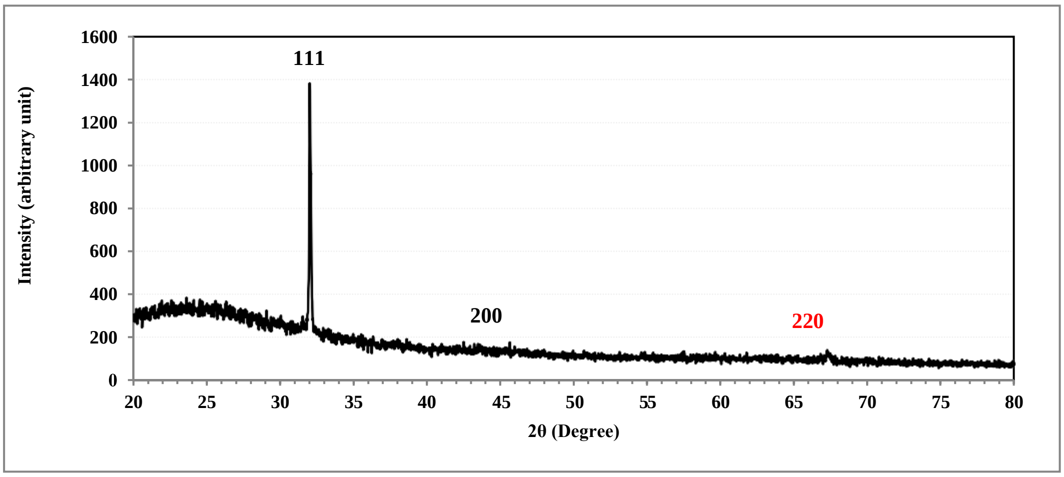

Fig. 9: XRD for silver nanoparticles synthesed by date palm aqueous extract at 40 KGy of Gamma radiation

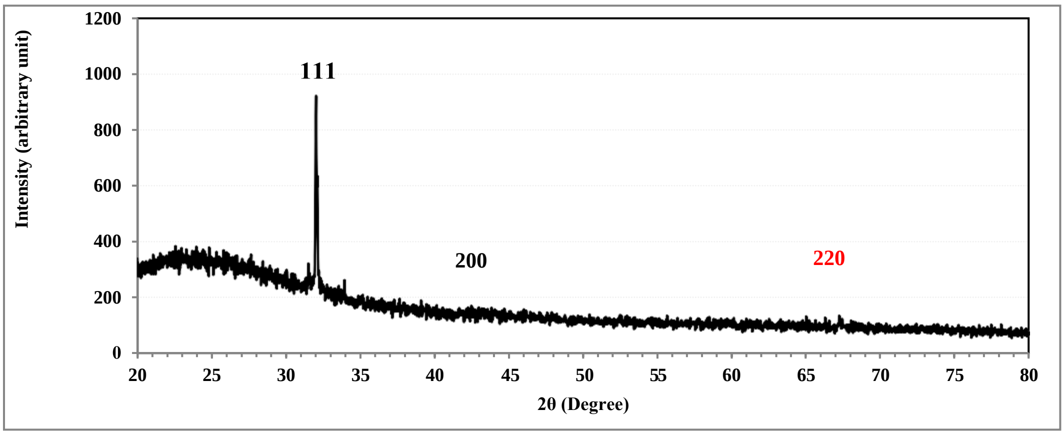

Fig. 10: XRD for silver nanoparticles synthesed by date palm aqueous extract at 60 KGy of Gamma radiation

Determine the size and shape of nanoparticles and the proportions of components

Scanning electron microscopy images (fig.11b,c,d) showed the formation of silver nanoparticles in the form of spherical clusters with a diameter of 26.75, 22.41 and 16.83 nm when treated with 20, 40 and 60 KGy of Gamma radiation doses respectively compared with the control 31.36 nm (fig.11a).The energy dispersive X- ray detector (EDX) (Fig. 12a,b,c,d) showed The silver nanoparticles are a good proportions with other elements such as nitrogen, silicon and oxygen in low proportions as impurities from the plant extract residue.

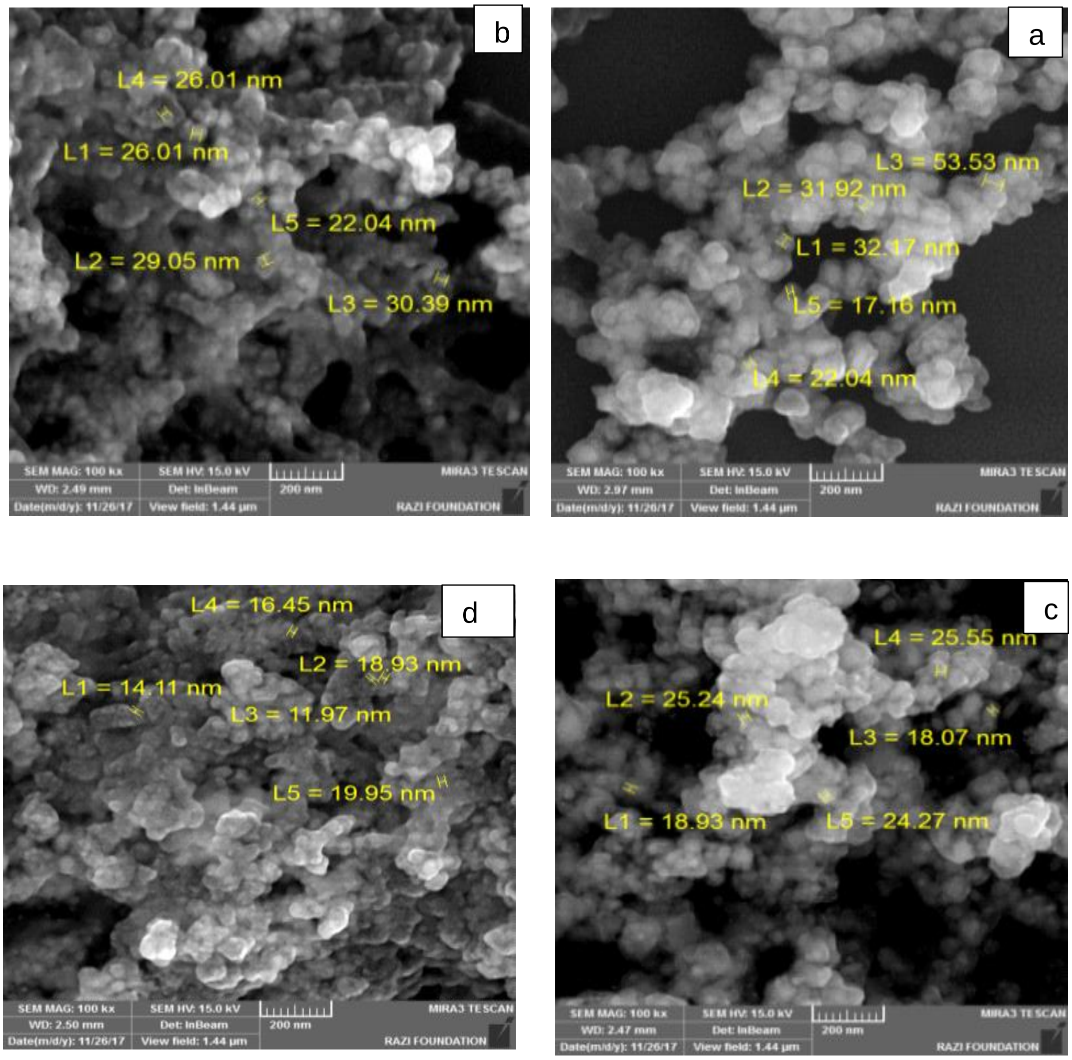

Fig.11: SEM images of silver nanoparticles synthesed at different doses of Gamma rays
a: non: irradiated b: 20KGy, c: 40KGy, d: 60KGy

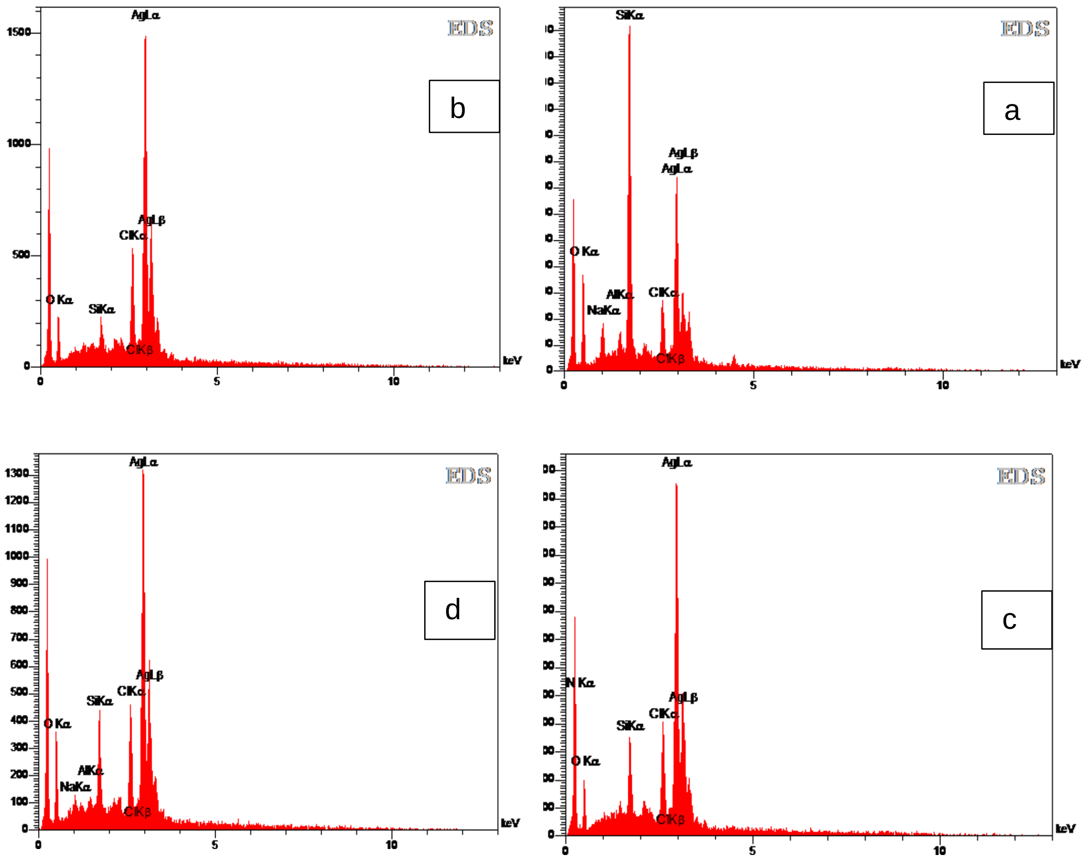

Fig.12: EDS for silver nanoparticles synthesed at different doses of Gamma radiation
a: non: irradiated b: 20KGy, c: 40KGy, d: 60KGy

CONCLUSIONS

The results showed that the use of Gamma rays with aqueous extract of palm fronds is a good and ecofriendly method in synthesis of silver nanoparticles with good nanostructures compared to other chemical and physical methods that are costly and hazardous . the aqueous extract of date palm fronds proved that it is rich in important secondary compounds such as phenols, carboxylates, ketones, aldehydes and aromatic compounds which have a great role in reducing, capping and stabilizing of silver nanoparticles.

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