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Effect of electron beam on morphological structure and photochemical properties of *Peganum harmala* medical seeds

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Abstract: *Peganum harmala seeds* used as anti-inflammatory, abortifacient, analgesic and treatment of bronchial asthma. There is a little study on the effects of electron beam on structure, phenolic compounds and antioxidants of seeds. For this reason, the aim of this work is to study the effect of the electron beam, with doses 3, 5, 7, 9 and 11 kGy on the chemical composition, (such as carbohydrate, protein, fat, fiber and protein), molecular structure and antioxidants for *Peganum harmala* seeds. The results show that, phenolic compounds in Peganum harmala seeds increased, while ascorbic acid and super oxidase dismutase decreased after exposure to electron beam doses. Protein and fiber contents in *Peganum harmala* seeds decreased after irradiated by 11 kGy with a little decreased in fat at 3 kGy. However, a significant increased of carbohydrates at 3 and 11 kGy. Internal structure of *Peganum harmala* seeds such arrangement or orientation or interconnection of molecules changed after exposure to electron beam.

Keywords: Electron beam (EB), Carbohydrate, Protein, Fat, Fiber, Ascorbic acid, Phenolic

1.Introduction

The effects of ionizing radiation are direct or indirect. The radiation acts directly on the material, that causing breakdown of molecules but the radiation reacts with water form a hydro-peroxide and free radicals acts indirectly [1, 2]. Two major irradiation technologies have been explored, gamma irradiation and high-energy electron beam (HEEB) besides X-ray as good technology for food against viruses [3-5]. Irradiation technology is used in food irradiation through ionizing radiations such as gamma rays or high energy electrons and X-rays in that [6]. The food industry are favored non-thermal and less invasive cleansing technologies as low energy electron beams [7]. Food irradiation was done by electron beams and gamma rays as the forms of electromagnetic radiation [8- 10], where gamma rays are emitted from radioisotopes, while electron beams generated from an electron accelerator. High energy electron beam accelerators or gamma sources are used to eradicate microorganisms from food [11]. The objective of this work is to study and analyze the effect of electron beam (EB) on molecular structure, chemical composition and anti-oxidants properties of *Peganum harmala* seeds

2. Materials and methods

Radiation source: The electron beam radiation system used in this study located at the Egyptian Atomic Energy Authority. Seeds of *Peganum harmala* was exposed to dose of electron beam (3, 5, 7, 9 and 11 kGy) with dose rate, (4 mA - 12.73 m⁄min, 8 mA- 15.53 m⁄min, 8mA- 10.27 m⁄min, 8mA- 7.68 m⁄min, 8mA- 6.13 m⁄min) respectively.

Structure of used samples studied by scanning electron microscope (JEOL JSM-6510LV, Japan) and molecular structure by Nicolet™ iS™ 10 FT-IR Spectrometer from USA.

Phenolic compound:

To measure the phenolic content in *Peganum harmala*, Folin-Ciocalteu (F-C) assay used following the procedure reported by Wolfe et al and Issa et al. [12, 13], in which the standard curve of Gallic acid was used.

To determine content of flavonoid in *Peganum harmala*, aluminum chloride colorimetric assay following the standard curve of Catechin "secondary metabolite" [14] was used.

Superoxide dismutase: Superoxide dismutase (SOD) was assayed by a photochemical method as described by Giannopolitis and Ries [15].

3. Results and Discussion

3.1. Super oxidase dismutase (SOD)

Figure 1 shows that super oxidase dismutase content in *Peganum harmala* seeds increased after irradiated by EB at 3, 5, 7, 9 and 11 kGy doses. Where increased gradually from 234.4 to 864.7 at 0 to 11 kGy respectively.

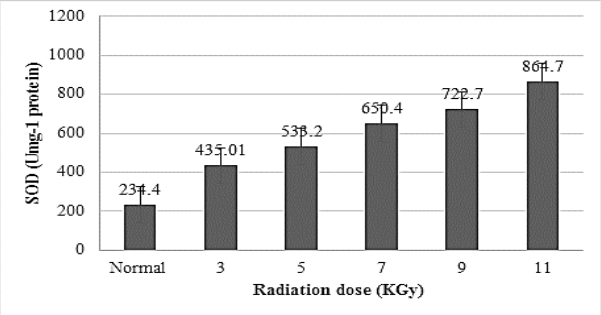

Figure 1: SOD content in *Peganum harmala* seeds after exposure to electron beam.

3.2. Phenolic compound

Changes observed in phenolic content for *Peganum harmala* seeds where increased by 58.3%, 34.12%, 21.26%, 18.3% and 0.8% after irradiated by EB at 3, 5, 7, 9 and 11 kGy doses respectively as shown in Figure 2. It is possible that radiation induce the incorporation of amino acid to protein. The change in phenolic content directly linked to protein synthesis where, if any change in protein content caused a change in phenol quantity. Also EB caused breaking down of bonds and removing the free radicals from the cells, which effect on phenolic content and this result agree with other studies [16, 17]. The complex phenolic compounds were dissolved or broke bonds of it due reacting with EB rays caused a fine or smooth phenolic appeared leads to increasing phenolic content.

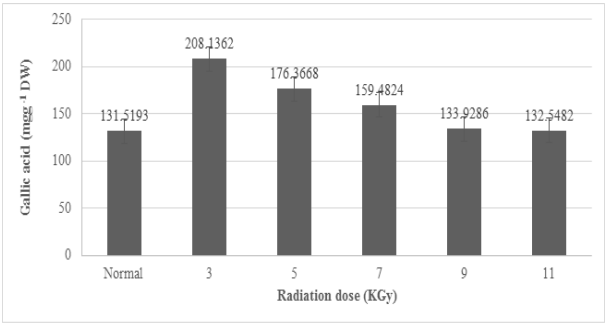

Figure 2: Phenolic content in *Peganum harmala* seeds after exposure to electron beam.

Figure 3 shows flavonoid content of *Peganum harmala* seeds increased, variable increase, after irradiated by EB at 3, 5, 7, 9 and 11 kGy doses where increased by 22.33%, 13.14%, 5.98%, 3.06% and 2.5% respectively. The stress produced by BE caused a variation in protein bands which caused a variable increase in flavonoids content. Also a change on O-H bond characteristic structure causes a change of flavonoids content.

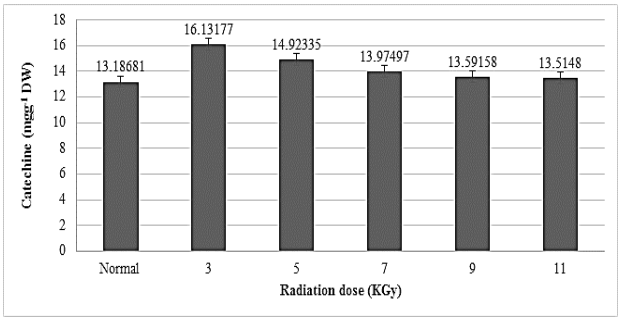

Figure 3: Flavonoid content in *Peganum harmala* seeds after exposure to electron beam.

3.3. Ascorbic acid

Ascorbic acid content in *Peganum harmala* decreased gradually from 34.76 to 9.52 gradually after exposed to EB from 0 to 11 kGy doses as shown in Figure 4, may be due to inhibition of its biosynthetic enzyme by EB.

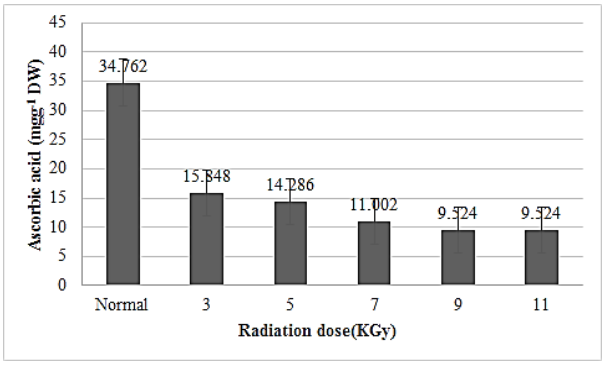

Figure 4: Ascorbic acid in *Peganum harmala*-seeds after exposure to electron beam.

3.4. Chemical composition

Chemical composition, such as carbohydrate, protein, fat, fiber and moisturize, in Peganum harmala seeds greatly was affected after exposed to electron beam doses 3 and 11 kGy as listed in Table 1 where carbohydrate content increased by 69.4% and 33.97% at 3 and 11 kGy respectively. Protein decreased by 30.45% at 3 kGy and increased by 11.79% at 11 kGy. Fat and fiber decreased by 27.28% and 13.73% at 3 and 11 kGy respectively. EB react with cell matrix broke or modified bonds or produce free radical, caused a change in all bio-content or its connecting branches, meant variation in all quantity of it.

Table 1: Chemical composition of *Peganum harmala* seeds after exposure to EB at 3 and 11 kGy.

Composition	Normal	3 kGy	11 kGy
% Ash	7.66	6.81	5.53
% Fat	12.5	9.09	13
% Fiber	43.7	43.8	37.7
% N	2.89	2.01	3.23
moisturize%	9.73	8.18	9.29
% Protein	18.06	12.56	20.19
%Carbohydrates	15.19	25.73	20.35

3.5. Internal and molecular Structure

Morphological study by scanning electron microscope (SEM), Figure 5, for *Peganum harmala* seeds showed that, there is a greatly change in cell matrix structure such as interconnection forming a dimensional network, (ring shape), particles and flat sheet-like structures.

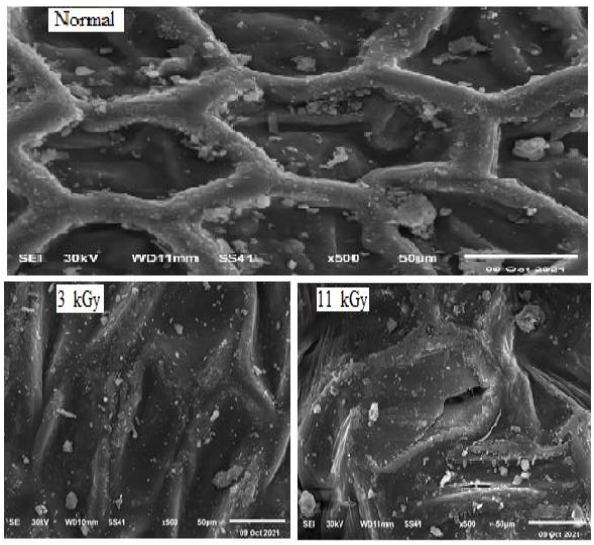

Figure 5: SEM of *Peganum harmala* seeds after exposure to EB.

IR spectrum and its analysis, Figure 6 shows that there is a change occurred in the position and intensity of O-H group for *Peganum harmala* after exposure to EB rays. That is because the EB ray has enough energy to break or destroy or modify chemical bounds may be causing a change in molecular bonds in cell matrix, and a photochemical reaction effected on enzymatic and non-enzymatic antioxidants.

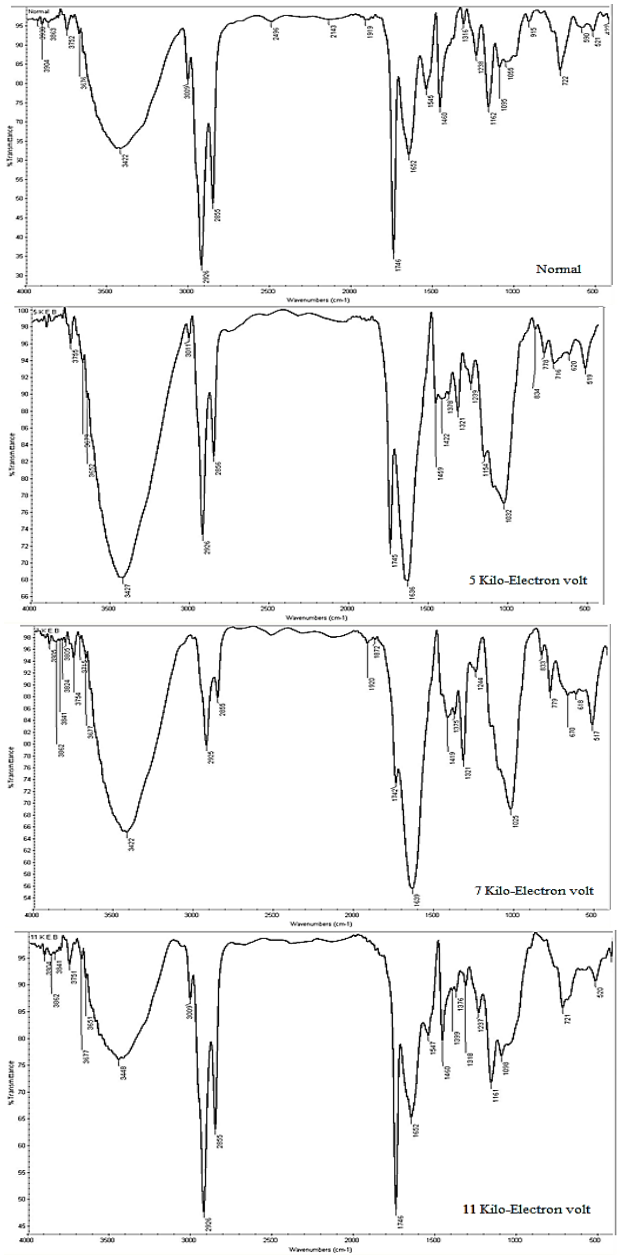

Figure6: IR of Peganum harmala seeds before and after exposure to EB.

Figure 7 was showed x-ray dispersive energy (EDX) spectrum of *Peganum harmala* seeds after exposure to electron beam radiation, where there a change in molecular component such as carbon, oxygen, calcium and etc…of it after exposure to 11 kGy dose.

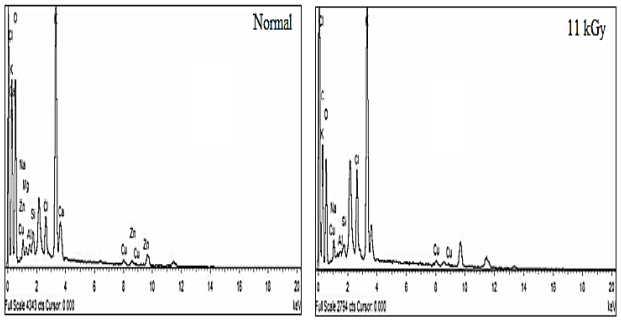

Figure7: EDX spectrum of Peganum harmala seeds after exposure to EB.

4. Conclusion

Morphological structure (such as shape and interconnection of molecules in cells), chemical composition (such as protein, fat, carbohydrate, and etc…), molecular structure, phenolic compounds and ascorbic acid content in *Peganum harmala* seeds are greatly affected after exposure to EB rays for different doses.

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