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Research Article

EPR Study of Hazelnut Species Irradiated with UV and Gamma Rays[#]

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Abstract: In this study, we aimed to investigate the electron paramagnetic resonance (EPR) spectra of a hazelnut species called Kalinkara grown in Ordu, a city in the eastern black sea region of Turkey. The hazelnut was subjected to various doses of gamma rays and later at certain times the EPR spectra were recorded at room temperature. Also, the EPR spectra were recorded when the unirradiated species was subjected to ultraviolet (UV) light for a period of time. As a result of both type of irradiation, the damage centers were observed in the EPR spectra. The g factors were also obtained for all spectra. No significant change in g factors lead us to the result that the same damage centers were formed when the species were exposed to both gamma and UV rays, separately. The intensity of EPR spectra for the Kalinkara hazelnut species changed according to the life span of the damage centers. When the UV light was turned off, the intensity decreased as well.

1. Introduction

Irradiation is widely used to sterilize and extend the shelf life of food. Gamma rays and ultraviolet (UV) light are mainly treated radiation sources for irradiation of food. Electron paramagnetic resonance (EPR) spectroscopy is used to investigate the possible damage centers in irradiated food [1-5]. These centers are also called as free radicals, and investigation of their properties, types, and kinetics is very important for the food science. For the past few decades, the importance of identification of free radicals in irradiated food increased further. Kameya et al. investigated EPR spectra of black pepper irradiated with gamma rays [6], Sanyal et al. studied EPR of irradiated cashew nut [7], Maghraby et al. examined EPR of irradiated walnuts [8].

On the other hand, hazelnuts are rich in fatty acid composition, nutritive, and grow widely in the black sea region of Turkey, world's leading hazelnut producing country [9]. There are eighteen varieties of hazelnuts cultivated in Turkey [10]. Koyuncu et al. investigated fat and fatty acid composition of hazelnut kernels in vacuum packages during storage period [11]. D'oca and Bartolotta studied the optimal dose in dried fruit including hazelnuts by EPR spectroscopy [12]. Yordanov and Mladenova investigated thermally generated free radicals in nuts by using EPR [13]. However, there is no report about the free radicals produced during or after irradiation of hazelnut species in literature. In this study, we examined the EPR spectra of unirradiated and irradiated hazelnut species named Kalinkara grown in Ordu, one of the main hazelnut producing provinces in Turkey.

2. Materials and Methods

The Kalinkara hazelnuts were obtained from the Department of Horticulture, Ordu University. They were irradiated as a whole by using a ^{60}Co source with the doses of 0.5, 1.0, and 1.5 kGy. They were cracked gently and classified as whole hazelnuts, kernel, and membrane in the laboratory. EPR spectra of the gamma-irradiated samples were recorded three times. The time interval between the first two records was one month and that of between the last two records was six months. Also, unirradiated kernels were exposed to UV light for 25 minutes and during irradiation EPR spectra were taken at following certain times: 1, 5, 10, 15, 20, and 25 mins. After that, the UV source was switched off and EPR spectra were recorded to investigate the decreasing intensity of the spectral lines.

EPR spectra were recorded at room temperature by using Varian E109 Century model X-band spectrometer. To calculate the g-factor of the samples, we used a dpph (diphenylpicrylhydrazyl) sample, which has a known g factor to be 2.0036.

3. Results and Discussion

3.1. Gamma Irradiation

The unirradiated Kalinkara samples (kernel plus membrane) showed no EPR signal (Fig. 1.i), whereas irradiated ones exhibit an EPR singlet with g=2.0060±0.0007 and peak to peak linewidth ΔH_{pp}=15±0.5 G (Fig.1.ii-iv). Since kernels contain 60-70 % fat and fatty acids [11], the generated free radicals in kernels should be lipid type radicals [13]. However, for the membrane, the free radicals may be produced due to cellulose [13].

The effect of gamma doses on the samples were also investigated. The optimum dose for types of nuts was proposed as 1 kGy [8, 12]. The idea of the optimum dose among three different doses is also supported from the intensity of EPR peaks in this study since the free radical concentration can easily be detected from the intensity of EPR peaks. For Kalinkara, the intensity of EPR peaks doesn't increase linearly with increasing doses. Figure 1 (ii-iv) shows the three EPR spectra belonging to the doses 0.5, 1.0, and 1.5 kGy, respectively. The intensity of the EPR spectrum for 1 kGy dose is even more than for 1.5 kGy dose. One month after the first record, the decrease in intensities of all doses shows that the decay of free radicals occurs slowly (Fig. 1b). Six months after the second record, it can be seen on Fig. 1c that the activity of free radicals still continues and it will take more time for the complete decay process of free radicals.

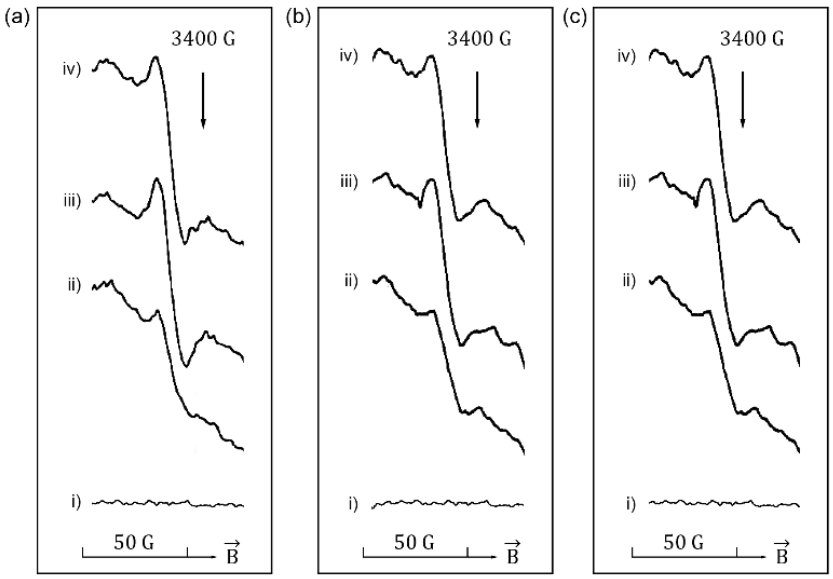

Figure 1. *EPR spectra of (i) unirradiated Kalinkara hazelnuts and gamma irradiated with the doses of (ii) 0.5, (iii) 1.0, and (iv) 1.5 kGy. The spectra belong to (a) after irradiation, (b) one month later, and (c) seven months later.*

3.2. UV Light

The EPR spectra were recorded during the irradiation of the sample with UV light. The spectra were taken consecutively at 1, 5, 10, 15, 20, and 25 mins after the irradiation began. The intensity of the lines in the spectra increases with time and reaches a constant value as shown in Fig. 2a. Since no significant change in the intensity of EPR lines was observed after 20 min, it can be said that the saturation is reached at about 20 min. The free radicals generated during UV light are also the

same type generated as a result of gamma irradiation. The decay process of free radicals is also very similar to that of for gamma irradiation just discussed above (Fig. 2b).

4. Conclusion

The purpose of the study was to investigate the possible damage centers produced in Kalinkara hazelnuts when exposed to irradiation. Gamma and UV light were chosen as the sources of irradiation. EPR technique was used to examine the damage centers in the samples. We observed the same radicals when the samples were irradiated by either gamma or UV light, while unirradiated samples showed no radical centers. The radical type for the kernels may be attributed to lipid type radical as a result of the oxidation of present fatty acids. For membrane, it may be attributed to cellulose type radical as stated in similar works [7, 8, 13].

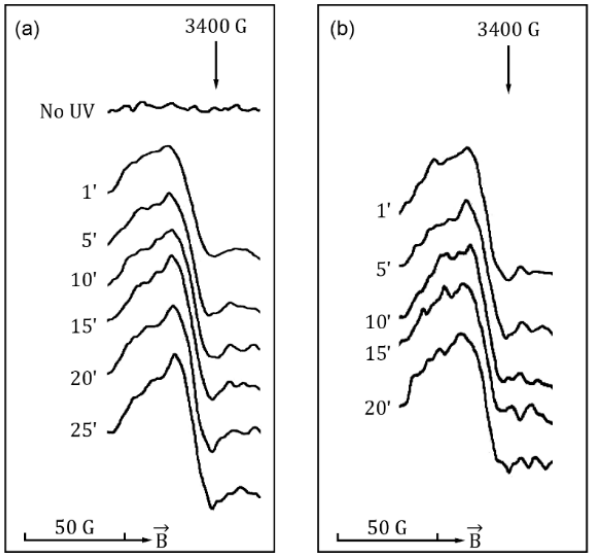

Figure 2. *EPR spectra of Kalinkara hazelnuts exposed to UV light. The expressed time (min) is (a) during irradiation and (b) after UV is turned off.*

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