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An EPR Study of Gamma Irradiated Medicinal Plants: Cress Seeds and Mistletoe

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ABSTRACT

The EPR spectral properties of non-irradiated and gamma-irradiated dry plants, cress seeds and mistletoe, have been studied with electron paramagnetic resonance method and the differences between non-irradiated and irradiated samples have been determined within this study. It has been shown that EPR spectra of these non-irradiated samples have very weak signal. But these plants have an intense EPR resonance line after irradiation with g value of 2.0046 ±0.0005.

Keywords: *EPR, Gamma irradiation, Medicinal plants.*

1. INTRODUCTION

In the recent years, food irrradiation is very important because of being a safe, cheap and an effective method for forming life standarts. This process affects hygienic quality of foodstuffs in positive way and extends their shelf life. The electron paramagnetic resonance (EPR) technique is widely used for identification of foodstuffs, this is because free radicals, molecules with an odd (unpaired) number of electrons, can be produced by high energy radiation and are detectable by EPR method. There is a relation among free radicals and quality of life and health. But some foodstuffs have paramagnetic properties naturally and they show a single EPR spectral signal before irradiation [1-3]. So, the natural antioxidant properties of herbs are recommended strongly nowadays. Antioxidants are molecules which can safely interact with free radicals and terminate the chain reaction before vital molecules are damaged. Antioxidants process in different ways: they may diminish the energy of the free radical, stop the free radical from forming in the first place and minimize the damage caused by free radicals. Many studies have been existed in the literature about the identification of irradiation process of foodstuffs important for our life [1-9]. The method of electron paramagnetic resonance (EPR) is one of the ways used in three Protocols [10-12] for recognition of irradiated foodstuffs. The first one is for bones [10], the second one is for cellulose containing [11] and the last one is for crystalline sugar containing foods [12].

In this paper, we have studied the EPR spectra of some medicinal herbs, such as mistletoe; effective for regulating the heartbeats and blood circulation, balancing blood pressure, affecting the secretion system in positive way; cress seed for accelerating metabolism, increasing the resistance to diseases and reducing the damages of cigarettes. In the previous reports, two typical EPR spectra of dry plants have been seen, "cellulose-like" triplet [4,5] and singlet [5,13-15]. In this work our aims are to determine the kind of EPR spectrum obtained from mistletoe and cress seeds, and to understand the effect of irradiation on these plants.

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2. EXPERİMENTAL

2.1. Samples, Irradiation and Instrumentation

Mistletoe and cress seeds were purchased from herbalist. Mistletoe was dried leaves and cress seeds were as sesame seeds, so they were investigated in the form of used in our daily lifes. Each of the samples was put in polyethylene bags. These samples were prepared also for irradiation. Irradiation was performed in air and at room temperature with a ^{60}Co gamma-ray source. For both of the samples, irradiation dose rate was from 0.5 kGy to 2.5 kGy.

All EPR measurements were performed at room temperature on Varian X Band EPR Spectrometer, operating at a microwave frequency of 9.53 GHz, with 100 kHz field modulation, using a standard rectangular cavity. Samples were inserted in quartz tubes (3-4 mm). In addiation, reference material containing Mn^{2+} was fixed in EPR cavity and the ratio of $\frac{I_{sample}}{I_{Mn^{2+}}}$ has been evaluated. This is due to the fact that position of samples in cavity affects the intensity of lines [16,17].

3. RESULTS AND DISCUSSION

3.1. EPR Study Before Irradiation

Samples of mistletoe and cress seeds have a weak EPR signal with $g = 2.0046 \pm 0.0005$ value before irradiation. The EPR spectrum of mistletoe is shown in Figure 1a. The origin of this single line is not obvious. In previous studies, various evaluations were made about the origin of this singlet, as free radicals of semi-quinones [18], lignin [19,20] or due to oxidation of fatty acids visible in some vegetables [21], phenols especially flavonoids [22,23]. Addition to this singlet we are able to see the lines of Mn^{2+} for the sample of cress seeds (Figure 2) before irradiation. Mn^{2+} is readily recognized in biological materials by its six hyperfine lines. We can experience this kind of lines naturally in some of EPR spectra [24,25].

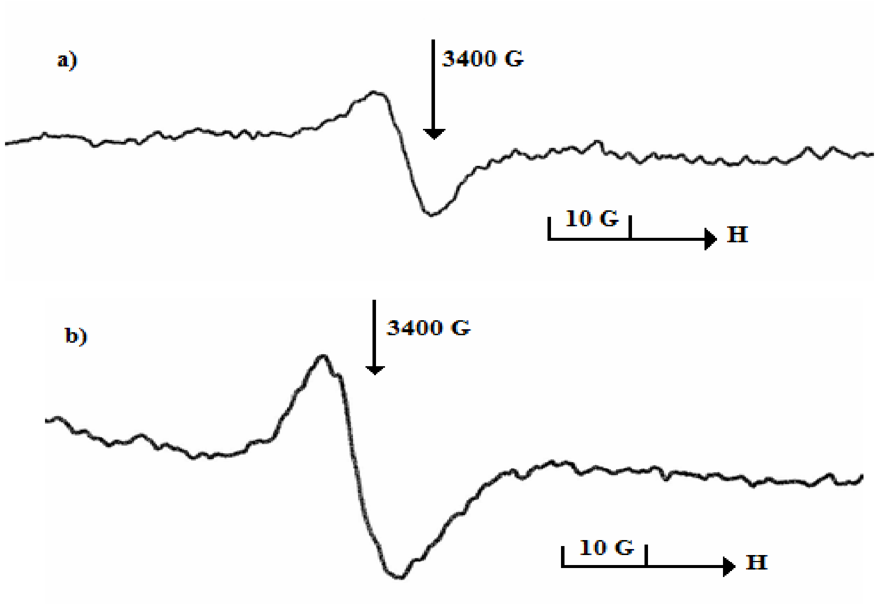


Figure 1. EPR spectra of mistletoe recorded at room temperature a) non-irradiated b) irradiated.

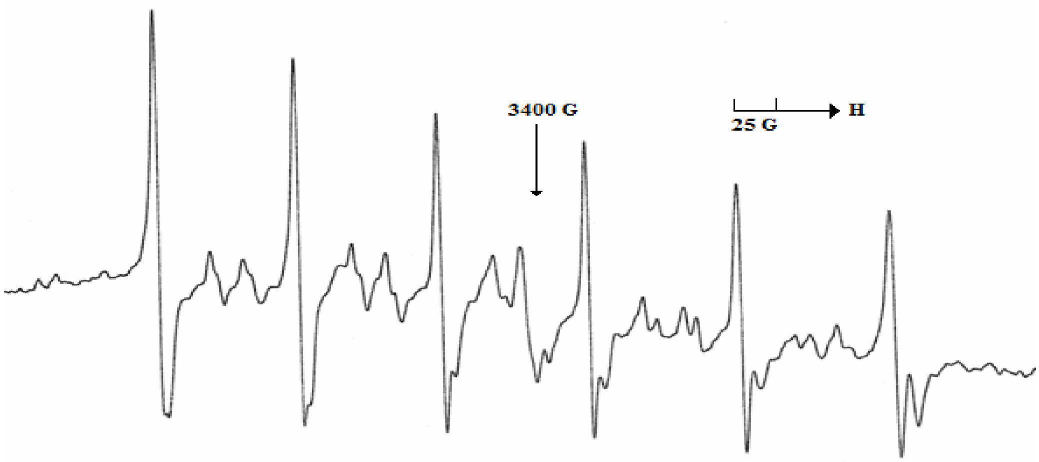
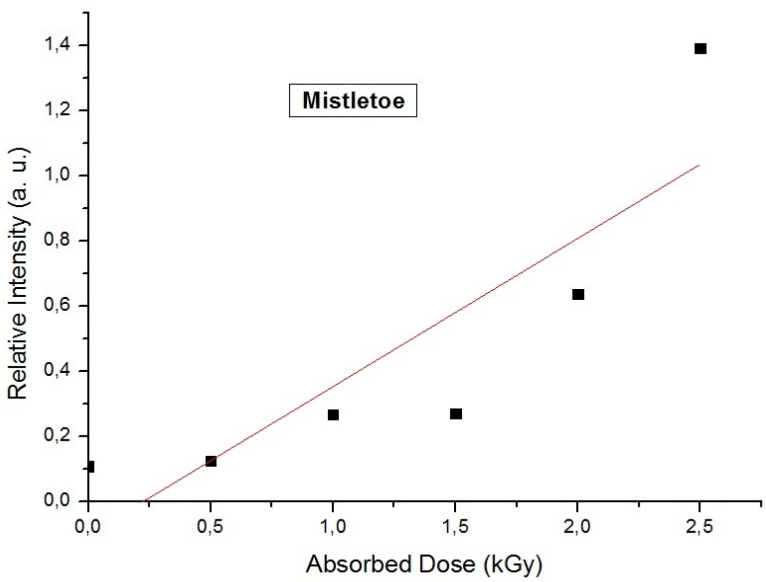


Figure 2. EPR spectrum of non-irradiated cress seeds recorded at room temperature.

3.2. EPR Study After Irradiation

Both of the samples have a resonance line in EPR spectra after irradiation appeared with $g = 2.0046 \pm 0.0005$ value between the third and forth lines of Mn^{2+} (I=5/2) . The only difference from non-irradiated properties is intensity. For mistletoe very weak intensity has been seen at 0.5 kGy; the ratio of $\frac{I_{sample}}{I_{Mn^{2+}}}$ for mistletoe and cress seeds have increased with absorbed dose. The relative intensity-absorbed dose relations for samples have been shown in Figure 3.

a)



b)

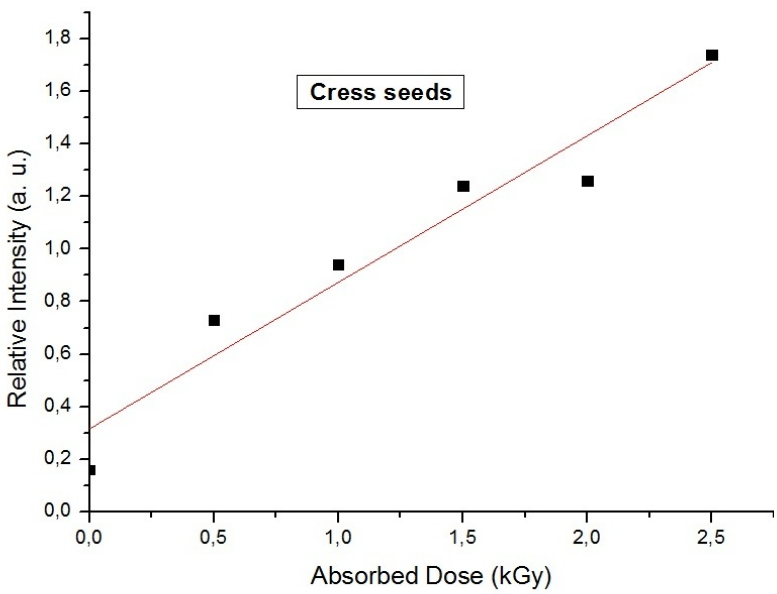


Figure 3. Relative intensity ($\frac{I_{sample}}{I_{reference}}$) changes with absorbed doses of irradiated samples a) mistletoe b) cress seeds

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The recognition process of dry herbs (EN 1787, 2000) consists of one singlet EPR signal for non-irradiated samples [5, 8, 13, 17]. The intensity of signal increases after irradiation and also two satellites are observed [4,5]. This triplet EPR spectrum is attributed to free radicals of cellulose produced by irradiation and these two lines are accepted as an evidence of irradiation. In addition to this, for some herbs only one EPR signal with increasing intensity have been observed after irradiation process [13,26,27]. During our experiment, we haven't seen any satellite lines after irradiation like some other reports, despite the fact that the EPR spectra were recorded with ten times increased amplification of the spectrometer, this may be due to the absence of cellulose containing pieces in the samples [8,17]. So in this circumstance, the application of Protocol (EN 1787, 2000) isn't valid for our experiment. It is clear that also "sugar-like" EPR spectrum isn't observed after irradiation. In Figure 1b, we can see the EPR signal of mistletoe after irradiation for which the value of $g=2.0046 \pm 0.0005$. [5, 8,13].

4. CONCLUSIONS

In this study, one of our aims was about determining the irradiation effect on some dry plants and the relation of intensity ratios with absorbed dose. The present paper demonstrates that cress seeds and mistletoe have a weak signal before irradiation. After irradiation, the only difference is the intensity of lines. Any triplet, the evidence of irradiation, hasn't been seen in this report. This may be because of the absence of cellulose in our samples. It is concluded that there are no significant differences about the number and place of lines between non-irradiated and irradiated samples.

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