

Electron spin resonance (ESR) studies on irradiated cocoa beans and niger seeds

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Electron spin resonance (ESR) spectra of irradiated (10 kGy) and unirradiated cocoa beans and niger seeds have been compared. Unirradiated cocoa beans failed to give any ESR signal, whereas after irradiation (10 kGy) an ESR signal at $g = 2.0042$ was observed. However, ESR signals are given by both irradiated and unirradiated niger seeds. The intensity of signal was found to be dose-dependent up to 10 kGy for both seeds. The signals were stable up to 180 days in both cases. The results indicate the possibility of using ESR for distinguishing between irradiated and unirradiated cocoa beans but not for niger seeds. © 1997 Elsevier Science Ltd

INTRODUCTION

The treatment of food by ionizing radiations is used to reduce food losses caused by microbial spoilage and insect infestation. In recent years, food irradiation has been a well-accepted method of food preservation. However, there are no satisfactory methods available for the detection of irradiated foods. Reported work in the literature suggests that electron spin resonance (ESR) spectrometry is a promising method for detecting radiation-processed foods such as spices (Cakir *et al.*, 1991; Raffi & Agnel, 1989; Dodd *et al.*, 1989). Recently, the National Monitoring Agency of the Government of India has cleared the irradiation of cocoa powder for use in pharmaceutical preparations. Thus the detection of irradiated cocoa beans assumes importance. Niger seeds, one of the important oil seed crops, can be exposed to radiation treatment for preventing insect infestation, which causes enormous losses. The possibility of identifying irradiated cocoa beans and niger seeds by employing ESR signals was therefore studied in the present work.

MATERIALS AND METHODS

The cocoa beans (*Theobroma cocoa*) and niger seeds (*Guiziotia abscinia*) used in the present study were procured from the local market. Cocoa beans were powdered prior to recording the ESR spectra as the

cuvette size of the ESR instrument did not permit use of whole beans. In the case of niger seeds, both whole seeds and crushed seed were initially tried, but, since the sample preparation was not found to affect the spectra, whole niger seeds were used for recording the spectra in all further experiments.

A ⁶⁰Co gamma-chamber (BARC) was used for irradiation. The seeds were irradiated at doses in the range 1–25 kGy. ESR spectra of all the samples were recorded on a Bruker ESP 300 spectrophotometer at X band frequency (9 GHz) at room temperature (30 ± 2°C). α, α -Diphenyl picrylhydrazyl, with a g value of 2.0036, was used for determining the values of unknown radicals. The irradiated and unirradiated seeds were stored at room temperature for 180 days in polypropylene (200 gauge) bags. Signals were recorded at different time intervals up to 180 days to determine the stability of the signal. The intensity of the signal was measured as peak height (in mm) of the signal. Ten samples each of cocoa beans and niger seeds were tested and the variability between samples was found to be negligible.

RESULTS AND DISCUSSION

ESR spectra of irradiated and unirradiated whole seeds of niger are shown in Fig. 1. A comparison of the spectra of control and irradiated seeds reveals that both contain a resonance with a g factor of 2.0034, and the only notable point is that there is relative increase in the intensity on irradiation. Similar observations have been reported for apples and grapes by Desrosiers & McLaughlin (1989).

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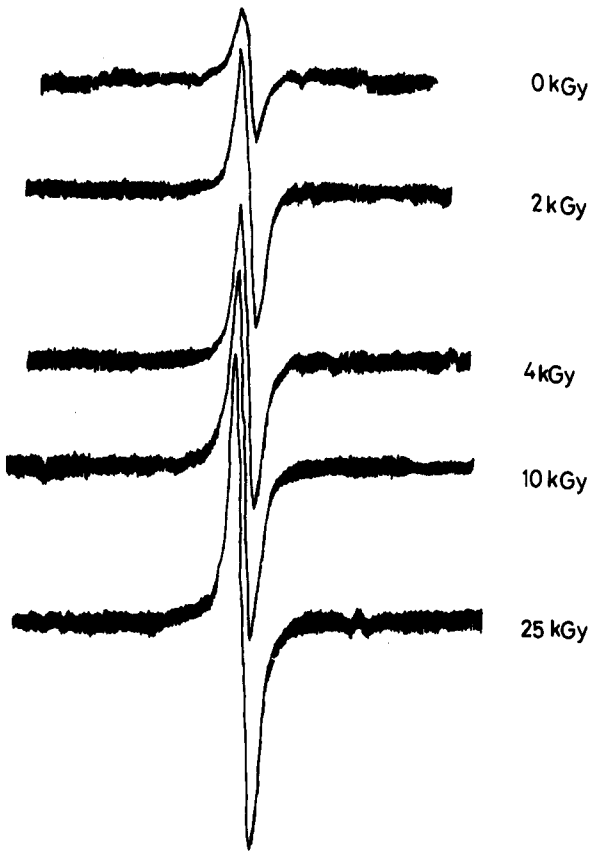


Fig. 1. ESR spectra of unirradiated (0 kGy) and irradiated niger seeds.

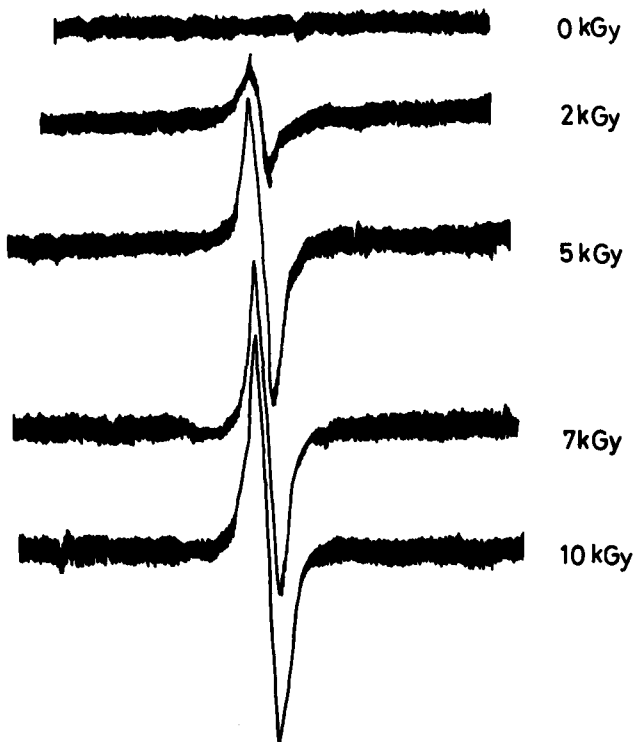


Fig. 2. ESR spectra of unirradiated (0 kGy) and irradiated cocoa beans.

Figure 2 shows ESR spectra of irradiated (10 kGy) and unirradiated cocoa beans. In the case of the unirradiated samples, no ESR signal was observed, whereas in the case of irradiated samples an ESR signal at resonance $g = 2.0025$ was seen. From studies on papaya seed, Boshard *et al.* (1971) noted that there was an unusual radiation-induced ESR signal in the papaya seeds only if they were stored at 77°K. Their study showed that, for papaya seeds stored at dry-ice temperature, the only changes observed were that of intensity at a singlet g value of 2.0000 (Boshard *et al.*, 1971). An unusual radiation-induced ESR signal has also been observed in mango seeds (Desrosiers & McLaughlin, 1989). The present observations on cocoa beans are in agreement with both these reports.

Observations on the effect of irradiation dose on ESR signal intensity for both niger seeds and cocoa powder are shown in Fig. 3. The dose range used was 1–30 kGy. The ESR signal intensity was found to be dose-dependent for both cocoa powder and niger seeds. The spectra were recorded immediately after irradiation. It was also observed that, in both cases, the effect was proportional up to about 10 kGy, after which it gradually levelled off.

As shown in Fig. 4, the ESR signal intensity for both cocoa and niger seeds subjected to irradiation decreased markedly within a storage period of 5–7 days and

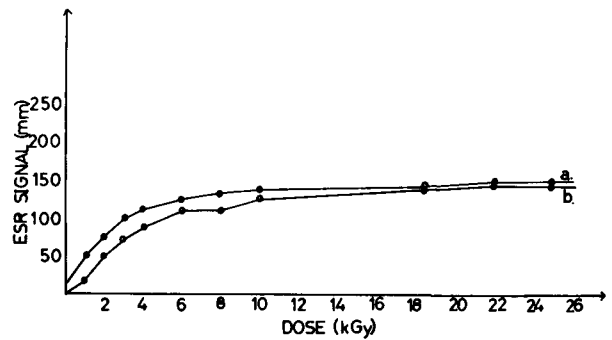


Fig. 3. Effect of irradiation dose on ESR signal intensity: (a) niger seed; (b) cocoa bean.

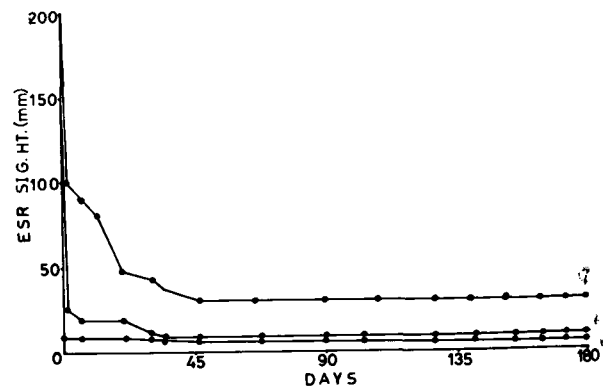


Fig. 4. effect of storage on ESR signal intensity of irradiated cocoa beans and niger seeds: (a) irradiated niger seeds (0 kGy); (b) irradiated cocoa beans (0 kGy); (c) unirradiated niger seeds (control).

remained almost constant for 45–180 days of storage. Control niger seeds showed a similar decrease in signal intensity patterns. The control cocoa beans did not show any ESR signal.

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