Pergamon

0969-806X(95)00243-X

Radiat. Phys. Chem. Vol. 46, No. 4–6, pp. 689–692, 1995
Elsevier Science Ltd. Printed in Great Britain

DETECTION OF IRRADIATED CHICKEN BY ESR SPECTROSCOPY OF BONE

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ABSTRACT

Ionizing radiation has been used to treat poultry to remove harmful microorganisms, mainly Salmonella, which contaminates chicken, goose and other fresh and frozen poultry. This microorganism is sensitive to low dose radiation. Thus, irradiating these foods with doses between 1 to 7 kGy results in a large reduction of bacteria.

Since it is necessary to determine whether irradiation has occurred and to what extend, this work studied the signal produced by ionizing radiation within the hard crystalline matrix of chicken's bone to establish a control method. Chicken's drumsticks were irradiated and bones separated from flesh were lyophilized and milled. ESR spectrum was then obtained. The ESR signal increased linearly with dose over the range 0.25 to 8.0 kGy. Free radicals evaluated during 30 days after irradiation showed stable in this period.

KEYWORDS

Ionizing radiation, chicken, electron spin resonance, free radicals, bone

INTRODUCTION

The treatment of poultry with ionizing radiation to eliminate harmful microorganisms has been used by many countries. Salmonella is one of the main harmful bacteria that contaminates poultry and is sensitive to low dose radiation.

The irradiation of poultry with dose between 1 to 7 kGy results in a large reduction of bacteria. In Brazil there is a legislation about food irradiation. Poultry is allowed to be treated with Co-60 and Cs-137 with media dose up to 7.0 kGy (DINAL, 1985). The aim of this treatment is to increase the storage period. So it is necessary the development of methods to distinguish if irradiation processing took place and to what extent.

Ionizing radiation produces long lived free radicals within the hard crystalline matrix of hydroxiapatite of bone, that can be detected by Electron Spin Resonance (ESR) spectroscopy (FAO-IAEA, 1990). ESR is a well established technique for the nondestructive detection of molecules containing unpaired electrons by means of their interaction with an external magnetic field. The ESR signal is characteristic of irradiation and provides unequivocal proof that the sample has been irradiated (Delincee et al, 1989).

Internationally, the technique used in this work was already studied by others autors. A very important step in the study of irradiated chicken is the sample preparation, because the humidity and grinding grade alter the results. The minimal detected dose is 50 Gy (IAEA TEC-DOC 587, 1991; Delincée, 1989; Dodd, 1989; Lea, 1988; Desrosiers, 1988; Gray, 1990).

EXPERIMENTAL

In this study it was used frozen chicken's drumsticks sealed to commercialization. The samples were individually sealed with domestic plastic and irradiated to ambient temperature using a Co-60 Gamma Cell 220 with dose rate of 571.3 Gy/h. To obtain the dose-response curve, samples were irradiated with the following doses 0.25, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 kGy. Six samples of each dose were prepared. After irradiation, the bones were separated from flesh, frozen and lyophilized by 12 hours . Then the bones were milled and sifted in 16 mesh.

The quartz tube of ESR spectrometer, Japan Electron Optic Ltd. - JEOL - JESME3X, X-band, was filled with sample to 3.5 cm high and 4.0 mm diameter. The working conditions of ESR spectrometer are presented in Table 1. The instrument was standardized to give the optimum results, the setting may differ in terms of the absolute calibration of power level and modular amplitude. The calibration setting depends on the sensitivity of the particular instrument and on the dose the sample was received. Correction for the signal was made by the use of a standard manganese marker recorded at the same time.

Table 1 - Standard conditions for ESR measurements

VARIABLE	SETTING
Field set	3345 $\pm$ 100 G
Modulation	0.5 x 10 G
Power	0.1 mW
Time constant	0.3 s
Amplitude	5.0 x 100
Temperature	ambient

Samples irradiated with 3.0 and 7.0 kGy were measured for 30 days to determine the stability of the free radicals. Samples from distal part of the bone were separated from the central part to

verify the influence of bone density. To verify if grinding process produces free radicals, a non irradiated sample was processed in pieces, milled and the ESR spectrum was obtained.

RESULTS AND DISCUSSION

Figure 1 shows the spectrum obtained for hydroxyapatite matrix.
The curve of Figure 2 was built with results obtained for different radiation doses. It seems that it would be possible to estimate the irradiation dose by measuring the signal height. The central part of the bone showed better results than the distal part. It can be explained because in the central part the bone density is higher than in the distal part , so more hydroxyapatite is available and consequently more free radicals are trapped in the crystalline structure.

Figure 3 shows the stability of signal during 30 days. The signal height appears to show a small decay, which happened due to the humidity, once water absorbs microwaves, these samples were lyophilized again and the signal came back to the anterior height. Liophylization showed to be an efficient drying method.

The results are comparable with other methods from the literature.

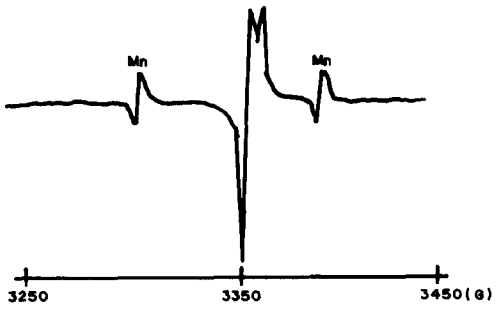

Fig. 1. Characteristic ESR spectrum of irradiated chicken's bone

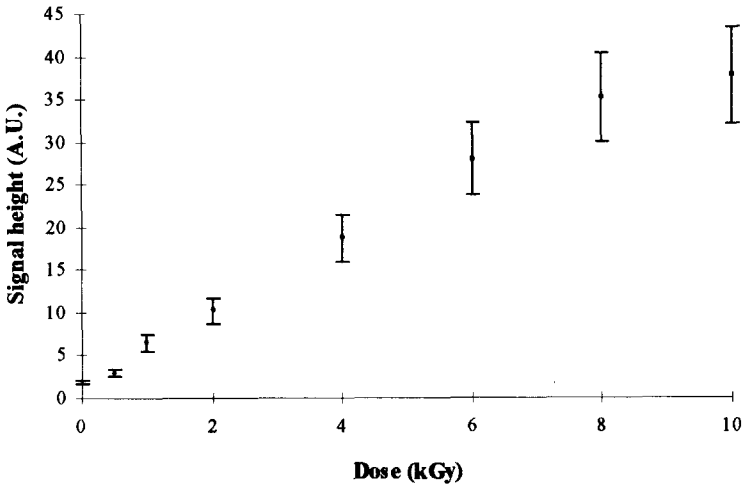

Fig. 2. Curve radiation dose versus height (Arbitrary Units) of ESR signal

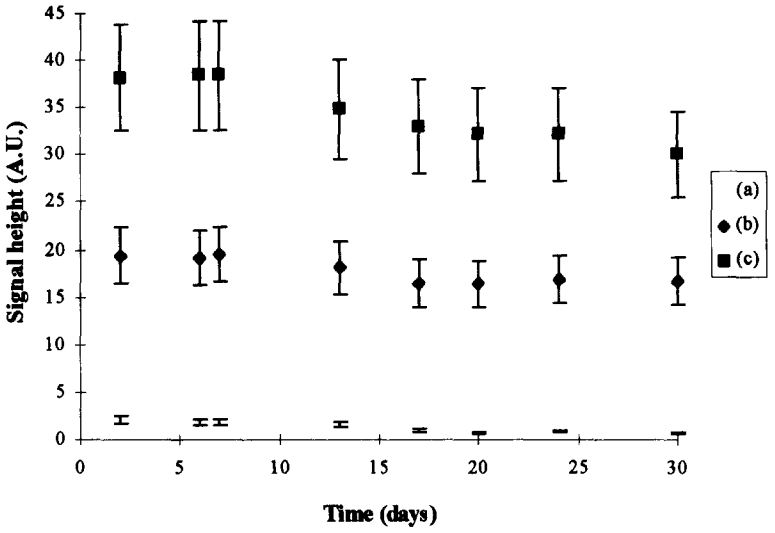

Fig. 3. ESR signal decay: Non irradiated (a), 3.5 kGy (b) and 7.0 kGy (c)

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