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# The use of Electron Spin Resonance Spectroscopy for the Detection of Irradiated Mackerel

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Free radicals produced in Spanish mackerel fish bone by $^{60}$Co $\gamma$-rays were measured using electron spin resonance spectroscopy. The ESR spectra of the irradiated fish were found to have an asymmetric absorption characterized by a major resonance at $g_1 = 2.0020$ and a minor resonance at $g_2 = 1.9980$. The intensity of the radiation-induced ESR signal was found to increase with the absorbed dose. The results obtained after irradiation in the dose range 0.5–5.7 kGy gave a nonlinear relationship between the radiation dose and ESR signal height. The radiation-induced ESR signal of Spanish mackerel decayed most significantly in the first 15 days after irradiation, but could still be detected even after 60 days.


## Introduction

In addition to the traditional methods of processing and preserving food, irradiation of food is gaining more attention around the world as a suitable technique for reducing food losses and enhancing the safety, wholesomeness and nutritional quality of food products (WHO, 1988, 1994; FAO/IAEA/WHO, 1981). Many countries started research to develop convenient methods and standard procedures for determining whether or not a particular food product (domestic or imported) has been irradiated with ionizing radiation. Significant progress has been made in the development of detection methods during the past few years. Schreiber *et al.* (1993) stated that thermoluminescence (TL), detection of volatile hydrocarbons, and electron spin resonance (ESR) analysis may be regarded as being particularly successful. Electron spin resonance spectroscopy is now established as a qualitative test for the detection of irradiated food containing bone, such as poultry, pork and fish (Dodd *et al.*, 1988; Gray and Stevenson, 1989; Gray *et al.*, 1990; Stewart *et al.*, 1991).The ESR method is based on the measurement of long-lived free radicals produced in bones as a result of irradiation. The intensity of the ESR signal of the irradiated bone depends on both the dose of radiation and the crystallinity of the tissue mineral (Ostrowski *et al.*, 1974). The ESR method could be also used for quantitative analysis to estimate the absorbed dose in radiation-processed foods containing bone. The so-called additive dose method implemented by Dodd *et al.* (1988) and studied by Desrosiers *et al.* (1990); Desrosiers (1991) and Desrosiers and Le (1993), was used for assessment of absorbed dose in irradiated foods containing bone.

This paper describes the application of ESR spectroscopy for the detection of irradiation of Spanish mackerel available in the Saudi Arabian market. The dose response, $g$-values and post-irradiation stability of the radiation-induced free radicals in fish bones were investigated.

## Experimental

Spanish mackerel (high-fat sea-water fish; *Scomberomorus commerson*) samples were purchased in the local market in Saudi Arabia and transported while still alive to the laboratory. The fish were killed, gutted, beheaded, sliced and washed. Some fillets were minced through a 3.5 mm grinder and packed in polyethylene plastic bags for irradiation.

The prepared samples were placed in ice boxes, transported to the irradiation facilities. Irradiation was carried out using the irradiation facilities, pool type $^{60}$Co source, at King Faisal Specialist Hospital and Research Center (KFSHC) and Gamma Cell 220 (Nordion Inc.), at King Abdulaziz City for Science and Technology (KACST). The absorbed dose in the water at the irradiation position was determined a using Fricke dosimeter and was found to be 0.937 kGy h$^{-1}$ at KFSHC and 14.5 kGy h$^{-1}$ at Gamma Cell 220 (ASTM, 1992). The dose is reported as the absorbed dose in water.