Identification of Irradiated Fish jerky by EPR Spectroscopy

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1. Introduction

Irradiation technology for food has excellent technical effects such as sterilization, insecticide, germination inhibition, ripening control, and improvement of physical properties.

The safety of irradiated foods has been announced by relevant international organizations such as FAO/IAEA/WHO, stating that all foods irradiated with an average dose of 10 kGy or less do not cause any toxicological damage and do not cause any nutritional or microbiological problems.

As trade in irradiated foods is expected, research on the confirmation of irradiation for distribution and trade management is required. Thermoluminescence (TL), electron paramagnetic resonance (EPR), single cell electrophoresis (DNAcomet assay), and microbiological screening (DEFT/APC) are used as methods for detecting irradiated foods [1].

Irradiation of dried fish is currently permitted in 16 countries, and in Korea, gamma irradiation of up to 7 kGy is permitted for sanitary treatment of dried fish powder[2]. This study examined the detection characteristics of the EPR analysis method to secure a systematic detection method for irradiated dried filefish.

2. Methods and Results.

2.1 Experiment material

The dried filefish used in this experiment were purchased as irradiated food sold in supermarkets and as non-irradiated dried filefish.

Dried filefish were cut and dried in a vacuum dryer at 40℃ for more than 3 hours. 100 mg of dried filefish sample was placed in an EPR tube and analyzed for radiation exposure using an EPR spectroscopy.

Figure 1. Dried filefish sample

2.2 EPR measurements and analysis

The EPR irradiation food testing method is a method for spectroscopically measuring free radicals generated by irradiation that remain in foods containing bone, cellulose, and crystalline sugar. It is a method for determining whether or not irradiation has occurred by measuring the difference in energy emitted after electrons resonate due to a magnetic field.

The EPR measurements were performed using a Bruker EleXsys E500 X-band spectrometer. The dried filefish samples were evaluated individually, with each having a single orientation while being held in a quartz tube with a sample support system for reproducible positioning in the cavity. The dose-dependent parameter of the sample spectrum of the dried filefish was evaluated as the vertical peak-to-peak intensity of the dominant peak.

To determine the measurement parameters of dried filefish samples, EPR signals were measured in response to changes in microwave power.

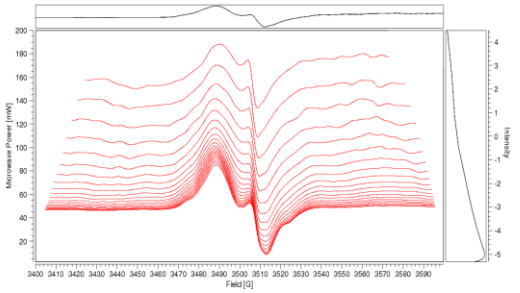

Figure 2. Microwave power dependence of X-band EPR spectra for Dried filefish samples

Table I: EPR spectroscopy measurement parameters

Parameters	value
Center Field	3500 G
Microwave frequency	9.85 GHz
Number of scans	10
Sweep width	200 G
Power	1.002 mW
Time constant	163.84 ms
Sweep time	30.75 s

Since dried filefish samples contained bones, we were able to confirm the presence of radicals generated by reaction with hydroxyapatite (HA). Figure 3 shows the irradiated food and background samples. The g1 peak is known to be a radical generated by collagen, and the g2 peak is known to be a radical generated by HA[3,4].

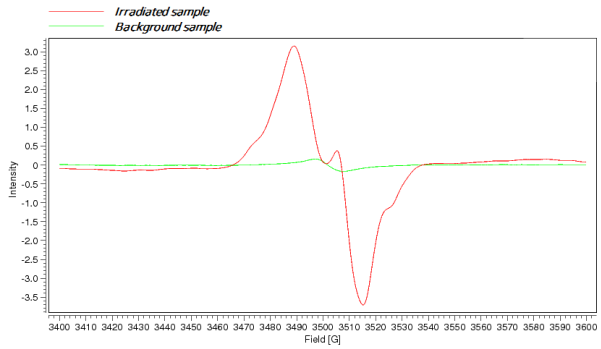

Figure 3. Typical EPR spectra of irradiated dried filefish samples

2.3 Irradiation

The linearity of dose-response due to radiation was confirmed by irradiating dried filefish samples. The irradiation device used for the dried filefish sample in this study was a gamma-ray irradiator (Biobeam-8000, STS GmbH, Germany) with a ^{137}Cs source (2,200 Ci) installed at the Dongnam Institute of Radiological & Medical Sciences. The gamma irradiator was set such that the dose rate absorbed by the air was 2.5 Gy/min.

As the dose increased from 50 to 300 Gy, the EPR signal increased in proportion to the dose. The dose-response curve for the peak-to-peak EPR signal intensity with the increasing dose is shown in Figure 4. The dose-response curve showed a coefficient of determination, R^2, of over 0.998 when calculated using the linear fitting equation.

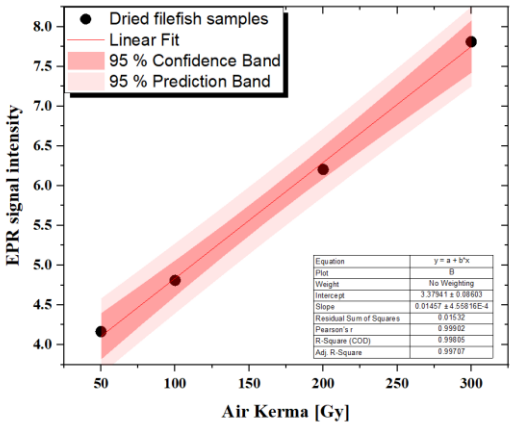

Figure 4. EPR dose-response curve of dried filefish using a sample mass of 100 mg. The response is linear from 50 to 300 Gy.

3. Conclusions

The spectral characteristics of irradiated dried filefish samples were measured using the electron paramagnetic resonance (EPR) method. It was confirmed that irradiated dried filefish samples exhibited an asymmetric spectrum through EPR measurements, and its potential use as a test method for identifying irradiated foods was confirmed.

The dried filefish samples used in this study were confirmed to generate radicals as they contained bones. Additionally, comparison of measurement results for various dried fish and results of separating bones and flesh should also be derived. The final result will be a study that can evaluate the radiation exposure estimates for irradiated foods using dose response curves.

Acknowledgment

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