

5-14 Which Liver-Sashimi was Treated by Radiation?

— Development of a Method to Distinguish Disinfected Liver —

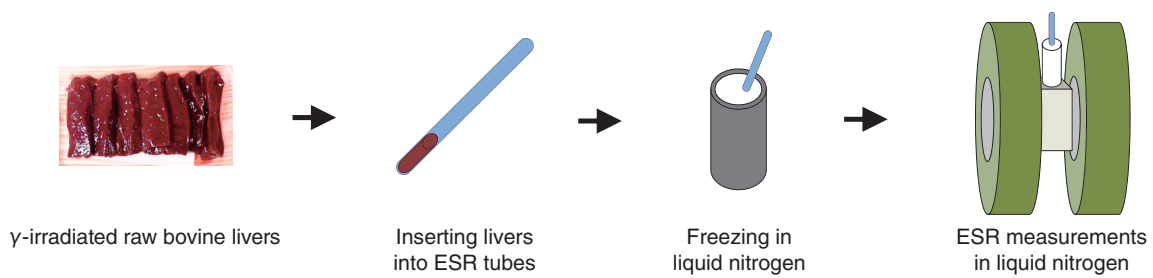


Fig.5-35 Schematic of electron spin resonance (ESR) measurements

Raw bovine livers were irradiated with 1.0, 2.6, 5.2, and 7.8 kGy γ -rays at 0 °C. The irradiated samples were inserted into ESR tubes, frozen at -196 °C with liquid nitrogen, and measured on an ESR at their frozen temperature.

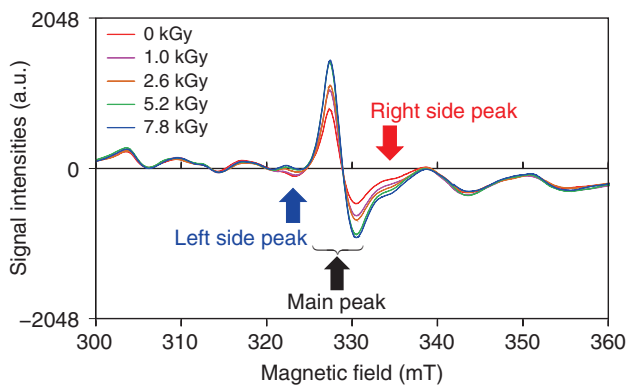


Fig.5-36 Changes of ESR spectra of irradiated raw bovine livers
ESR spectra of raw bovine livers irradiated with different doses are depicted on this plot. Arrows indicate the dose-responsible peaks after irradiation. A large peak in the center is called the main peak, and the two small peaks to the left and right of the main peak are called side peaks.

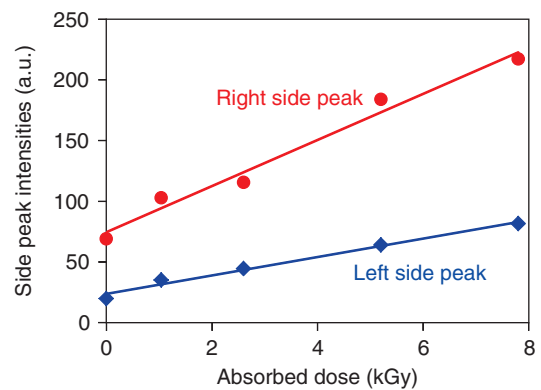


Fig.5-37 Dose responses of side peaks on bovine livers

The intensities of the right and left side peaks were plotted against absorbed doses. The peak intensities on the plot increased linearly according to increasing dose at each different slope.

To prevent foodborne illness in Japan, after the outside of raw meat had been roasted and then the cooked parts were trimmed off, the steak tartare must be prepared from only the inside meat in restaurants. However, since pathogenic bacteria such as some *E. coli* were found inside raw bovine livers where no disinfection method is effective, the sale of any raw bovine liver to eat as “liver-sashimi” has been prohibited since July 1, 2012. Providing for the radiation exposure that is used to sterilize bacteria out of a sealed food package without heating, detection methods have been developed to distinguish raw livers that have been disinfected by radiation.

At first, the irradiated raw bovine livers were subjected to the ELISA method, which was developed as for irradiated ground meats. The ELISA method could distinguish irradiated livers when such irradiation was done in the chilled condition (0 °C), but not at all could be detected when irradiation was done in the frozen condition (-80 °C).

The ELISA method can detect an oxidative lesion in DNA that reacts with active species (radicals) caused by ionizing radiation. Therefore, the radical migration to DNA might be inhibited in the frozen condition. Next, we tried to detect the radical itself. Basically, unpaired electrons of radicals can be measured using electron spin resonance (ESR) spectroscopy. This apparatus

utilizes an electromagnetic wave similar to a microwave oven. Therefore, the method has a weak point in that the electron cannot resonate when the water within the samples absorbs the microwave. However, we have demonstrated that ESR can measure radicals in the flesh of fresh fruits irradiated as a disinfection treatment for the plant quarantine. Thus, we thought that it might be possible to measure radicals in livers using ESR.

After raw bovine livers were irradiated in the chilled condition, they were measured at liquid-nitrogen temperature to suppress microwave absorption by stopping the motion of the water molecules during ESR measurement (Fig.5-35). According to the results, we found a main peak and two side peaks in the livers (Fig.5-36), and the side-peak intensities increased according to the increasing doses (Fig.5-37). Since the measuring errors were involved in experimental values, we assumed that the side-peak intensities of the raw bovine livers irradiated at approximately 3 kGy could be clearly distinguished from those that were not irradiated. Therefore, it is suggested that raw bovine liver treated by irradiation beyond 3 kGy can be distinguished using the ESR method.

Since the ESR method can be used to investigate the raw bovine livers being irradiated for disinfection, we believe that this technique can help consumers to choose reliable liver-sashimi.

Reference

Kikuchi, M. et al., ESR Signal Changes Recorded in γ -Irradiated Bovine Livers, *Shokuhin Shosha* (Food Irradiation, Japan), vol.50, no.1, 2015, p.9-12 (in Japanese).