Spin density distribution in foodstuff after heat treatment or irradiation

P. P. Levêque[1], Q. Godechal[2], and B. Gallez[2]

[1]Biomedical Magnetic Resonance Unit, Université catholique de Louvain, Brussels, -, Belgium, [2]Biomedical Magnetic Resonance Unit, Université catholique de Louvain, Brussels, Belgium

Introduction

Free radicals are usually very unstable species which react quickly with other molecules, so that they can hardly be detected in liquid solution. In solid state, on the contrary, their half life is considerably longer and their presence has been widely demonstrated for years by EPR spectroscopy.
In foodstuffs, free radicals are known to be generated by various treatments commonly used in the industry, such as heat treatment or decontamination (sterilization) with ionising radiations. EPR spectroscopy is now recognized internationally as a gold standard method to detect radiation-processed food containing bones, cellulose or crystalline sugar[1].In this report, we go a step further than standard EPR spectroscopy and investigate the possibilities offered by development of EPR imaging to delineated free radical distribution within biological samples (e.a. foodstuffs).

Method

Several representative samples of commercial foodstuff from various origins (vegetal & animal) were selected because they are known to be treated by heat or ionising radiation during their industrial processing: coffee bean, frog leg, etc.
Frog legs were freeze-dried to remove water before imaging; other samples were directly investigated.
Imaging was performed on a Bruker Elexsys E540 system operating at 9 GHz (100 kHz modulation frequency), equipped with a Super High Sensitivity Probe. Images were acquired either in 2D or 3D mode. Microwave power was selected within the linearity part of the Power-Intensity curve. Amplitude modulation was chosen so that it does not exceed one third of the signal line width.

Results

The spin density of the distal part of a frog hind leg is shown on Fig. 1. The main bones (calcaneum & astragalus) are very well delineated with a rather homogenous signal distribution. Tarsal and part of the metatarsal bones are clearly visible, but not resolved. Surprisingly, muscle tissue and Achilles tendon also give an EPR signal at g=2.0081 & 2.0076, but much lower in intensity, so that they are not visible with the conditions chosen to image the bones.
Roasted coffee bean presents a single band EPR signal at g=2.0100, with a line width of 0.8 mT, whereas this signal is absent from green coffee. Intensity distribution is not homogenous within the bean, the strongest signal arising from the centre (Fig. 2).

Discussion

EPR imaging is a powerful tool to study spatial distribution of spin densities within biological sample. In frog-leg irradiated at 5 kGy, it allows a very good separation of distal bones whose width does not exceed 1-1.5 mm; and smaller structures are also clearly visible even with a rather large signal bandwidth (~1mT).
EPR imaging could be used together with conventional spectroscopy where a regional distribution of radicals is needed, particularly in irradiated samples. The method offers unique capabilities to monitor the fate of these free radicals in biological samples.

References

1. European Committee for Standardisation, analytical methods EN1786, EN 1787 & EN13708

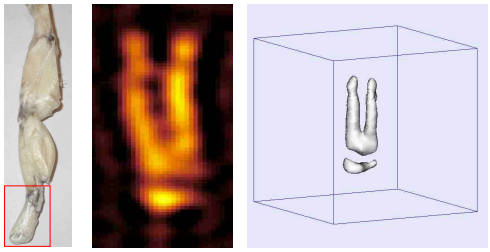

Fig 1: A Frog hind leg **B** 2D view of distal part (red square) **C** 3D view

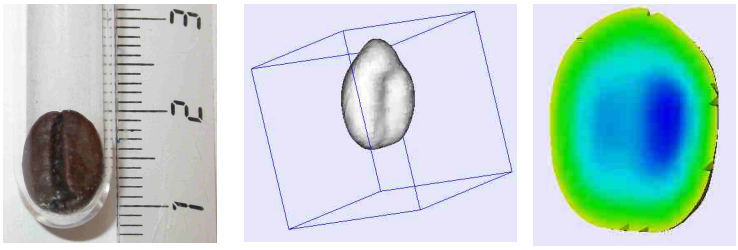

Fig 2: A Original roasted coffee bean **B** 3D surface view **C** Coronal slice around the middle of the bean. Colour scale: blue is the most intense signal.