EPR Dosimetry of *Sprague-Dawley* Rat Teeth for Retrospective Dosimetry

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Introduction

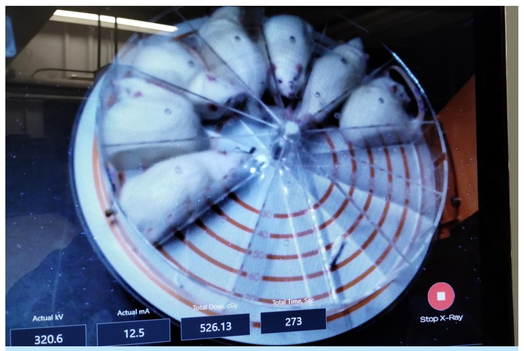
- In the event of a radiological or nuclear accident, there is a need for **reliable methods of measuring the dose** to potentially exposed populations [1], [2].
- When alternative dosimetry techniques are unavailable, current practice is to use **materials found in the environment** such as vegetation or animals.
- **Electron paramagnetic resonance (EPR)** spectroscopy studies magnetic field induced energy differences between unpaired electrons in a material [3].
- The number of unpaired electrons is ideally proportional to the **absorbed dose** in a material.
- **Hydroxyapatite**, found in tooth enamel and bones, is a **well-established** material used in EPR dosimetry [4].
- The radiation-induced signal from hydroxyapatite is **highly stable** and **dose rate independent**.

This work will investigate the use of ***Sprague-Dawley* rat tooth enamel** for purposes of retrospective dosimetry using EPR.

The teeth used in this study have been part of a biodosimetry study being conducted at Canadian Nuclear Laboratories (CNL).

Sample Irradiations

- Irradiations were done on live ***Sprague-Dawley* rats** by CNL
- **X-rays** from a X-Rad320 irradiation system
- Dose rate of **1.2 Gy/min**
- Doses of **0, 2, 4, 6, and 8 Gy**



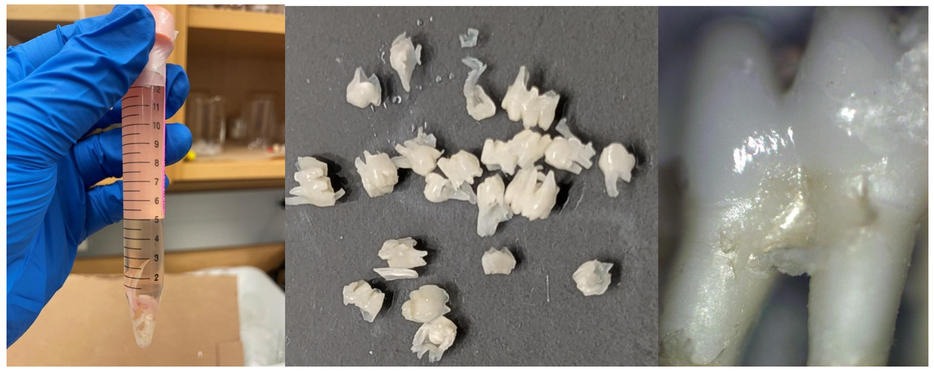
Sprague-Dawley rats in an irradiation pie cage.

Sample Preparation and Measurement

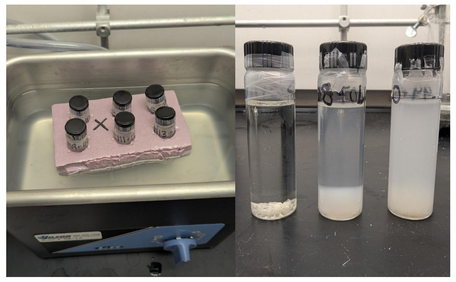
Isolating the enamel and thoroughly drying the samples is important because:

- The inclusion of dentine can mask or distort the dosimetric signal
- Moisture can alter the signal intensity

Thus, proper sample preparation is important to ensure spectra accurately reflect the absorbed dose.



1) Pour off PBS medium and sanitize with household bleach for 24 hours.



2) Remove the dentin using 8M NaOH. Teeth were sonicated for 1 hour then soaked for an additional 23 hours.



3) Dry and crush to a grain size of 0.1-0.5 mm.

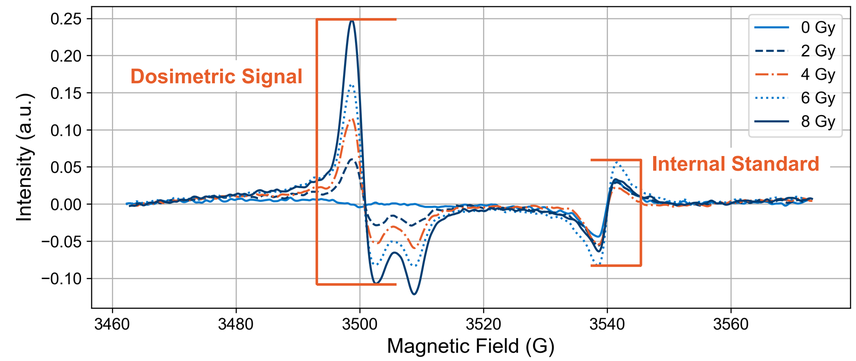


4) Combine enamel to get a sample size of ~100 mg. Store in EPR tubes in a dark desiccator.



5) Insert the EPR tube into the spectrometer and record a spectra.

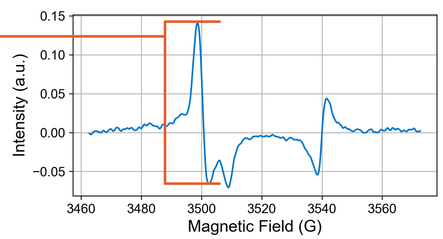
Analysis and Results



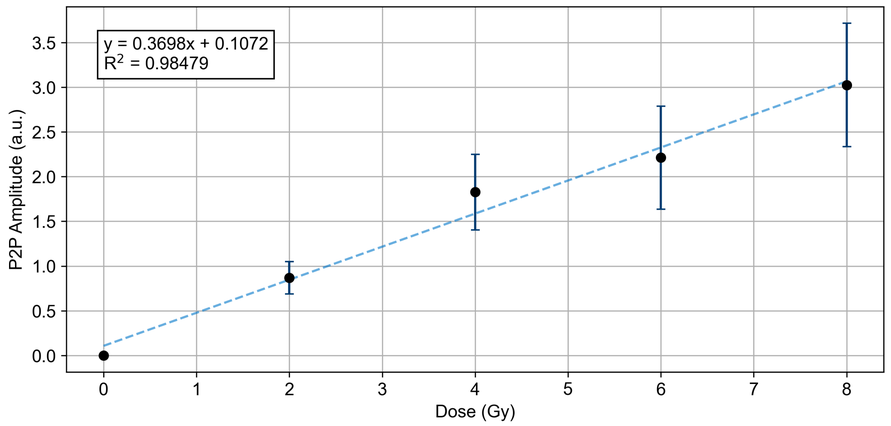
EPR spectra at each dose. Note how the amplitude increases with dose.

Each dose has **5 samples**, and each sample was **measured 3 times** for a total of **15 spectra** per dose.

Sample	P2P Amplitude
1	0.206581
2	0.210030
3	0.212478
…	
15	0.270707
Average ± STD	**0.29 ± 0.07**



To account for different sample densities and environmental conditions, the peak-to-peak (P2P) amplitudes are normalized by the **sample density** and the **P2P amplitude of the internal standard**. The normalized P2P amplitudes are then plotted against the dose to get a dose-response calibration curve:



Dose response curve for Sprague-Dawley *rat tooth enamel. Each point is the average of 15 spectra plotted against absorbed dose. Error bars are the standard deviation.*

Findings and Future Work

The response to radiation was found to be **linear** making the *Sprague-Dawley* rat tooth enamel suitable for retrospective dosimetry.

Using the **0 Gy control samples**, the following will be investigated:

- Determining the **lowest dose** that will still produce an EPR signal
- Creating **blind samples** to validate the dose response curve

Additionally, repeated measurements of the 2, 4, 6, and 8 Gy samples will be done to ensure there is **no signal fading** and that the measurements are **repeatable**.

Acknowledgements

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References

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