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Bone as a Biomarker to Differentiate Single Doses from Fractional doses

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Introduction:

Ionizing radiation has indeed played a significant role in both the diagnosis and treatment of various diseases, particularly cancer, since the late 19th century. The key breakthrough in this field was the shift from administering a single dose (SD) of radiation to adopting fractional dose (FD) delivery.This approach offers several advantages like as Normal Tissues Preservation, enhanced Tumor control, reduced side effect and so on.

Methods:

This work has the objective of understanding the changes in bone tissues performed in SD and FD, for this, we use Fourier Fourier-transformed infrared spectroscopy combined with Attenuated Total Reflectance (ATR_FTIR) performed in the fragments of bone from bovine femur diaphysis cut into 1 cm x 1 cm x 1 mm were irradiated with a multipurpose irradiator of Cobalt-60, separated into two groups: the first one containing these single doses (1, 15kGy), and the second one containing these fractional doses (1, 15kGy). For every spectrum, in the range of 4000 to 400 cm-1, with 4 cm-1 of spectral resolution, 100 scans were co-added.In the data analysis, the first and crucial step was pre-processing to eliminate unwanted artifacts. this step was divided into the second derivative of absorbance, and a Savitzky-Golay filter was applied (second order polynomial in a fifteen-point window) to signal-to-noise ratio reduction, normalization. After that, the principal components analysis an linear discriminants analysis (PCA_LDA) model was used to explore the similarities and hidden patterns among single or fractional ionizing doses. All procedures were performed using Python and Google Collab.

Result:

Perfoming multivariate analysis using the (PCA_LDA) and the loadings plot were possible determined as the most discriminative spectral markers: Carbonate Accumulation, Carbonate to Mineral, Mineral to Matrix, Mineral Maturity, Crystallinity, Secondary Structure of Protein, Area 3070 cm^1, Area 1201 cm^1, Area 1240 cm^1, Area 1317 c^1, Area 1547 cm^1.

Discussion:

The biochemical composition of bone material may be detected by FTIR spectroscopy, regardless of small changes. The inherent complexity of spectra often makes it difficult to assess absorbance fluctuations directly from the raw data. In order to solve this issue, the pre-processing procedures were employed in this work to examine the commonalities and latent patterns between single and fractional ionizing doses using the PCA-LDA model. Carbonate accumulation (CA), carbonate to mineral (CM), and mineral to the matrix (MM)

are crucial spectral markers for assessing the distinctions between SD and FD, according to the chemometric analysis.

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