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RADIOCHROMIC FRICKE GELS WITH CYANINE ERIOCHROME FOR RADIOTHERAPY DOSIMETRY

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Introduction: Fricke gels (FG) are tissue equivalent, non-toxic materials that allow the three-dimensional mapping of the dose delivered by a beam of ionizing radiation. FG dosimeters are synthesized from chemical substances whose final composition is sensitive to radiation through the oxidation of Fe^{2+} ions to Fe^{3+} ions as a function of absorbed radiation dose [1].

One of the shortcomings of FGs is the blurring caused by the diffusion of Fe^{3+} ions formed after irradiation. In the attempt to solve this problem, new formulations of radiosensitive gels were developed [2,3]. In this research, we investigated the addition of the ligand eriochrome cyanine R (ECR) in the FG-PVA matrix crosslinked with glutaraldehyde as a dose marker in the visible ultraviolet (UV-VIS) region.

Material and method: FG-PVA with ECR was synthesized under optimized stoichiometric proportions with 0.20 mmol L^{-1} of ECR, 0.70 mmol L^{-1} of Fe^{2+}, 8.00 mmol L^{-1} of H_2SO_4, 26.50 mmol L^{-1} of glutaraldehyde and PVA (10%). The gel obtained was transferred and stored in poly(methyl methacrylate), acrylic cuvettes and then irradiated in the dose range from 0.0 to 40.0 Gy under charged particle equilibrium inside a water phantom.

Results: Under optimized conditions, FG-PVA with ECR showed radiation sensitivity, matrix stability, a low minimum detectable dose, and linearity for the range from 0.0 to 40.0 Gy. The UV-VIS absorption spectrum is shown in Figure 1a.

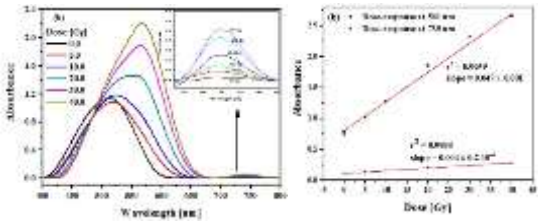

Figure 1: (a) Absorption spectra of FGECR irradiated with X-rays and (b) FGECR dose-response curve, in the dose range of 0.0 to 40.0 Gy. The dots correspond to the maximum intensity of the absorption band at 561 and 739 nm.

The signal exhibits a linear dose response in correspondence to the two absorption maxima. Figure 1b shows the dose-dependent absorption values measured at the wavelengths of 585 and 739 nm.

In particular, the signal at 585 nm can be used to measure doses in radiotherapy, and presents a minimum detectable dose of 0.67 Gy. The signal is fairly stable over time: non irradiated samples present an increase in absorption of 0.007/day due to spontaneouns oxidation. The absorption band at 561 nm presents a linear regression coefficient of $r^2 = 0.9922$, while the slope, used to express the sensitivity, was 0.0408 ± 0.0001 Gy^{-1}.

The band of lower intensity, a characteristic band of the *d-d* transitions from the metallic center (Fe^{3+}) coordinated to the ECR ligand, presented a linear regression coefficient of 0.9992 and a sensitivity of 0.01265 ± 0.00006 Gy^{-1}.

Conclusions: FG-PVA with RCT has several advantages for application in radiotherapy, as it is easy to prepare, does not require a complex synthetic route system, is tissue equivalent, sensitive to low doses, and is fairly stable over time.

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