ABSTRACT

Panoramic dental radiography is a widely used imaging technique in clinical practice; however, it exposes the thyroid gland, which is highly sensitive to radiation. Protective measures using lead aprons have limitations due to their toxicity, thereby requiring alternative shielding materials that are both safe and effective. This study aimed to evaluate the effectiveness of silicone rubber–tungsten (SR-W) composites as non-lead radioprotective materials against X-ray exposure and to assess their impact on image quality. The composites were synthesized by mixing silicone rubber with various tungsten concentrations (0–15% wt). Material characterization included density measurements using the Archimedes principle and Energy Dispersive X-Ray (EDX) analysis. Results showed that the addition of tungsten increased the density from 1.1076 g/cm³ (without W) to a maximum of 1.2254 g/cm³ at 3% concentration, with fluctuations attributed to mixing homogeneity and particle dispersion. EDX analysis confirmed the distribution of Si and W elements in accordance with the added mass fractions, with W content increasing up to 25.023% in the 85:15 composite. Radioprotective performance was tested using an anthropomorphic phantom with a Black Piranha detector placed at the thyroid position. The findings demonstrated a reduction in primary dose by 30–46% (up to 9% W) and secondary dose by 25–40% (up to 15% W). Image quality analysis using ImageJ revealed a decrease in Signal-to-Noise Ratio (SNR) from 19.25 to 15.65 and Contrast-to-Noise Ratio (CNR) from 10.15 to 7.60 at 15% W. Nevertheless, both SNR and CNR values remained within clinically acceptable diagnostic ranges. These findings indicate that SR-W composites exhibit high density, favorable elemental distribution, significant thyroid dose reduction, and preserved image quality. Therefore, SR-W has strong potential as an eco-friendly, flexible, and effective non-lead radioprotective material applicable in panoramic dental radiography.

Keywords: Radiography Panoramic, Silicone Rubber, EDX, SNR, CNR.