ABSTRACT

Metal ions such as Fe^{3+}, Cu^{2+}, and Al^{3+} are often found in laboratory wastewater due to the use of reagents, catalysts, and test materials. Graphene Quantum Dots (GQDs) are widely used in sensor applications due to their ability to detect metal ions through the interaction of their surface functional groups, indicated by changes in intensity or shifts in emission wavelengths. Their combination with hydroxyapatite (HAp) can provide a synergistic effect, increasing the sensitivity and selectivity of fluorescence sensors to Fe^{3+} ions due to the presence of phosphate (PO_4^{3-}) and hydroxyl (OH^-) groups in their structure. Graphene Quantum Dots (GQDs) were synthesized from rice stalk waste (Oryza sativa L.) using a hydrothermal method at 180°C for 12 hours, while hydroxyapatite HAp was synthesized using a sol-gel method.

The combination of HAp and GQDs was achieved through a hydrothermal process. To increase fluorescence emission efficiency, nitrogen doping of the GQDs was also performed to obtain N-GQDs. Material characterization was carried out using UV-Vis spectrophotometry, photoluminescence (PL), Fourier Transform Infrared (FTIR), X-Ray Diffraction (XRD), HRTEM, and Quantum Yield (QY) measurements. The results of this study are GQDs and N-GQDs with QY values of 48% and 57%, where the highest peak in GQDs at 136.48 a.u. and N-GQDs 150.56 a.u. GQDs have high sensitivity and strong selectivity towards Fe^{3+} compared to Cu^{2+} and Al^{3+} with F/F0 ratios of 0.914 and 0.844, while GQDs/ Fe^{3+} experienced very strong quenching with F/F0 of 0.026. The composite of GQDs and N-GQDs with HAp is able to provide increased detection capability as a selective fluorescence sensor for Fe^{3+} ions in laboratory wastewater as evidenced by smaller emissions compared to samples without HAp combination.

Keywords: *emission, fluorescence, GQDs, HAp, Fe^{3+} ions, wastewater, sensing*