Supplementary File

S1: Elemental study using EDS spectroscopy:

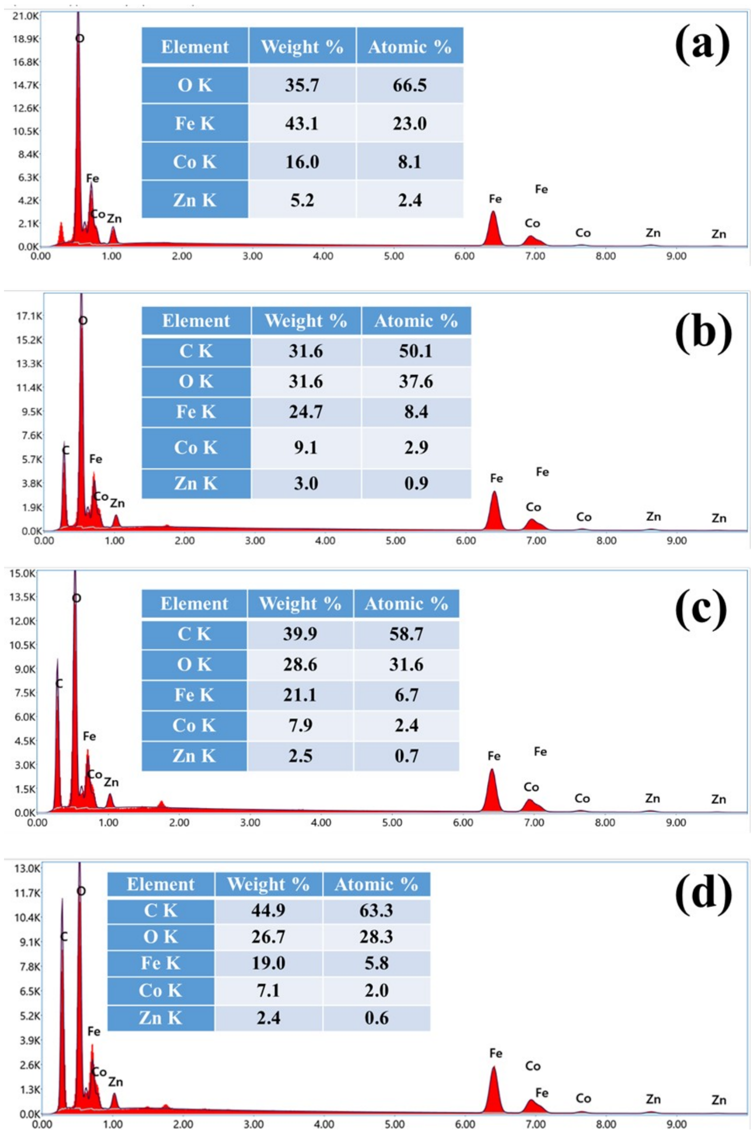

Figure S1: (a-d) EDS spectra with corresponding elemental composition of Z0, Z1, Z2 and Z3 samples, respectively.

S2: UV-Visible study-

The room temperature optical absorption (UV-Vis) spectra of GO, rGO and CZFO/rGO (Z0, Z1,Z2 and Z3) nanocomposites are shown in Figure S2. In Figure S2 the optical absorption spectra of GO and rGO shows a sharp absorption peak around 221nm. This peak is related to the π- π^* transitions for aromatics -C-C- originating for sp^2 domains [1]. For pure $Co_{0.8}Zn_{0.2}Fe_2O_4$ MNPs in figure 9(b) significant absorption shows in the visible range. After adding of rGO in $Co_{0.8}Zn_{0.2}Fe_2O_4$ MNPs in different wt % , the main absorption peak was observed at around 200-230nm ,which can be attributed to the intrinsic absorption of rGO and $Co_{0.8}Zn_{0.2}Fe_2O_4$ MNPs respectively .The optical energy band (E_g) of all the sample compositions was calculated from the absorption spectra by using the Tauc plot method follows; $(\alpha h\nu)^n = A'(h\nu - E_g)$, where hν indicates the energy of the incident photon, A' is a constant and n shows an index that is characterizes of the optical absorption process and its value is n = 2 and 1/2 based on the direct and indirect band gap transitions, respectively [2]. Here, the value of n taken ½ for direct band gap transitions. This depends on the nature of the electronic transmission responsible for the reflection in the materials. The absorption coefficient α can be calculated by the Beer Lambert Law [3, 4].

$$I = I_o e^{-\alpha t}, \text{ where } \alpha = 2.303 \times A/t$$

Where A is the absorbance and t are thickness (1cm) of standard quartz cuvette which we have used during experiment. The energy band of pure GO, rGO and $Co_{0.8}Zn_{0.2}Fe_2O_4$/rGO (Z0, Z1, Z2 and Z3) nanocomposites have been calculated to be about 2.7, 2.8,2.5,2.3,2.1 and 2.6 eV respectively. The calculated energy band of pure rGO and $Co_{0.8}Zn_{0.2}Fe_2O_4$/rGO nanocomposites corresponds to the result to previous study. On the other hand pure $Co_{0.8}Zn_{0.2}Fe_2O_4$ MNPs have reduced the energy band gap of $Co_{0.8}Zn_{0.2}Fe_2O_4$/rGO nanocomposites as the increases the rGO % content ,the energy band gap change from 2.5 to 2.1 eV and further increases 2.6 eV. This reduction of energy band gap of $Co_{0.8}Zn_{0.2}Fe_2O_4$/rGO nanocomposites with different rGO doping concentration is due to the increase of photoexcited electron-hole in the $Co_{0.8}Zn_{0.2}Fe_2O_4$/rGO nanocomposites with increases the rGO contents. The another reason of decreases or increases the energy band gap is due to high conducting nature of rGO and smaller crystallites size of MNPs [32].

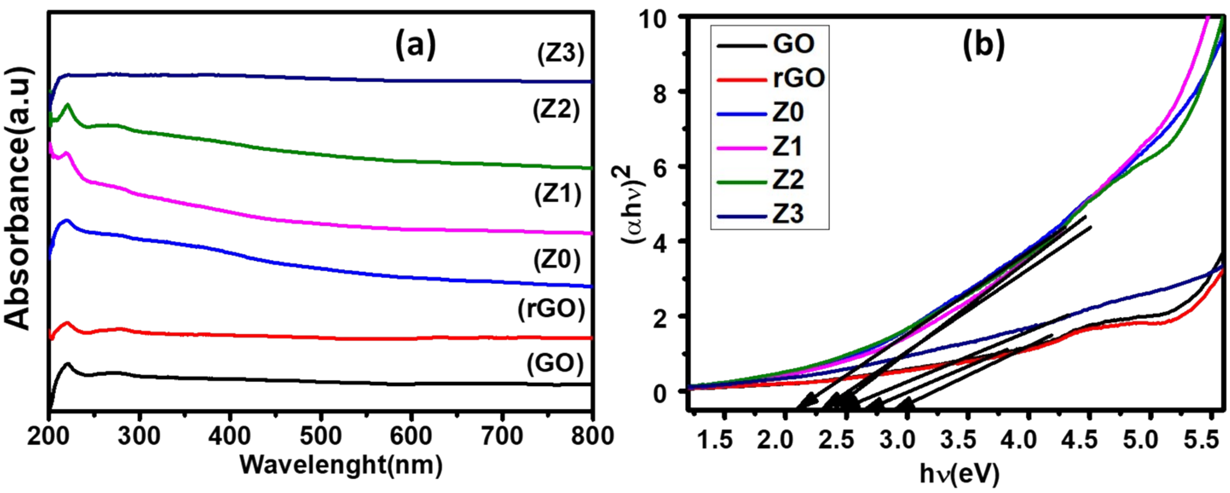

Figure S2: (a) UV-Vis absorption spectra (b) energy band gap of pure GO, rGO and CZFO/rGO (Z1,Z2 and Z3) nanocomposites at room temperature.

Reference:

[1] Almessiere MA, Slimani Y, Korkmaz AD, Taskhandi N, Sertkol M, Baykal A, et al. Sonochemical synthesis of Eu3+ substituted CoFe2O4 nanoparticles and their structural, optical and magnetic properties. Ultrasonics Sonochemistry 2019;58:104621.

[2] Ansari MMN, Khan S. Structural, electrical and optical properties of sol-gel synthesized cobalt substituted MnFe2O4 nanoparticles. Physica B: Condensed Matter 2017;520:21-7.

[3] Ansari A, Siddiqui VU, Rehman WU, Akram MK, Siddiqi WA, Alosaimi AM, et al. Green Synthesis of TiO2 Nanoparticles Using Acorus calamus Leaf Extract and Evaluating Its Photocatalytic and In Vitro Antimicrobial Activity. Catalysts 2022;12:181.

[4] Rana A, Pathak S, Kumar K, Kumari A, Chopra S, Kumar M, et al. Multifaceted properties of TiO 2 nanoparticles synthesized using Mangifera indica and Azadirachta indica plant extracts: antimicrobial, antioxidant, and non-linear optical activity investigation for sustainable agricultural applications. Materials Advances 2024;5:2767-84.