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Nickel vanadate-polyaniline nanocomposite for electrochemical sensing of metronidazole in urine and milk

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ABSTRACT

A facile synthetic approach has been followed to synthesize nickel vanadate ($Ni_3V_2O_8$: NiV) and develop a nanocomposite with polyaniline (PANI). All three synthesized materials were characterized to understand their structure and morphology, and the results indicate the formation of nanocomposite. NiV, PANI, and NiV/PANI were used to modify glassy carbon electrode (GCE) and used as working electrodes for the electrochemical detection of metronidazole (MTR), an antibiotic drug. Enhanced electrochemical performance (in cyclic voltammetry) is observed in NiV/PANI-modified GCE compared to other electrodes due to increased surface area and conductivity. The differential pulse voltammetry (DPV) technique was evaluated using NiV/PANI@GCE for the determination of MTR and found to be sensitive with a linear range of 0.1–980 μM with 0.01 nM limit of detection (LOD). The MTR estimation was also carried out on tablets, urine, and milk samples. The percentage recovery was good and in the range of 97.52–99.42 %, with the relative standard deviation (RSD) less than 2.52 %. NiV/PANI@GCE showed good selectivity, and no deviation was observed in the current response even in the presence of other organic and inorganic molecules. The good stability, wide linear range, low limit of detection, and selectivity of the NiV/PANI-modified GCE indicate its suitability for use in pharmaceutical industries for metronidazole monitoring.

Introduction

As the global population has increased, there is a growing desire to improve the quality of life for everybody. Antibiotics can improve human life expectancy. Antibiotics aim to improve the quality of human life and are used to treat and prevent bacterial infections in humans and animals [1–3]. Metronidazole (MTR: 2-(2-Methyl-5-nitro-1H-imidazol-1-yl)ethanol) is a nitroimidazole class of antibiotic that is used to treat a range of bacterial infections like giardiasis and trichomonas and also protozoans in patients [4,5]. MTR is effective against bacterial infections including skin, respiratory system, gastrointestinal system, and pelvic region. Giardia lamblia, Trichomonas vaginalis, and Entamoeba histolytica are just a few of the parasites infections also could be treated using MTR. MTR works very well against bacteria that live in anaerobic conditions. MTR is susceptible to developing resistance over time, which reduces its efficacy in treating specific diseases [6]. This emphasizes how crucial it is to use antibiotics appropriately in order to reduce resistance. Improper use for a long time and an overdose of MTR may lead to health issues like peripheral neuropathy, nausea, seizures, headaches, and other neurological disorders [7,8]. Later, this MTR enters the environment mostly from human and animal waste, as well as incorrect disposal of old drugs. It can stay in the environment for a long time, potentially contaminating water sources. Even tiny quantities of MTR in water can harm aquatic creatures, disturb ecosystems, and potentially infiltrate the food chain [9]. Given the potential hazards connected with MTR exposure to both human health and the

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