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Conductive polymer based MWCNTs nanocomposite as electrochemical sensing platform to detect chloramphenicol

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ABSTRACT

A sensing platform for the determination of chloramphenicol is put forward based on a nanocomposite of conductive polymer (polypyrrole), MWCNTs, and Ionic liquid (Ppy-MWCNTs-IL). The synthesized polypyrrole and its nanocomposite were characterized through FTIR spectroscopy, SEM, and HR-TEM. Polypyrrole possesses excellent conductivity compared to other insulating polymers and can be utilized to selectively interact with analyte through π-π interaction. MWCNTs are also known for their conductivity and high surface area which is essential for sensing purposes. The ionic liquid acts as a conductive binding agent which helps in preparing a uniform nanocomposite layer. Fabricated electrode gave excellent results for chloramphenicol with a detection limit of 8.94 $\mu g\ L^{-1}$ and linear range of 30 – 700 $\mu g L^{-1}$. Other analytical parameters such as repeatability and reproducibility (RSD 2.09 %) were also measured and found to be satisfactory. The stability of the nanocomposite film on the Indium tin oxide (ITO) electrode was attributed to the excellent film-forming capability of polypyrrole and ionic liquid that resulted in providing good shelf life (25 days). The fabricated sensor was further used to detect chloramphenicol in real water samples by spike recovery test.

1. Introduction

Chloramphenicol (CLM) comes in the category of phenolic antibiotic which is helpful in treating various bacterial diseases caused by both Gram-negative and Gram-positive bacteria. The long term exposure to CLM can lead to various health problems in humans such as gray baby syndrome, leukaemia, fetal toxicity, anaemia, and bone marrow suppression, etc. It has been already banned in animal foods in countries like the United States and China due to its numerous undetermined adverse effects. The continuous release of the drug into water bodies by untreated discharge through hospitals and pharmaceutical companies should be monitored to prevent health hazards. Several techniques have been developed for the determination of CLM such as high performance liquid chromatography (HPLC) gas-chromatography mass spectrometry (GC–MS) and liquid-chromatography mass spectrometry (LC-MS). But they suffer from various drawbacks like complex handling, sample preparation, and large instruments [1]. So, to overcome these drawbacks electrochemical sensors have gained a lot of attention these days because of their low cost, high sensitivity, and simple handling procedure. Electrochemical sensors are highly efficient in the simultaneous and on-site determination of various pollutants because of their portability and high sensitivity with selectivity [2]. Further, the selectivity can be enhanced by incorporating functional groups through modification by different nanocomposites [3–6].

There are numerous reported electrochemical sensors that have been used for the determination of chloramphenicol but are not economical due to the use of costly materials such as silver [7], gold [8,9], Palladium [10], tungsten [11], titanium [12], etc. Nanomaterials have high surface area and possess exceptional catalytic and conductive properties as compared to bulk which is highly beneficial for fabricating electrochemical sensors. Carbon-based nanomaterials like MWCNTs are one of the popular choices when fabricating sensors due to their high conductivity and ease of their modification [13,14]. Nowadays, the trend of using green materials in nanocomposites has gained popularity to follow green chemistry principles. Ionic liquids possess high electrochemical stability, conductivity, low volatility, and toxicity with a wide potential window. The nanocomposites built with insulating polymer, instead of conducting polymers don't serve as a good charge transfer material

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