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Enhanced Electrochemical Sensing of a Medication Belonging to the Novel Class of Selective Cholesterol-Absorption Inhibitors Using Magnesium-Oxide Nanoparticles-Infused Carbon Paste

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ABSTRACT

This research study specifically focuses on the electrochemical properties of a very important medication belonging to the novel class of selective cholesterol-absorption inhibitors, Ezetimibe (Eze) in a phosphate buffer solution (PBS, pH 7.0), utilizing a carbon paste electrode (CPE) that has been enhanced with Magnesium-Oxide Nanoparticles (MgONP). To assess the oxidation behavior of Eze, cyclic voltammetry (CV) was utilized on both the standard and MgONP-modified CPEs. The findings revealed that Ezetimibe produced a single irreversible oxidation peak at both electrode types; however, the incorporation of MgONP led to an increase in the current intensity of this peak accompanied by a negative shift. This suggests a significant enhancement in electrocatalytic activity. A comprehensive evaluation of several factors—including scan rate, pH, and solvent—on Eze's electrochemical response was conducted. Additionally, differential pulse voltammetry (DPV) established a linear relationship for the oxidation of Eze. The newly developed sensor proved effective for measuring Eze concentrations in pharmaceutical formulations, presenting a straight-forward and efficient approach for quantitative analysis. The MgONP-modified CPE demonstrates notable advantages regarding sensitivity, low detection limits, and simplicity in fabrication, thereby making it a valuable assetfor the electrochemical detection of pharmaceuticals and various ionic species.

Keywords:-Selective Cholesterol-absorption inhibitors, Ezetimibe (Eze),Electrochemical sensor, Electrochemical behavior, Magnesium-Oxide Nanoparticles (MgONP), Carbon paste electrode (CPE), Differential pulse voltammetry (DPV),Cyclic voltammetry (CV), Detection limit.

INTRODUCTION

Cyclic voltammetry uses a carbon-paste electrode enhanced with Magnesium-Oxide Nanoparticles (MgONP). This determines the phosphate buffer solution's Ezetimibe (Eze) concentration (PBS, pH 7.0) (CV). Ezetimibe’s chemistry at the unmodified and MgONP-modified CPEhave been studied along with that examination ofEzetimibe's biological significance and oxidation have also been carried out.

Ezetimibe revealed a single irreversible oxidation peak at CPEs with and without MgONP modifications. Ezetimibe'soxidation peak current raises and shifted negatively at the MgONP-modified CPE, suggesting electrocatalytic activity. During the MgONP-modified CPE, the scan rate of Ezetimibe, pH, and solvent were all investigated. Ezetimibe’s oxidation was linearly calibrated using differential pulse voltammetry.

Five times ten to the power five is the detection limit for this graphic (DPV). This system has proven effective in calculating pharmacological doses in many dosage forms. The MgONP-modified CPE's high sensitivity, low detection limit, and simplicity of manufacture allow the construction of a sensitive voltammetric sensor for ion measurement which was extremely difficult to measure before.

MATERIAL AND METHODOLOGY

Experimental Reagents and Chemicals:-

Fisher Scientific in Mumbai, India supplied 99.0% of Ezetimibe inventory. The stock standard solution of Ezetimibe was kept in acetonitrile (>99.5%). This prevented it’s contamination. MgO nanoparticles were produced in laboratory. 0.05M sodium hydroxide was added to 0.1M KH_2PO_4-prepared phosphate buffer solution (PBS) to get the desired results. LobaChemie delivered spectroscopically pure graphite powder, while the other compounds were pure enough for analytical work. The Ezetimibe stock solution was made by diluting the stock solution.

Preparation of MgONP-Modified Carbon Paste Electrode

The MgONP-modified CPE electrode was prepared by grinding various concentrations of MgO nanoparticles with bare carbon paste. Following that, the electrode that was manufactured from modified carbon paste which was utilized in the same manner as the electrode that was made from naked or unchanged carbon paste. This was done so in order to compare the two types of electrodes. Before beginning the measurement, the surface of the electrode was smoothed off using a piece of translucent paper in order to create a surface that was consistent, uniform, and totally untouched.

RESULTS AND DISCUSSIONS

To test the approach of analytical application for tablet analysis theMgONP-modified CPE was used to quantify Eze in commercially available Ezetimibe pills, such as Zetia or Ezetrol (10 mg Eze-tablet), in PBS (pH 7.0) without treatment, to test the method's viability. Zetia and Ezetrol both contain 10 mg of Eze. To prove the procedure's dependability, known amounts of the Eze standard were added to several pre-analyzed solutions. The peak current climbed the same after adding standard Eze, proving that Eze caused the peak.

Five sets of triplicate measurements yielded recoveries of 98.86% to 100.13% with a relative standard deviation of about 2.05%. Relative standard deviation showed this. MgONP was seen to be unaffected by several chemical molecules. Conclusions showed that the suggested method could detect tyrosine in pharmaceutical formulations.

CONCLUSION

1. A detailed investigation of the oxidation of zinc was accomplished by combining cyclic voltammetry (CV) and differential pulse voltammetry (DPV) with a simple and low-cost CPE that had been modified with MgO nanoparticles in PBS (pH 7.0).
2. At both unmodified and MgONP-modified CPE, Eze had a single peak of irreversible oxidation.
3. By evaluating the impact of the scan rate of Eze, the influence of pH, and the kind of solvent that was used, it was determined that the electrode process at the MgONP-modified CPE is adsorption-controlled. This was done in order to determine how the process works.
4. The electrocatalytic activity for the oxidation of Eze was proven by the MgONP-modified CPE, and as a consequence, a probable oxidation pathway for Eze at the MgONP-modified CPE was proposed. The shift toward a more negative anodic peak potential resulted in a considerable increase in the oxidation peak current of Eze at the MgONP-modified CPE. This was due to the fact that the anodic peak potential was changed.

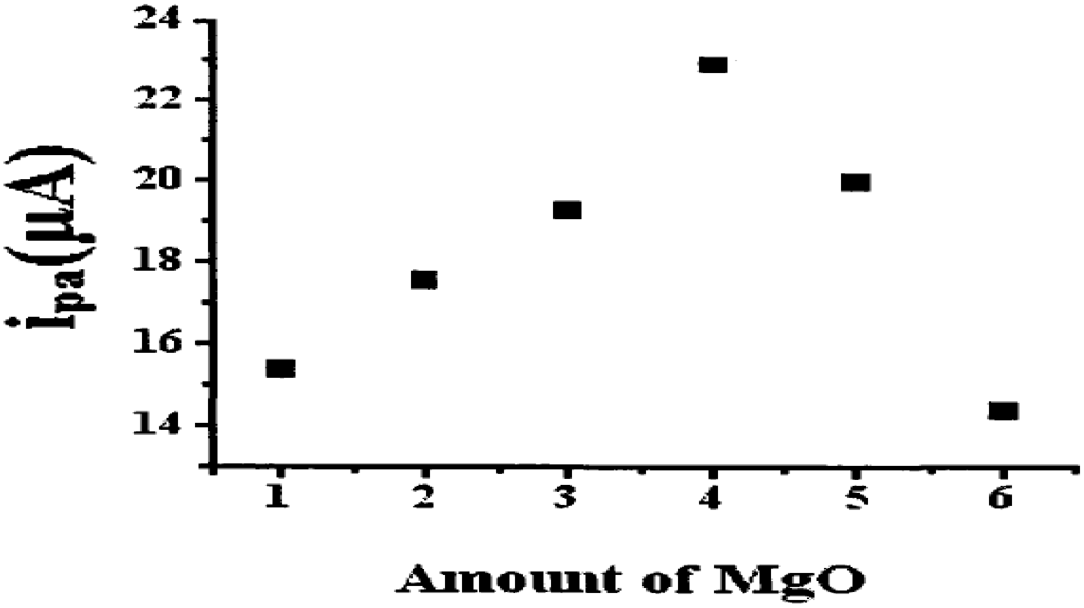


Figure-(a): Plot of amount of MgO nanoparticles (Img to 6mg) v/s anodic peak current in the presence of 0.1 mMEze at a scan rate of 100 mV/s.

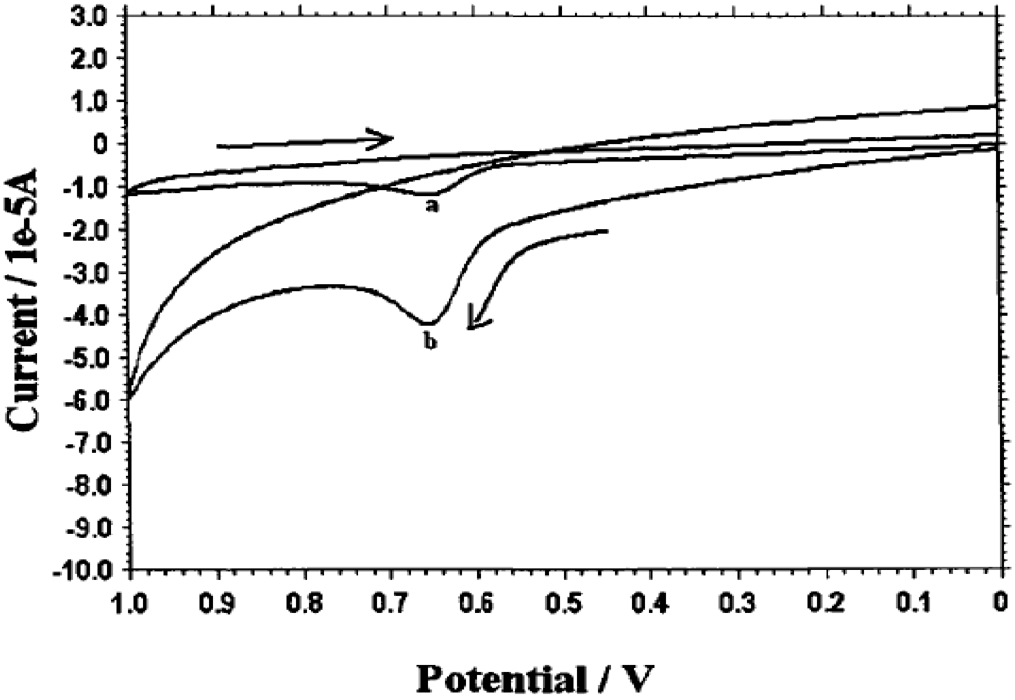


Figure-(b): Cyclic voltammograms of 0.1 mMezetimibe at bare CPE (curve 'a') and at MgONP-modified CPE (curve'b') in PBS (pH 7.0) at a scan rate of 100 mV/s

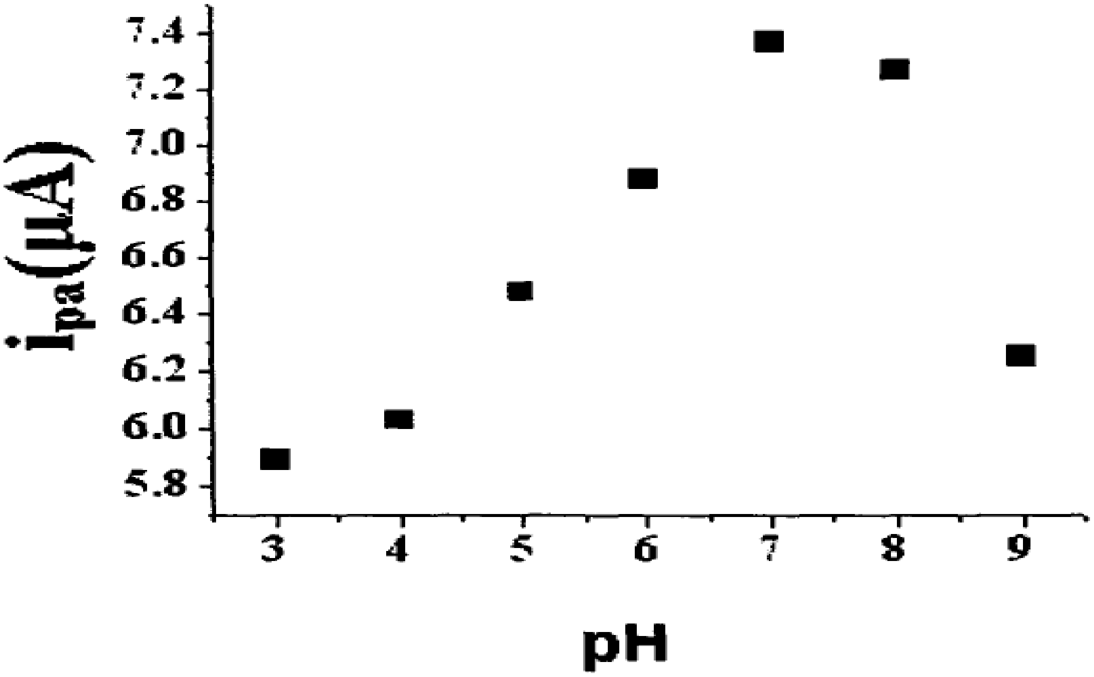


Figure-(c): Plot of anodic peak current vs. pH (3.0 to 9.0) of 0.1 mMEze at the MgONP-modified CPE

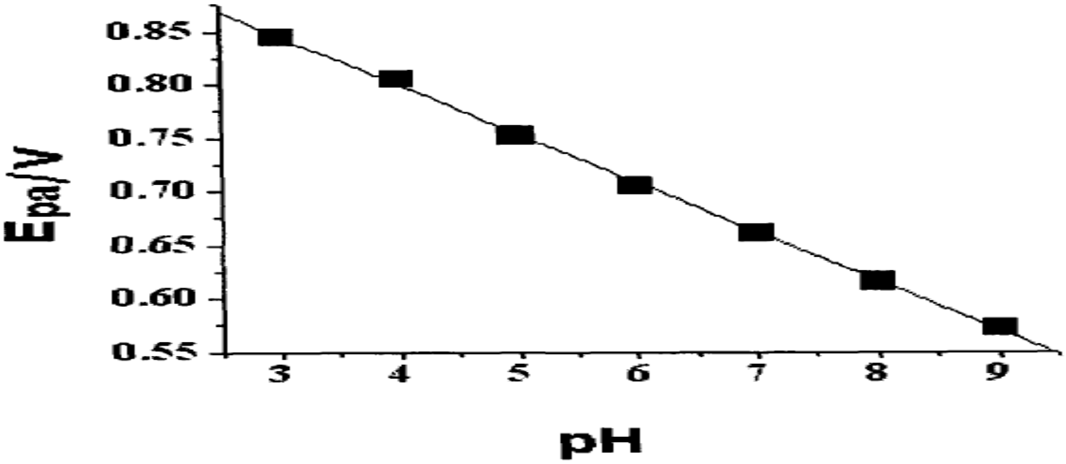


Figure-(d): Plot of Epa vs. pH for Eze.

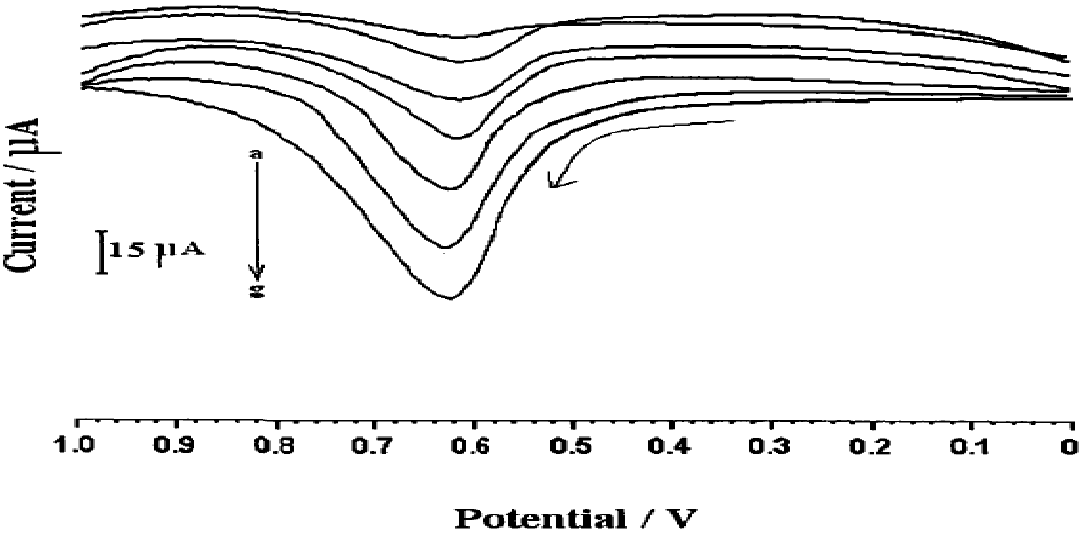


Figure-(e): Differential Pulse Voltammograms of Eze with different concentrations: (a) 0.2 (b) 0.5 (c) 0.75 (d) 1 (e) 5 (f) 10 and (g) 25 ^M in pH 7.0 PBS at MgONP -modified CPE.

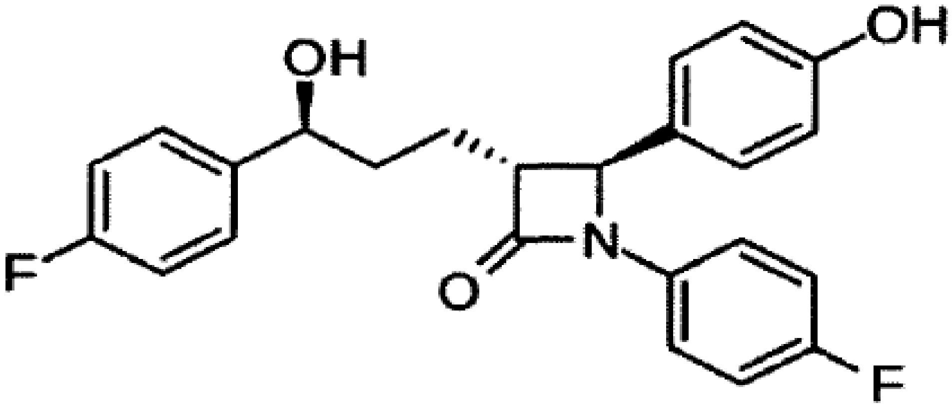
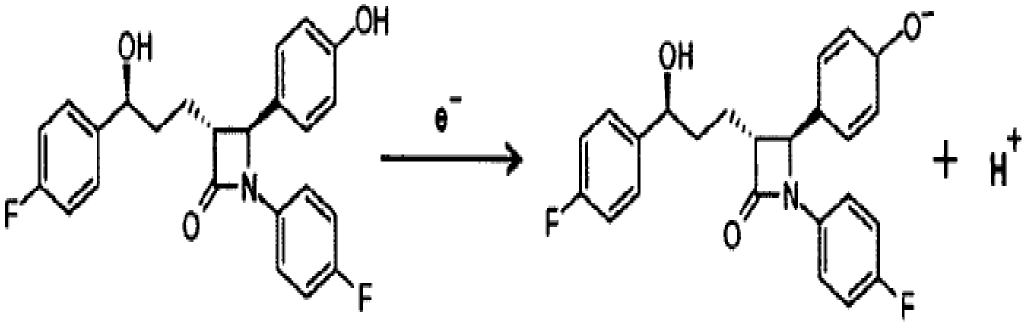


Fig.:-Structure of Ezetimibe.



Scheme:-Proposed mechanism of the electrochemical oxidation of Ezetimibe at the MgONP-modified CPE

Table-1:- Effect of different dissolving solvents on the current and potential response of the MgONP -modified CPE at 0.1 mMEze in PBS (pH 7.0) at a scan rate of 100 mV/s.

Dissolving Solvent	Current (uA)	Potential (mV)
Methanol	4.39	713
Acetonitrile	7.42	662
DMSO	6.93	671
O.lMNaOHin Ethanol	9.35	672

Table-2:-Determination results of Ezetimibe in commercial tablets:-

Sample no.	Specified(mg) (n=5)	Detected(mg)	RSD%
1	10.0	9.81	1.01
2	10.0	9.85	1.27
3	.10.0	10.01	0.85
4	10.0	9.93	1.2
5	10.0	9.87	1.16

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