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PREPARATION OF TRIDODECYL METHYL AMMONIUM CHLORIDE (TDMAC) ANION EXCHANGE MEMBRANE AND THEIR OPTIMIZATION FOR POTENTIOMETRIC SENSOR

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ABSTRACT

The aim of this present work was to develop a modified potentiometric sensor for determination of Gallic acid in wine samples, based on anion exchange membrane (TDMAC) fabricated on the silver working electrode in terms of its analytical performance. To achieve this aim the anion exchange membrane made by the adding of 200 mg of 9 weight% TDMAC (Tridodecyl methyl ammonium chloride), 31 weight% polyvinyl chloride, and 60 weight% o-NPOE and dissolve into the 2.0 ml of The with a thickness of 210 nm. The Gallic acid value obtained by this biosensor were evaluated and compared with the standard Folin-Ciocalteau spectrophotometric method.

Keywords: Poly (vinyl chloride), anion exchange membrane, conductivity, potentiometric sensor

1. INTRODUCTION

Presently, the alkaline fuel cell has been growing worries because of the development of novel anion exchange membranes (TDMAC) of hydroxyl anion, separating two electrode regions. The anion exchange membranes are predictable to be more effective than proton exchange membranes in potentiometric sensor application. The anion exchange membrane active features are higher energy renovation efficiency, a lesser amount of corrosion, and additional economical catalyst materials. In addition, the potentiometric sensor uses the anion exchange membrane that is supplementary outstanding than normal alkaline fuel cell because of obstructive movement of cation [1], overpowering carbonate precipitation, reducing fuel loss, and increasing specific energy density. Previous studies showed that hydroxyl anion exchange membranes based on poly vinyl chloride displayed good performances in term of ionic conductivity, anion exchange capacity. Additionally, the manufacturing process is much simpler with using THF solvent during fabrication [2-4]. However, the application of PVC-based membranes has still faced numerous challenges which need to overcome such as the high water absorption capacity leads to the reduction of the membrane durability. In order to address the aforementioned issue, the exchanging membrane is fabricated based on the denatured PVC or the incorporation of PVC with other polymers which have different characteristics which could enhance the fundamental properties as well as optimize the performance in order to benefit for the practical application of anion exchange membrane. On that basis, the researching team focused on synthesis and characterization denatured PVC-based anion exchange membranes which could fulfill the basic requirements for potentiometric sensor cell application.

2. EXPERIMENTAL

2.1 Chemicals

Folin-Ciocalteu reagent, high molecular weight polyvinyl chloride (PVC), 2-nitrophenyl octyl ether (o-NPOE), tridodecylmethylammonium chloride (TDMAC), tetrahydrofuran (THF) and gallic acid (GA) were purchased from Sigma–Aldrich (St. Louis, MO, USA). Potassium permanganate, tartaric acid, sodium tartrate, sodium chloride, lithium acetate and ethanol were obtained from Chemical Reagent Hi-Media Lab (Pvt. Ltd. Mumbai), stock solution of 0.1M for gallic acid was prepared with the model wine solution (12% vol ethanol, 4 g/L tartaric acid, pH 3.6). A 0.1 M Potassium permanganate was prepared daily and stored in the dark. Other aqueous solutions were prepared by dissolving the appropriate salts in the freshly de-ionized water (18.2 MW cm specific resistance) obtained with a science laboratory water system.

2.2 Preparation of anion exchange membrane

The anion exchange membrane was made by the adding of 200 mg of 9 weight% TDMAC (tridodecyl methyl ammonium chloride), 31 weight% polyvinyl chloride, and 60 weight% o-NPOE and dissolve into the 2.0 ml of THF with a thickness of 210 mm. Before being put to use, the membrane mixture was first dry by using the sonification for ten minutes. It was then overflowed onto a tumbler disc with a thickness of 26 mm that was protected inside a glass plate. After that, it exposed in the air and dehydrated off entirely. After that, disc of membrane with a diameter of 6 mm were cut from the membrane.

2.3 Optimization of anion exchange membrane TDMAC by different wt%

Anion exchange membrane TDMAC will be optimized by different wt% of TDMAC salt at fixed gallic acid concentration, and shows the most favourable wt% value of the membrane will be selected for the experiment.

2.3.1Effect of membrane composition

The anion exchange membrane TDMAC plays an important role for extracting the ion from the sample solution. It is semi permeable in nature and passes through them only special ion. After adding gallic acid to the mixture, various mass percentages of TDMAC were tested to see what would happen, and any unexpected results were investigated. Gallic acid biosensors with TDMAC membranes of varying compositions were dipped into sample solutions containing gallic acid. Then found that the potential of the membrane sensor increase according to different composition of membrane. This shows that the increase no of membrane particles done more redox reaction with gallic acid molecules and increase the potential, but after the 1.7 g/L concentration of gallic acid and the composition of membrane 9.0% not increased the potential of the potentiometric sensor . So we selected this as optimum composition, which is more stable for the system shown below in the fig:

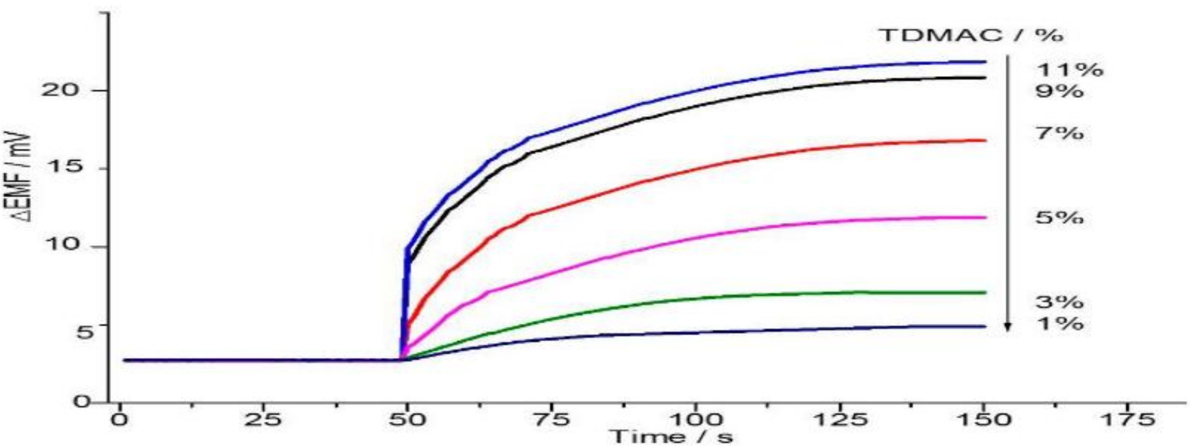

Fig: 1. The effect of the amount of TDMAC on the potentiometric sensor with different concentration of gallic acid

2.4 Fabrication of membrane

Fabrication of anion exchange membrane on the silver working electrode, the anion exchange membrane TDMAC was sliced 6 mm disc and attached to the tip of the Ag working electrode with the help of rubber, in which10 -1 M Kmno4 solution used as a inner filling solution. Due to more stability and hardening of the anion exchange membrane with the working electrode, it placed in the 10 mM solution of Nacl at whole night. And the next day, we used this for the sample solution and note the amount of permanganate released in the sample solution was determined by using an absorption spectrophotometer to measure the colour change of the solution after being exposed to the permanganate. When the membrane is not used then it placed at the room temperature and dry places.

2.5 Evaluation of anion exchange membrane potentiometric gallic acid sensor

Using a functioning TDMAC anion exchange membrane that was built on the Ag working electrode, a new method was devised for the potentiometric detection of gallic acid in wine samples. This method makes use of the samples. The oxidation of gallic acid using permanganate ions that came from the inner filling solution and went through the anion exchange membrane was the method that was used. The potentiometric biosensor worked by measuring the voltage response of gallic acid using a digital potentiometer. This voltage response was produced through the oxidation of gallic acid. The gallic acid content of the wine samples was shown to have a direct and proportional relationship to the potential that was measured. The benefit of the current system is that it is straightforward, sensitive, and easy to manipulate. Additionally, it is more particular and quick to respond. After some period of time, the electrodes that are used in the procedure become more stable and can be reused. The linear concentration range of the present biosensor is lower than that of the reference methods, which are immobilization of tyrosinase or laccase on the surface of GCE modified with GO-**111** MWCNT hybrid (1-2.6 g/L) and ITO/LAC/Tyr electrode (1.6-8.3), respectively. The linear concentration range of the present biosensor is between 0.05 and 3.0 g/L. The analytical performance of the current gallic acid biosensor, which makes use of the TDMAC anion exchange Ag working electrode, was evaluated based on the following criteria, which were researched and investigated.

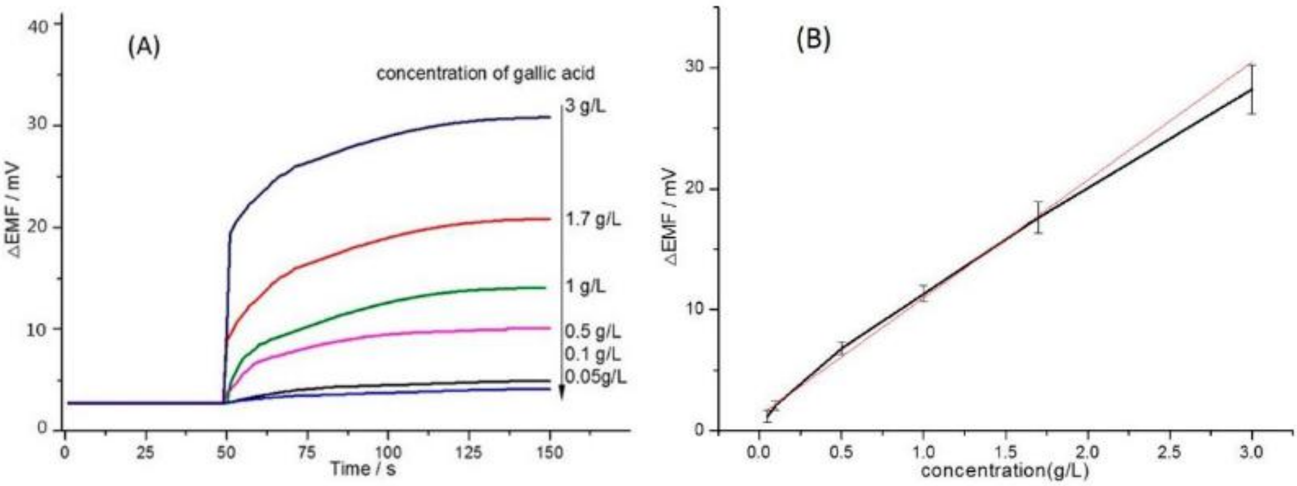

Fig: 2. (A) Gallic acid reactions with time. (B) Gallic acid concentration linearly correlates with potential response values.

2.6 Linear range

"There was a relationship between potential(mV) and gallic acid concentration (g/L) of the present gallic acid biosensor ranging from 0.05- 3.0g/L), response was constant after 3.0 g/L which is better than previous reported potentiometric gallic acid biosensors based on chitosan membrane(0.0016-0.1g/L), ZnO-NPs-CPE by the CV, and DPV in the red wine (1 × 10-6 to 6.5 × 10-5, SiO2-NPs -GrO nanocolloids-GCE by the CV, and DPV in red and white wine(6.25 × 10-6 to 1 × 10-3), Amorphous Zirconia-CPE by the CV, DPV in red and white wine 1 × 10-6 to 6–1 × 10-3, ZrO2/Co3O4/rGO-FTO by CV, DPV in the Fruit juice, Tea 6.24 × 10-9 to 9–4.8 × 10-7, Bismuth-NPs-MWCNT-CPE CV, by The lower detection limit of the present biosensor was 6.6mg/L matched with those obtained by by standard folin ciocalteu method."

3. CONCLUSION

In order to construct this sensor, we initially fabricated the anion exchange membrane TDMAC using a variety of chemicals and a range of weight percentages. The details of this process may be found in the thesis work. To facilitate the formation of a membrane electrode system, TDMAC contributes a binding capacity that facilitates the covalent connection of the membrane onto the exposed surface of the silver electrode, after that put into 0.1 M sodium chloride solution so that it could become more durable. The voltammogram of the solution that has been altered to contain potassium permanganate and gallic acid at a concentration of 0.05 g/L has arrived at the electrode that has been modified. This method of quantitative analysis is based on the potential changes of the TDMAC-based silver working electrode that are generated by the redox action between the permanganate ion, which comes from the inner filling solution through the polymeric membrane, and phenols such as gallic acid in the sample solution. The potential changes of the TDMAC-based silver working electrode are generated when the permanganate ion reacts with the phenols in the sample solution. To be more specific, the permanganate ion is utilised in this procedure for the purpose of determining the amount of phenols present in the sample solution. The degree to which there is a shift in potential is directly proportional to the amount of permanganate ion that is present in the solution. This is because the amount of change in potential is proportional to the number of ions that enter the solution and react with the gallic acid. It is a simple and robust potentiometric approach for determining the total phenolic content has been successfully proposed. The quantitative analysis method is based on the potential changes induced by redox action between permanganate ion fluxes across the polymeric membrane and phenols such asgallic acid in the sample solution. Additionally, these also exhibit a fast response time, an acceptable reproducibility and long-term stability. Note that, although the total phenolic content assessed by the proposed potentiometric sensor was higher compared to the data obtained by the Folin–Ciocalteu method.

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