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# Glassy Carbon Electrode Modified with Sodium Molybdate/Poly(Methyl Red) for Electrochemical Catalytic Oxidation of Uric Acid

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**Abstract**- Uric acid shows good quality sensitivity with sodium molybdate and methyl red personalized glassy carbon electrode. In this amend sodium molybdate was ionically deposited resting on the surface of the working electrode of the glassy carbon electrode, and then the facade of the electrode was electropolymerized with methyl red. The electropolymerization of methyl red on the working electrode was done by potential cycling in 0.2M phosphate buffer solution at pH 5.0 to 8.0. Very sensitive peak potentials of uric acid pragmatic in the presence of two made-to-order materials. This sensitivity nature was precisely investigated at physiological pH of 7.4, the rate of scan consequence tells regarding circulation inhibited electrode assets and concentration effect gives for uric acid good limit of detection that is 3.020 x 10-5 M calculated at the modified electrode. The complete study explains the oxidation mechanism of uric acid concerning an identical number of electrons and protons on the surface of the Sodium Molybdate/Poly (Methyl Red) modified glassy carbon electrode with elevated sensitivity.

**Keywords-** Methyl Red; Sodium Molybdate; Uric acid; Electro ionically deposited; Electropolymerization

### **1. INTRODUCTION**

Human being cadavers produce uric acid (UA) as the prime item for consumption of the metabolism of purine [1-3]. Quite a few ailments and mayhems ;(such as gout, Hyperuricemia, diseases of cardiovascular, pneumonia, and leukemia) are reasoned outstanding in the direction of the uncharacteristic attentiveness echelons of UA. As a rule, inside the serum points of uric acid, sorts from 240-520  $\mu$ M, in addition to it is assessed in urine as 240-750 mg/24 hr. It is needful to resolve the Uric acid next to budding an uncomplicated and quick routine [3-6]. Irreparable electroactive oxidation of uric acid1 provides allenton like the foremost item for consumption [6,7]. Electrochemical modus operandi through modified electrodes in favor of fortitude of uric acid (UA) is for in receipt of their settlement of living being straightforward, despicable, and opening of fast psychotherapy in concert by elevated sensitivity [6-13]. In later years electrodes be worn seeing that modifiers sponsor for contemplation and build up the electroanalysis of chemical, and physical properties [14-16].

Sodium molybdate (SMD), Na<sub>2</sub>MoO<sub>4</sub> is constructive as a resource of molybdenum. It was white crystalline salt as dehydrated, the molybdate(VI) anion is tetrahedral and two sodium metal cations coordinate with anions [17,18]. It was worn in mainly commerce for decomposition embarrassment and as it is a non-oxidizing anodic inhibitor. The calculation of SMD radically diminishes the nitrite prerequisite of fluids subdued with nitrite–amine and improves the decay protection of carboxylate salt fluids [19]. In industrial water conducting applications wherever galvanic deterioration is a potential owed toward bimetallic erection, the function of SMD is chosen in excess of sodium nitrite. SMD has the plus in so as to the dosing of inferior ppm of molybdate consent to support of lower conductivity of the flowing water [18].

In modern days, electrodes sheltered with electropolymerized demean ring substances have been compensated giant courtesy unsettled a route for their inaccessible compound in adding up toward objectives belonging when glowing as electro energetic catalysis [19-21]. A number of revisions designate to polymer misrepresented electrode liberate intensify domino effect projected pro the tenacity of therefore numerous biological and variety of quantifiable. Customized glassy carbon electrodes arraign carrying facial appearances like breadth and infiltration are capable to be handled by the potential and; functionalized current [21]. On average dyes on polymerization. beginning which oligomer with a cantankerous link bestow the superior absorptive competence [22]. The Methyl red (MR) (2-[4-(dimethylamino) phenylazo] benzoic acid), ( $C_{15}H_{15}N_3O_2$ ), is an untreated dye and 'aromatic azo compound. In this nearby paper put in plain words, the electrochemical acknowledgment of uric acid (UA) sustained on SMD/Poly (Methyl red) modified Glassy carbon electrode was ionically deposited on the plane of the working electrode which is a compound of inorganic one, and then after electro-polymerized with MR was an aromatic azo composite with carboxyl functional assemblage which is sympathetic to adsorb UA [21]. Yet

to be paid to its absorption capacity SMD/PMRE modified glassy carbon. electrode furnished the electrochemical oxidation of uric acid. The result achieves at the modified electrode gives you an idea in relation to the sensitivity, stability, and reproducibility of the strength of mind of Uric acid. at physiological pH. Therefore, the fictional electrode can be worn as a helpful sensor for the quantification of Uric acid in pharmaceutical formulations.

# **2. PROCEDURE**

#### 2.1. Material and used products

Sodium molybdate (SMD) and methyl red were obtained from Himedia Laboratories Pvt. Ltd. Bangalore. The stock solution of  $25 \times 10^{-5}$  M UA was geared up by using double distilled water. For pH maintenance phosphate buffer solution (PBS) was prepared by combining of suitable percentages of NaH<sub>2</sub>PO<sub>4</sub> and Na<sub>2</sub>H<sub>2</sub>PO<sub>4</sub>. All the chemicals are analytical grade and used without any supplementary decontamination.

### 2.2. Apparatus

The electrochemical workstation by model CHI-660 (CH Instrument-660c) with a conservative three-electrode cell has been used for this study. A saturated calomel electrode (SCE) was used as a reference, a platinum wire was used as a counter electrode, and the working electrode was a modified glassy carbon electrode.

#### 2.3. Preparation of glassy carbon paste electrode

The glassy carbon electrode. was refined by using 0.3 and 0.05  $\mu$ m  $\alpha$ -alumina slurry resting on the facade of a polished fabric in anticipation of an imitation similar to manifestation be pragmatic.



**Figure 1.** A cyclic voltammogram of 1 mM uric acid at bare glassy carbon electrode (BGCE) in pH 7.4 PBS

Afterward, as hygienic GCE was washed down meticulously through double distilled water. The ionically deposited with SMD, and then electrochemical polymerization of Methyl

red lying on the surface of GCE was accomplished as a result of cyclic voltammetric (CV) modus operandi. The GCE was inspected for 10 cycles of multiple within an electrochemical cell controlling 1.0 mM UA monolayer in 0.2 M PBS of pH 7.4 in connecting the potential window of -0.4 to 1.6 V at the scan rate of 0.1 Vs<sup>-1</sup>. Subsequent to that, the fictitious SMD/ poly(methyl red) MGCE was methodically used with double distilled water and worn and designed for the fortitude of UA. It is revealed in Figure 1.

# 2.4. Electropolymerization of Methyl Red (MR) amid SMD MGCE

The SMD electro-ionically tailored glassy carbon electrode was promoting electropolymerized among MR to revise the temperament of UA electrochemical activity. So in this experiment parameter designed to facilitate  $25 \times 10^{-5}$  M methyl red average solution was equipped and SMD modified GCE fictitious by CV performance at the potential range of -0.6 V to +0.6 V, the scan rate is 0.1 V s<sup>-1</sup> with numerous crinkle over cycles in incidence of 0.2 M PBS at pH 7.5. This practice was unremitting to attain an unvarying cyclic voltammogram, with an attractive cyclic period as revealed in Figure 2. The electrochemical multiple knows how soaring thickness influences the electrocatalytic activity of the implicated and instrumentalist, and this. was continued by amending remove divisions [22,23,38,39].



**Figure 2.** A cyclic voltammogram of electrochemical deposited of SMD MGCE with poly methyl red Modified glassy carbon electrode, scan rate 0.1 mVs<sup>-1</sup> on PBS solutions at pH 7.5

#### 2.5. Description of SMD/poly (methyl red) modified glassy carbon electrode

Figure 3 evidently shows the diverse voltammogra1ms of SMD/poly (methyl red) customized GCE. Cyclic voltammogram of BGCE (dashed line), a cyclic voltammogram of MGCE among sodium molybdate (solid line), and the cyclic voltammogram of SMD/poly (ethyl red) MGCE (dotted line). During cyclic voltammetry peak' explains at the scan, rate 0.05 Vs<sup>-1</sup> at sustaining electrolyte solution of 1 M KCl. The acquired voltammogram of customized glassy carbon; electrodes with SMD and methyl red pointed out significant modernization in the transferring process of the electron. The sophisticated upshot of electron

progress next to voltammetric rejoinder was achieved from sustaining electrolyte on MGCE amid SMD, and poly(methyl red); proving the morphology subsists satisfactorily custom-made and the consequence shows the electrocatalytic doings. The calculated values of peak current with Randles–Sevcike equation (1) [4,6,24,25,35-37]:

$$I_p = 2.69 \times 105 n^{3/2} A D^{1/2} C_0 v^{1/2}$$
(1)

where the  $C_0$  is the concentration of the electroactive species it was in (mol cm<sup>-3</sup>), the I<sub>p</sub> is the peak current it was measured in A, the *n* is the transferred number of electrons, the diffusionco efficient is *D*, the *u* is scan rate (Vs<sup>-1</sup>), and *A* is the electroactive surface area (cm<sup>2</sup>). For SMD/poly(methyl red) MGCE, the facade region of electroactive is maximum (0.0385 cm<sup>2</sup>) when compared with bare GCE (0.031 cm<sup>2</sup>).



**Figure 3.** Cyclic voltammograms of 1 mM PBS at the Bare GCE (Dashed line) and cyclic voltammogram of MGCE among SMD (solid line) at poly(methyl red) MGCE (dotted line)

During this predictable scheme, the uric acid oxidation step is rehabilitated to uric acid 1, 4 diol. It was revealed in Scheme 1.



**Scheme 1.** The SMD electro-ionic deposited on the surface of GCE then methyl red electropolymerized on the SMD MGCE and the probable oxidation of uric acid in the electrochemical cell

#### **3. RESULTS AND DISCUSSION**

# 3.1. The effect of scan rate

The effect of the scan rate parameter was taken at 0.5 mM UA pragmatic with cyclic voltammetry technique, for which 0.2 M PBS and SMD/poly(methyl red) was used (Figure 4, 5 and 6) relating to the 'Randles–Sevcik'' equation. It was a made-to-order GCE that illustrates well-enhancing redox peak current values with extending efficient scan rates, and an extremely slightest inconsistency of redox peak potentials can be deliberate. For the intervals of legalization to ascertain the progression of the electrode, the chart plotted against current (I<sub>p</sub>) *vs* scan rate graph is a straight line with 2.006 to 6.260 Vs<sup>-1</sup>. As revealed in Figure 5, the acquired correlation coefficient (r<sup>2</sup>) is 0.99672. The electrode peak current (I<sub>p</sub>) vs root scan rate ( $v^{1/2}$ ) graph was plotted, and the attained values of the parametric gauge be r<sup>2</sup> = 0.99845. This gained correspondence coefficient assessment is incredibly close up a route for one, thus this is primarily advised that choosing electrode procedure was an adsorption-controlled phenomenon. This was undoubtedly shown in Figure 4. The obtained slope was 0.85344, and it bears out the performer manner was exterior adaptation forbidden method [26-28,42,43].



**Figure 4.** Cyclic voltammograms of 0.5 mM UA in 0.2 M PBS solution of pH 7.5 at SMD and poly(methyl red) MGCE at various scan rates



Figure 5. A scatter graph of 0.5 mM UA in 0.2 M PBS at Ipa versus Scan Rate



Figure 6. A scatter graph of 0.5 mM UA in 0.2 M PBS at I<sub>pa</sub> versus square root scan rate

#### **3.2.** The concentration effects

In this parameter concentration variation, which acts as a foremost role to evaluate the analyte effect was shown by a cyclic voltammogram while the concentration of UA was varied in 0.2 M PBS of 7.5 pH, and scan rate was sustained at 0.05 Vs<sup>-1</sup>. Then cyclic voltammograms are documented with altering concentrations of UA ( $7.3852 \times 10^{-6}$  to  $2.599 \times 10^{-5}$  M) and the result was shown in Figure 7, which gives an explanation of the perfection of electrode peak current by the escalating of concentration of UA. Figure 8 shows a linear relationship connecting I<sub>pa</sub> and the concentration of UA. The linear relationship value  $r^2 = 0.9954$ , and it pointed out the identical digit of protons and electrons implicated in the redox reaction mechanism of UA. The LOD on the slighter attentiveness extent for UA was 7.7081×10<sup>-6</sup> M for the SMD/poly(methyl red) and the limit of quantification (LOQ) was  $3.020 \times 10^{-5}$  M. This LOD and LOQ values are premeditated with equations 2 and 3 [29-35,40-43]. The wished-for UA viewing oxidation progression was seen in Scheme 2.

$$LOD = 3s/m$$
 (2)

where s is the standard deviation peak currents of blank; m is the slop of the calibration curve.



Scheme 2. Oxidation of uric acid mechanism

Also, Table 1 represents the similarity of the analytical presentation of SMD/poly(methyl red)/GCE by adding modified electrodes for the determination of UA in  $\mu$ M in the literature.



**Figure 7.** Cyclic voltammograms of UA in 0.2 M PBS solution of pH 7.5 at SMD and poly(methyl red) MGCE at different Concentrations.



**Figure 8.** A Scatter Graph of UA in 0.2 M PBS solution of pH 7.5 at SMD and poly(methyl red) MGCE at Scan rate 0.05 Vs<sup>-1</sup> with different Concentrations

**Table 1.** The similarity of analytical presentation of SMD/poly(methyl red)/GCE by adding modified electrodes for the determination of UA in  $\mu$ M in the literature

Electrode	Limit of Detection in µM	Method	References
Pdop@GR/MWCNTs	15.0	CV	[33]
Penicillamine-Au	1.0	DPV	[35]
PdAg NFs/rGO/GCE	0.081	CV	[40]
RGO–ZnO/GCE	1.08	CV	[41]
Fe <sub>3</sub> O <sub>4</sub> @Au-GA/GCE	0.05	CV	[42]
GR/PVP/GCE	2.0	CV	[43]
SMD/poly(methyl red)/GCE	3.020	CV	This work

# 3.3. The effect of pH

The pH effect on the peak potentials of UA at SMD/poly(methyl red) MGCE was determined. The pH of PBS essentially affects the oxidation of UA, and it is precisely renowned by the CV procedure. Figure 9 shows poise at retort of cyclic voltammetry of 0.2  $\mu$ M UA at SMD/poly(methyl red) MGCE at the pH varying continuedly from 5.5 to 8.0. Thus, E<sub>pa</sub> obtained values ranging from 0.2818 to 0.3619 V. The results described and attractive at pH of 0.2 mM PBS the potentials of oxidation were changed to the further positive bearing. The anodic peak potentials (E<sub>pa</sub>) *vs.* pH graph undoubtedly notifies the catalytic oxidation potentials to depend linearly on the pH with the slope of 0.03165 V/pH (r<sup>2</sup>=0.98003), and it was shown in Figure 10. This exposes the participation of an equal number of electrons and protons in nearby exploit mechanisms. This was revealed by the preceding reports [31,32,40-43].



**Figure 9.** A Scatter graph of UA oxidation peak potentials at SMD and poly(methyl red) MGCE at pH 5.5 to 8.0



**Figure 10.** Cyclic voltammograms of 0.5 mM UA at SMD and poly(methyl red) MGCE in 0.2 M PBS at various pH

# **4. CONCLUSION**

In this research work, the electrocatalytic activity of GCE was improved with means construction of a demean ring of SMD/poly(methyl red) layer on its exterior all the way through electro-ionic deposited and polymerization techniques. The revised make cleared the strapping electrocatalytic of SMD/poly(methyl red) MGCE towards the oxidation of UA. The pH study makes to know the contribution of an equal number of protons and electrons in the redox mechanism. The electrode personalized procedure explains the good catalytic activity of UA with elevated sensitivity.

# **Declarations of interest**

The authors declare no conflict of interest in this reported work.

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