BIOANALYTICAL METHODS AND SENSOR TECHNOLOGIES | OSALUSI CHRISTOPHER (27689198)

|  |  |  |  |
| --- | --- | --- | --- |
| **Concentration 1 (Paracetamol)**  **(mg L-1)** | **Concentration 1**  **(Paracetamol)**  **(micromole/L)** | **Concentration 2**  **Solution**  **(mgL-1)** | **Concentration 2**  **Solution**  **(micromole/L)** |
| 200 | 1323.07509 | 50 | 330.768733 |
| 200 | 1323.07509 | 25 | 165.384386 |
| 200 | 1323.07509 | 10 | 66.1537546 |
| 200 | 1323.07509 | 5 | 33.0768733 |
| 200 | 1323.07509 | 1 | 6.61537546 |

(1a)

**Calculations**

To Convert mg/L to µmol/L

1. Paracetamol Molar Mass is 151.163. Convert mg/L to µmol/L

When mg/L is 200mg/L

200mg × 1000µg x 1µmol = 200,000 = 1323.075µmol

mg 151.163 151.163

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mg 151.163 151.163

Concentration 2 Solution (mgL-1)

* When mg/L is 50

Molar Mass of Paracetamol is 151.163

50mg × 1000µg × 1µmol = 50,000 = 330.768µmol

mg 151.163 151.163

* When mg/L is 25

Molar Mass of Paracetamol is 151.163

25mg × 1000µg × 1µmol = 25,000 = 165.384µmol

mg 151.163 151.163

When mg/L is 10

Molar Mass of Paracetamol is 151.163

10mg × 1000µg × 1µmol = 50,000 = 1511630µmol

mg 151.163 151.163

* When mg/L is 5

Molar Mass of Paracetamol is 151.163

5mg × 1000µg × 1µmol = 5,000 = 33.0768µmol

mg 151.163 151.163

When mg/L is 1

Molar Mass of Paracetamol is 151.163

1mg × 1000µg × 1µmol = 1,000 = 6.6153µmol

mg 151.163 151.163

(1b)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Concentration**  **(MgL-1)** | **Peak Intensity A (Amperes)** | **Peak Intensity B (Amperes)** | **Peak Intensity C (Amperes)** | **Average Mean Intensity (Amperes)** | **Standard Deviation** | **Relative Standard Deviation** |
| 50 | 197. 2199 | 191.7728 | 187.724 | 192.2397 | 3.88 | 2.01 |
| 25 | 92.01471 | 93.40125 | 88.92756 | 91.44784 | 3.49 | 3.81 |
| 10 | 50.35654 | 50.515 | 47.42077 | 49.43077 | 1.42 | 2.87 |
| 5 | 44.08602 | 41.83928 | 40.36503 | 42.09677 | 1.52 | 3.61 |
| 1 | 36.47708 | 31.00453 | 29.82527 | 32.435 | 2.89 | 8.91 |

**Calculations**

To Calculate the Concentration of 50 we sum up the Peak Intensity of A + B + C

3

The Average Mean is equal to the sum of the data value analyzed divided by the count of values in the data set.

AVERAGE SUM = SUM/ COUNT

Peak Intensity A + Peak Intensity B + Peak Intensity C

= 197. 2199 + 191.7728 + 187.7264

3

= 576. 7191

3

= 192. 2397Amperes

STANDARD DEVIATION =

N

= √ (197.2199 – 192.2397)² + (191.7728 – 192.2397)² + ( 187. 7264 – 192.2397)²

3

= √ ( 24.80239) + (0.2179) + (20.3698)

3

= 45. 3

3

= √ 15.13

Standard Deviation = 3.88

Relative Standard = Standard Deviation/Mean × 100

Deviation

= 3.88/ 192.2397 × 100

RSD = 2.01

To Calculate the Concentration of 25 we sum up the Peak Intensity of A + B + C

3 Peak Intensity A + Peak Intensity B + Peak Intensity C

= 92.01471 + 93.40125 + 88.92756

3

= 274.34352

3

Average Mean Intensity = 91.44784 Amperes

STANDARD DEVIATION

= √( 92.01471 - 91.44784)² + ( 93 .40125 – 91.44784)² + (88.92756 – 91.44784)²

3

= √(0.321341) + (3.81581) + (6.3518)

3

= 10.488961

3

SD = 3.49

R S D = Standard Deviation/Mean × 100

= 3.49/91.44784 × 100

= 0.0381 × 100

= 3.81

To Calculate the Concentration of 10 we sum up the Peak Intensity of A + B + C

3 Peak Intensity A + Peak Intensity B + Peak Intensity C

= 50.35654 + 50.515 + 47.42077

3

= 148.29231

3

Average Mean Intensity = 49.43077Amperes

S D = √(50.35654 - 49.43077)² + (50.515 – 49 .43077)² + ( 47.42077 – 49.43077)²

3

= √(0.8575) + ( 1.1755) + (4.0401)

3

= 6.0731

3

= 2.02

= √2.02

SD = 1.42

RSD = Standard Deviation/Mean × 100

1.42/49.43077 × 100

= 0.02872 × 100

= 2.872

To Calculate the Concentration of 5 we sum up the Peak Intensity of A + B + C

3

Peak Intensity A + Peak Intensity B + Peak Intensity C

= 44.08602 + 41.83928 + 40.36503

3

= 126. 29033

3

= 42.09677Amperes

SD = √(44.08602 – 42.09677)² + ( 41.83928 – 42.09677)² + (40.36503 – 42.09677)

3

= √( 3.958) + (0.0663) + (2.998)

3

= 7.0223

3

= √ 2.34

= 1.52

RSD = 1.52/ 42.09677 × 100

= 3.61

To Calculate the Concentration of 1 we sum up the Peak Intensity of A + B + C

3

Peak Intensity A + Peak Intensity B + Peak Intensity C

= 36.47708 + 31.00453 + 29.82527

= 97. 30688

3

= 32.435

SD =

√(36.47708 – 32.435)² + ( 31.00453 – 32.435)² + ( 29.82527 – 32.435)² + (29.82527 – 32.435)²

3

= √ (16.3384) + ( 2.0462) + ( 6.81069)

3

= (25.19529

3

= √ 8.39843

= 2.89

RSD = (2.89/32.435 × 100)

= 0.089 × 100

= 8.91

From my results, it shows that the average current intensity of all concentrations indicate that the data points are centered around each other. On analyzing the standard deviation, we noticed a significant decrease from 50 to 1.

This implies that the data become less dispersed as the sample size decreases and the relative standard deviation shows variability relative to the mean.

(1c)

|  |  |
| --- | --- |
| **Concentration of Paracetamol (mg L-1)** | **Average Current Intensity (Amperes)** |
| 50 | 192.2397 |
| 25 | 91.44784 |
| 10 | 49.43077 |
| 5 | 42.09677 |
| 1 | 32.435 |

**CALIBRATION CURVE OF PARACETAMOL CONCENTRATION VS AVERAGE CURRENT INTENSITY**

The Calibration Curve of Paracetamol Concentration vs Average current intensity gives a Correlation Coefficient of r2 = 0.9833, indicating a strong positive linear relationship between the two variables i.e ; the paracetamol concentration and the average current intensity. This means that if the paracetamol increases, the average current intensities increase. The error bars on the graph illustrate variability of individual measurements.

(1d)

|  |  |
| --- | --- |
| **Paracetamol (micro mole)** | **Intensity of Current (Amperes)** |
| Paracetamol A | 55.35654 |
| Paracetamol B | 51.90719 |
| Paracetamol C | 47.61177 |
| Paracetamol D | 46.52235 |
| Paracetamol E | 45.21505 |

AVERAGE MEAN INTENSITY - 49.32258 Amperes

STANDARD DEVIATION **–** 3.7

RELATIVE STANDARD DEVIATION **–** 7.6

**Calculations**

To Calculate the Average Current Intensity of Paracetamol concentration we sum up the peak intensity of all Paracetamol Concentration

= Paracetamol A + Paracetamol B + Paracetamol C + Paracetamol D + Paracetamol E

5

= 55.35654 + 51.90719 + 47.61177 + 46.52235 + 45.21505

5

Average Mean Intensity = 46. 6129

5

= 49.32258 Amperes

Standard Deviation = √∑〖|x-µ²|

N

*=* √ (55.35654 – 49.32258)² + (51.90719 - 49.32258)² + (47.61177 - 49.32258)² + (46.52235 - 49.32258)² + (45.21505 – 49.32258)²

5

= √ (36.40867) + (6.680208) + (2.92687) + ( 7.84128) + (16.87180)

5

= 70.728628

5

= √ 14.14

Standard Deviation = 3.7

Relative Standard Deviation = Standard Deviation/ Mean × 100

= 3.760/49.32258 × 100

= 7.6

(1e)



The curve shown below was obtained from a voltammetry experiment on paracetamol analysis, which shows that the analysis gives an irreversible reaction the Epa (Anodic peak potential) has only anodic peak potential.

Black Curve : 100mV/s

Red Curve : 80mV/s

Blue Curve : 60mV/s

Green Curve: 40mV/s

(1f)



(1g)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (mg/L) | V/s | √v | Epa (V) | Epc (V) | ΔEp (V) calc | E0’ (V)  ‘calc’ | Ipa  (µA)  ‘exp’ | ipc  (µA)  ‘exp’ | ipa/ipc  ‘calc’ |
| 50 | 0.04 | 0.2 | 0.875 | 0 | -0.875 | 0.4375 | 12.29 | 0 | 0 |
| 50 | 0.06 | 0.24 | 0.86 | 0 | -0.86 | 0.43 | 10.83 | 0 | 0 |
| 50 | 0.08 | 0.28 | 0.89 | 0 | -0.89 | 0.445 | 11.26 | 0 | 0 |
| 50 | 0.1 | 0.31 | 0.90 | 0 | -0.90 | 0.45 | 15.58 | 0 | 0 |

**Calculations**

Epa (V) : Anodic peak potential which is the maximum potential reached during oxidation of a redox reaction on the peak current of paracetamol which are 40mV/s, 60mV/s, 80mV/s and 100mV/s the maximum potential of the values analyzed are 0.875, 0.86, 0.89 and 0.90

Epc (V) : ( cathodic peak potential) There is no cathodic peak potential on the data analyzed.

ΔEp (V) = Epc – Epa

ΔEp (V) = 0 – 0.875

= - 0.875

ΔEp (V) = Epc – Epa

ΔEp (V) = 0 – 0.86

= - 0.86

ΔEp (V) = Epc – Epa

ΔEp (V) = 0 – 0.90

= - 0.90

ΔEp (V) = Epc – Epa

ΔEp (V) = 0 – 0.875

E0 = Epa + Epc

2

E0 = 0.875 + 0

2

= 0.875

2

= 0.4375

E0 = 0.86 + 0

2

= 0.86

2

= 0.43

E0 = 0.89 + 0

2

= 0.89

2

= 0.44

Ipa is the current at the working electrode which is plotted against the applied working electrode potential in which a cyclic voltammogram is traced on the peak current concentration of paracetamol which are 40mV/s, 60mV/s, 80mV/s and 100mV/s The values traced on the electrode potential are 12.29, 10.83,11.26 and 15.58.

(1h)

The reversibility of a redox process is related to the rate at which the electron transfer between the electroactive species and the electrode takes place. The ratio between the anodic and cathodic peak currents (ipa/ipc) is also used to estimate the reversibility of the system. For a less reversible electron transfer, the ratio ipa/ipc will move away from the reversible value (greater or smaller than 1). The peak ratio can be strongly affected by coupled reactions to the main redox process, and thus all the values in the experiment is greater than 1.

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(1i)

0 V +0.197V +0.241

SHE Ag/AgCl SCE

-0.535

▬0.535 ▬ (▬0.197 ▬0.241)

▬0.532 ▬ (▬ 0.044)

= ▬0.491

MODERN APPLICATIONS OF ELECTROANALYTICAL CHEMISTRY | OSALUSI CHRISTOPHER (27689198)

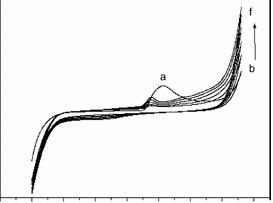
2

1. According to Lin et al., the key advantage of surface modification of electrodes is a significant reduction in overpotential and an increase in the electron transfer rate constant of the desired redox reaction at the electrode. This is obtained primarily for selectivity and sensitive determination.

Another advantage of surface modification is surface grafting, which is used for biosensor construction since the formed interfacial monolayer may serve as a molecular recognition element due to its biocompatibility .

1. The main aim of the experiment is to make use of a monolayer covalent modification of Tryptophan-grafted GCE and 5-hydroxytryptophan for experimental evaluation on glassy electrodes for the simultaneous determination of uric acid and ascorbic acid.
2. The electrode was sonicated in ethanol for 5 minutes and then in water for 5 minutes. The GCE was subjected to potential cycling between -1.7 and 1.8 V at 20 m/s in 0.1 M PBS containing 1.0 mM 5-HTP and 10 mM LiClO4 for several cycles. From this process, 5-HTP molecules could be grafted onto the carbon surface, forming a monolayer electrode denoted as 5-HTP/GCE. The 5-HT and TRP grafted GCEs were prepared and labeled as 5-HT/GCE and TRP/GCE, respectively. These electrodes were stored in 0.1 M PBS at a pH of 7.0 in a refrigerator at 4 degrees before use. After the experiments, the electrodes were subjected to potential cycling in 0.1 M PBS at a pH of 7.0 in a potential window of 0-0.8 V for 25 cycles to activate and renew the electrode surface until a clean and stable background cyclic voltammetry was obtained.

From the figure below, it can be seen that the grafting of 5-HTP on GCE was carried out by several cycles of potential cycling between -1.7V and 1.8V at 20 m/s. It can be observed from the figures that 5-HTP presented an oxidation peak at about 0.591V in the anodic sweeping on the first anodic scan in curve a. There is no re-reduction peak that appeared in the reverse cathodic sweeping, indicating a chemically irreversible oxidation process. The oxidation peak is attributed to the oxidation of the hydroxyl group on 5-HTP to the quinonimine.



1. Randles Sevcik Adsorption on electrode surfaceip=(nF)^2/4RTυAΓ^∗Where Γ∗ is the surface coverage of the adsorbed species in mol/cm2For analyte that diffuses freely (quiescent solution and high concentration of background electrolyte) deviations from i\_p~√υ suggest eitherThe modified layer on the electrode surface was investigated in ACN solutions which gives a cyclic voltammetry in ACN containing 0.1M A small anodic peak appeared at about 1.30V in the first anodic sweeping formed cathodic peak at −0.45V and two re-oxidation peaks were observed at 0.36 and 1.30V respectively which gives a reversible reaction and there is a peak to peak separation with scan rate