

Construction of Coated Selective Electrode with Copper Oxide Nanoparticles and its Comparison with the Conventional Selective Electrode for Determination of Cyproheptadine Hydrochloride

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Abstract

The tremendous advances in nanoscience and nanomaterials have witnessed great success for nanoparticles due to their unique properties, vastly diverse fields, uses, and electrical activity. Scientific researchers in the different and multifunctional activities of nanoparticles prompted to give great attention to these nanoparticles as materials of great usefulness and effective in electrochemical applications as well as for sensing. This study calculated the potential difference after two electrodes were made to estimate the antihistamine drug cyproheptadine hydrochloride (CPH). One is the conventional coated wire electrode and the other is the wire electrode enriched with CuONPs (modified electrode). The results show that the linear range of the conventional selective electrode (I) is range of ($10^{-2} - 10^{-7}$) mol/L, while the linear range of the nanoselective electrode (II) is range of ($10^{-2} - 10^{-8}$) mol/L. The slope of the conventional and nano-electrode enriched with nanoparticles (I, II) is (56.057, 58.143) mV/decade, respectively. We note that the estimation coefficients for the manufactured electrodes (II, I) are (0.9990, 0.9987) consecutively. These results found that the electrode enriched with nanoparticles (modified) is more sensitive and selective and has an advantage over the traditional selective electrode. Its advantage in electrical improvement enabled it to quickly perform the search for the drug under study (CPH) with wide concentration ranges and low limits, in addition to the speed of electrode sensing.

Keywords: Cyproheptadine Hydrochloride, Electrodes, Copper Oxide Particles.

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INTRODUCTION

Cyproheptadine hydrochloride (CPH) can be defined as an anti-allergic drug used to treat or relieve allergic reactions (1) effectively. It reduces or prevents allergic reactions, thus reducing vasodilation and increasing capillary permeability (2-3). It is also used as an appetite stimulant to treat migraines (4) and excessive sweating. It is a sedative and a powerful antihistamine (5). Its frequent use causes coma or death (6), so it was banned for a period of time in China (7), and it is considered an addictive drug (8). Its chemical name is:

[4-(5-Hdibenzo [a, d]-Cyclohepten-5-ylidene)-1-Methylpiperidine Hydrochloride].

As shown in Figure 1.

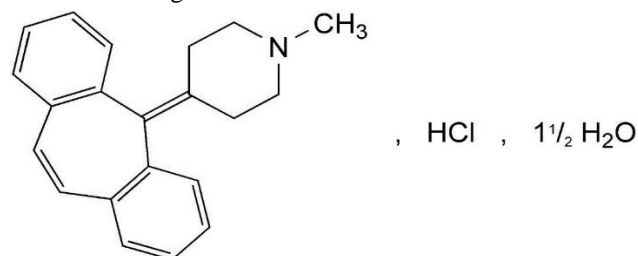


Figure 1: Cyproheptadine hydrochloride

There are many methods for the determination of cyproheptadine hydrochloride in pharmaceutical preparations, such as high-performance liquid chromatography (HPLC) (9), thin layer chromatography (TLC) (10), gas chromatography (GC), spectroscopic method (12), and electrophoresis (13).

Ionic selective electrodes are electrolytic sensors produce an electric potential in their ionic solutions (14). These ion-selective electrodes were discovered by (Willmost-Ostwald) in 1890, which depend on the transfer of ions in the electrolytic solution. The change in voltage of the selective electrode connected to one of the reference electrodes is measured at constant voltage (15-17). After that, the selective electrodes were developed, as the glass electrode was discovered to measure the acidity function pH in 1900 through the potentiometric measurement of hydrogen ions across the sensitive membrane, and these selective electrodes were developed to become sensitive to some ions such as (K^+ , Li^+ , Na^+) (18-19). The ion-selective membrane is of a liquid, solid, or vitreous solution. (20) (Ion-selective electrodes) (ISEs) are among the essential modern electrolytic techniques (21).

Recently, nanoparticles have been a potential key for synthetic electrodes, materials components, the medical field, drug delivery systems, etc. Researchers have continued to develop research in this field due to the good properties and advantages of nanoparticles in manufacturing electrodes with high sensitivity and selectivity⁽²²⁾. Copper oxide is essential in the chemical and physical fields and other sciences⁽²³⁾. The development of the electrode became possible for the strong bonding between copper oxide nanoparticles.⁽²⁴⁻²⁵⁾

MATERIALS AND METHODS

2-1. Chemicals

Sodium hydroxide NaOH, hydrochloric acid HCL, copper nitrate $\text{Cu}(\text{NO}_3)_2$, ammonium (precipitating agent), tetrahydrofuran (THF), cyproheptadine hydrochloride (CPH), polyvinyl chloride Pulp (PVC), diethyl phthalate (DEP), sucrose, glucose, starch, lactose, magnesium stearate.

2-2. Tools and devices:

It is used pH meter (3545 pH Meter) company (Jenway), a device (Jenway) to measure potential difference (mV), the pH Meter of (3545 pH Meter) company (Jenway), and the device (Jenway) to measure the potential difference (mV), saturated calomel electrode (Fisher Scientific Co. Germany) as a reference electrode, a sensitive electrical balance with four-

The experimental study through the prepared electrodes (Conventional selective electrode, nanocrystalline copper oxide coated selective electrode) respectively.

2-5. Preparation of the ion pair CPH-AMM:

Preparation of the CPH-AMM complex by adding 50 ml of each CPH pharmaceutical solution at a concentration of 0.01M and the solution of the precipitated substance AMM at a concentration of 0.01M, Which is the same concentration in a glass beaker while stirring on the magnetic stirrer for half an hour and leaving for a day in a dark place to form a light pink precipitate, then filter and wash The precipitate with distilled water is left for another day at laboratory temperature until it dries, then dried in a thermal oven at a temperature of 80°C.

2-6. Membrane composition and electrode fabrication

To prepare the conventional membrane electrode (I) CPH-AMM-DEP, 0.19 g of PVC was mixed with 0.01 g of the ion pair CPH-AMM in a 5 ml glass beaker and dissolved in 5 ml of THF, then mixed well by a glass stirrer, 0.35 ml of DEP plasticizer was added, then a copper wire was taken. Its length is 5 cm. It was washed well, rinsed with distilled water and Acetone, and left to dry. Placed in a polyethylene tube, one end of the wire is connected to the potential difference device, and the other end 1 cm of the wire is immersed in the membrane solution and left to dry for 5 minutes. The process was repeated several times until a thick layer of membrane

tenths orders Sartorius BL210 S AG GOTTINGEN, Jenway Hot Plate With magnetic stirrer_Germany, electric drying oven (Germany).

2-3. Nanoparticles CuONPs

After preparing 100 ml of 0.1 mol/L copper nitrate solution, take 50 ml of it in a glass beaker and slowly add 100 ml of 0.1 mol/L sodium hydroxide solution to it by burette with constant stirring until the pH becomes 14, then leave it for a day in a dark place to get a black precipitate and then filter it by paper Filtration The precipitate is washed with absolute ethanol and then distilled water several times and left for a day to dry at laboratory temperature, after which it is dried in a thermal oven at 80 °C for 16 hours.

2-4 Preparation of the standard drug solution cyproheptadine hydrochloride (CPH)

Prepared by dissolving 0.877 g of cyproheptadine hydrochloride (CPH) powder (white in color) in the least possible amount of ethanol in a glass beaker on a magnetic stirrer with a temperature of 40 °C to facilitate the dissolution process and added in a volumetric 250 ml vial and completed to the mark with distilled water. This is how we obtained a standard solution At a concentration (10^{-2})/L and then prepare a series of standard molar solutions ranging of (10^{-8} – 10^{-3})ol/L from it by the dilution law, the measured is formed.

To prepare the CPH-AMM-DEP-CuONPs(II) copper oxide-coated nanowire (modified wire electrode) membrane electrode, 0.19 g of PVC was mixed with 0.01 g of CPH-AMM ion pair with 0.005 g of nanoparticles (CuONPs) at Becker 5ml glass and 5ml dissolved THF Then it was mixed well by a glass stirrer and 0.35 ml of the plasticizer DEP was added. A copper wire of 5 cm length was taken, it was washed well and then rinsed with distilled water and then Acetone and left to dry and placed in a polyethylene tube, leaving one end of the wire to be connected to the potential difference device and the other end 1 cm of The wire is immersed in the membrane solution and left to dry for 5 minutes. The process is repeated several times until a thick membrane layer is formed.

2-7. Calibration graph

(20 ml) of series concentrations range of (10^{-8} - 10^{-2}) mol/L of the CPH standard solution were measured at the rate of six readings for each using the fabricated conventional electrode and the selective electrode coated with copper oxide nanoparticles (I, II) paired with the reference calomel electrode respectively, the electrodes are cleaned with distilled water and dried with a tissue after each successive measurement, and the calibration curve is drawn in Excel (2010) using Microsoft office.

2-8. The effect of pH

To find out the effect of the pH on the CPH standard drug solution of concentration (10^{-4} , 10^{-2}) mol/L after adding drops of 0.1M HCL solution and then increasing the pH after adding drops of the base solution For 0.1M NaOH and potentiometric measurement after coupling the manufactured electrodes, the conventional selective electrode and the copper oxide-coated nano-electrode (I, II) respectively with the reference calomel electrode, the electrodes are cleaned with distilled water and dried with a tissue after eachtime the measurement is made, then the curve is drawn by a system Microsoft office (excel 2010).

2-9 Preparation of CPH tablets solution:

Not less than ten cyproheptadine Tablets BP 4mg/tablet (India Company) were finely ground in an agate mortar. The total weight before grinding was 1.4204 grams. Then a weight equivalent to 0.001 mole/L preparation was dissolved in the least amount of ethanolin a volumetric flask of 100 ml and completed to the mark with distilled water, then filtered. and we obtained the solution of the tablets solution with a concentration of 0.001 mol/L, a series of other solutions range of (10^{-7} - 10^{-4}) mol/L prepared by dilution.

RESULTS AND DISCUSSIONS

3-1. The behaviour of manufactured electrode devices

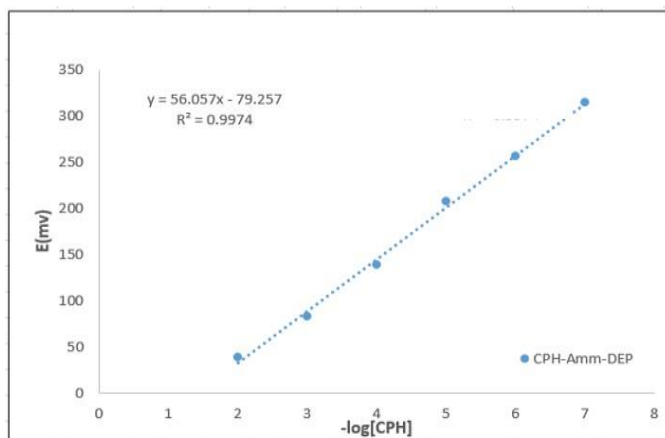


Figure (2): Calibration graph of Conventional Coated Wire Electrode (I) (CPH-AMM- DEP)

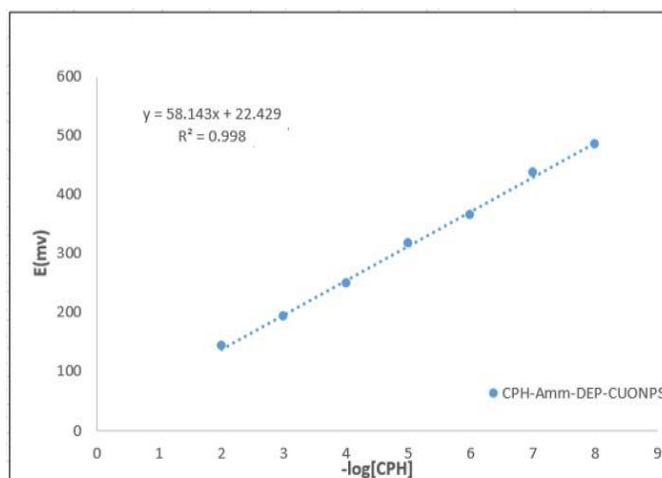


Figure (3): Calibration graph of Electrode for Nano-coated Wire (II) (CPH-AMM-DEP- CuONPs)

Table (1): Electrochemical response properties of conventional electrode wire (I) (CPH- AMM-DEP) and copper oxide nanoparticle (II) electrode wire (CPH-AMM-DEP- CuONPs)

Parameter	(CPH-AMM-DEP(I))	CPH-AMM-DEP-(CuONPs(II))
Slope (mV/decade)	56.057	58.143
Regression equation	56.057x-79.257	58.143x+22.429
Intercept	79.257	22.429
Linear range (M)	(10^{-2} - 10^{-7})	(10^{-2} - 10^{-8})
Correlation Coefficient (r)	0.9987	0.9990
Response time/s	(8-58)	(9-40)
Working PH range	(3.6-2.7)	(3.8-2.7)
Lifetime/day	14	20
Temperature C	25	25
LOD	5.75×10^{-8}	5.12×10^{-9}

The ionic pair (CPH_AMM) is produced from the reaction of the drug (CPH) and the precipitate (AMM) where the ion pair (CPH_AMM) is stable and can dissolve in organic solvents such as (THF) in the presence of PVC and the plasticizer diethylphthalate (DEP) which is a fluidized material The ionic complex makes its dissolution homogeneous and then spreads in the electrode membrane in a uniform manner, where we note through the results shown in the table that the linear range of the conventional selective electrode (I) is range of (10^{-2} - 10^{-7}) mol/L, while the linear range of the nanoselective electrode (II) is range of (10^{-2} - 10^{-8}) mol/L.

It was found that the slope of the conventional electrode and the nano-electrode enriched with nanoparticles (I, II) are (56.057, 58.143), respectively.

We note that the estimation coefficients for the manufactured electrodes (II, I) are (0.999, 0.9987).

Whereas the response time for a conventional selective

electrode is 58 seconds for a concentration of (10^{-2}) mol/L and 8 seconds for a concentration of (10^{-7}) mol/L, While the response time for the selective copper oxide nanoparticles electrode is 40 seconds for (10^{-2}) mol/L concentration and 9 seconds for (10^{-8}) mol/L concentration, and that the life of the conventional coated selective wire electrode is 14 days and 20 days for the copperoxide nano-coated selective electrode and both electrodes (conventional and nano) work at the best temperature of 25°C .

And the detection limit average of six readings for the conventional selective electrodes and the copper oxide-coated nanowire (I, II) electrode is $(5.75 \times 10^{-8}, 5.12 \times 10^{-9})$ mol/L, respectively. The effect of the pH on the response of the conventional and nano- electrodes (I, II) in the estimation of the drug (CPH), it was found that the best range of the acid function in which the conventional electrode works is (2.7-3.6) and (2.7-3.8) for the nano-electrode for the two concentrations of the drug $(10^{-4}, 10^{-2})$ mol/L.

And that the increase and decrease of the acid function may affect the response and work of the conventional and nano-electrodes (I, II) after they were operating in a linear range at pH (2.7-3.6, 2.7-3.8) respectively in the detection of the drug with its solutions of the two manufactured electrodes (the conventional selective wire electrode and the copper oxide nanoparticle-coated selective wire electrode).

The manufactured electrodes (II, I) at the high pH function of any base solution decrease the effort value as a result of the formation of a white precipitate of the medicinal substance CPH or the salt of the drug. In addition to the turbidity of the solution to be measured and the flocculation of the electrode membrane as a result of the increase in the concentration of the hydroxyl ion ⁽²⁷⁾, That is, there is intense competition between the hydroxyl ion and the drug ion towards the site of the double ion, and a decrease in the linear regression occurs due to the decrease in the interaction of hydroxyl ions and drug ions ⁽²⁸⁾.

As for low pH ratios, Any use of HCl, we also notice a (decrease) in the values of the potential difference, and this may explain the reason for the interference of the hydronium ion, That is, the increase of the hydrogen ion, and the formation of hydrogen ion pairs with little sensitivity towards the drug ions, while highly sensitive towards the hydronium ion inside the solution to be measured.

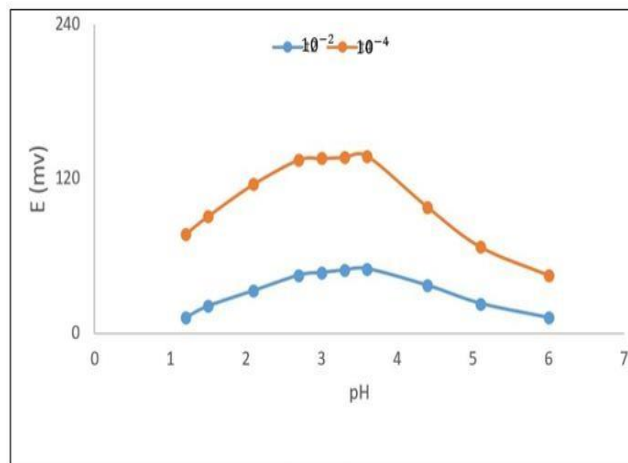


Figure (4): Effect of the acid function on the response of the conventional coated wire electrode (I) (CPH-AMM-DEP)

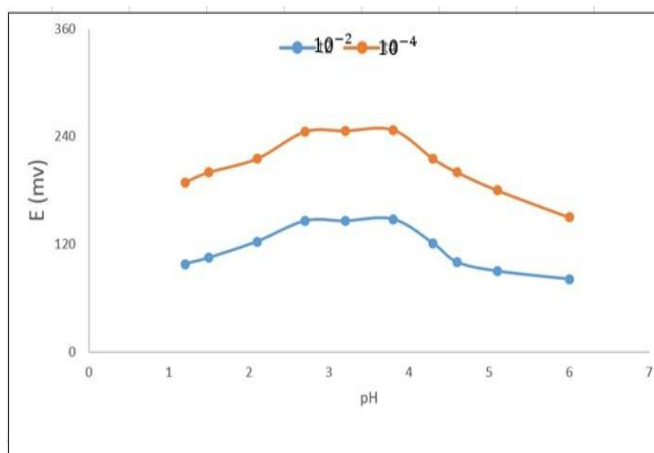


Figure (5): Effect of the pH on the response of the electrode coated with copper oxide (II) nanoparticles (CPH-AMM-DEP-CuONPs)

Table (2): Statistical treatment of the results of the calibration curve for the CPH-AMM-DEP electrode (I)

-Log[CPH] (Taken)	-Log[CPH] (Found)	Recovery%	Relative Standard Deviation RSD%
2	2.11	105.5	0.324
3	2.89	96.3	0.314
4	3.89	97.2	0.261
5	5.11	102.2	0.193
6	5.92	98.6	0.277
7	6.93	99	0.203

Table (3): Statistical treatment of calibration curve results for CPH-AMM DEP-CuONPs (II) electrode

-Log[CPH] (Taken)	-Log[CPH] (found)	Recovery%	Relative Standard Deviation RSD%
2	2.05	102.5	0.199
3	2.93	97.6	0.188
4	3.92	98	0.09
5	5.08	101.6	0.028
6	5.94	99	0.092
7	7.06	100.8	0.082
8	7.95	99.3	0.058

Table (4): values of the selectivity coefficient (K) for each of the manufactured electrodes (I) (CPH-AMM-DEP), (II) (CPH-AMM-DEP-CuONPs)

Interfering ion	$K^{pot}_{i,j}$	
	coated wire electrodes CPH)CPH-AMM-DEP(I) CPH-AMM-DEP CuONPs(II)	
sucrose	0.160	0.046
glucose	0.303	0.168
starch	0.180	0.012
Magnesium Street	0.581	0.024
lactose	0.132	0.022

As we note through the results shown in Table (4) that the selective electrode coated with nano-coated copper oxide (II) for CPH has a higher selectivity than the selectivity of the conventional selective electrode (I) and it turns out that the additives (glucose, sucrose, starch, magnesium stearate, lactose). There is no interference with the ion to be measured because the values of the selectivity coefficient are less than one correct for both the manufactured electrodes, the conventional selective electrode and the selective electrode coated with nano-coated copper oxide (II, I).

CONCLUSIONS

Electrochemistry was studied after the manufacture of two sensor copper wires, one covered with copper nanoparticles (nano-modified electrode) and the other (conventional electrode) to test the drug in its pure form and in the form of a pharmaceutical preparation, and then observe the resultant result of the manufactured electrodes (II, I) it was found that the nano-electrode has high sensing And a fast response time with stable results compared to the traditional electrode and its selectivity is due to the fact that the energy of the drug ion has the freedom of movement starting between the membrane of the electrode and its surroundings (drug solution), due to the good electrical conductivity of nanoparticles, in addition to a larger surface area and small particle size that make it quick to react, and its good physical and chemical properties

make the rapid transfer of drug ions ⁽²⁶⁾ and the fine copper oxide particles (nanoparticle) that were used in making the electrode enhanced the selection of drug analysis to the extent This led to a successful reliance on the nano- electrode in the rapid detection of cyproheptadine in pharmaceutical compounds in addition to research centers.

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