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Construction of Dopamine Hydrochloride Liquid Selective Electrodes

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Abstract

Three liquid selective electrodes were synthesized based on particle pair to selective dopamine chloride. The construction electrodes consist of phosphomolybdic acid (dopamine), di-n-butyl phosphate, Di-n-butyl phthalate, and di-octylphenylphosphonate as plasticizers materials. The construction of preparing probes was examined potentially with successes Nernstain response around 52.50 and 50. 50 mV/decade for electrodes on both DBPH and DOPH were as plasticizers, respectively. The most direct ranges concentrations of dopamine in drug form were found to be around 2.5×10-5-1.0×10-2 for DBPH and 4.30×10-5 -1.0×10-1 M for DOPH. The detection limits were reached to 2.31×10-6 in DBPH and 5. 63×10-6 M in DOPH electrode type. While third electrode relied on di-n-butyl phosphate (DPH), a non-Nernstain equivalent of around 19.10 mV/decade with a range of concentration about 2.2×10-5 -1.0×10-1 with a detection limit equivalent to 6.35×10-6. The pH values in the experimental application were asses to obtain the best determination of dopamine concentration at 10-3M. The optimisation of both electrodes DBPH and DOPH achieved good agreements to lifetime, selectivity, potentiometric techniques and accuracy of measurements. At the same time the standard expansion, various standard expansions and potentiometric titration result in an immediate strategy for the assurance of dopamine in drug form.

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1. Introduction

Dopamine is identified as one of the principal catecholamine neurotransmitters comprehensively scattered in the mammalian psyche and focal sensory system [1]. Dopamine levels can be provided an incite neurological issues such Parkinsonism and schizophrenia. Dopamine salts have been considered in extensive medical applications and the most popular salt is Dopamine hydrochloride. Dopamine hydrochloride is different important clinical prescriptions for bronchial asthma, cardiovascular operation, cardiovascular breakdown, hypertension and renal disappointments related to stun scenes [2]. Recently, it has been reported that dopamine salt has another advantages with in medicine despite being used in diagnostics and obsessive examination in natural liquids it can be used as a significant material during the preparation of various kinds of drugs. The main chemical of dopamine (3,4-dihydroxyphenethylamine, (DA)) is offered as a dynamic compound having a place with the gathering of catecholamine to use in chemical reactions and medical preparations [3]. The substance structure of dopamine hydrochloride is shown in figure 1.

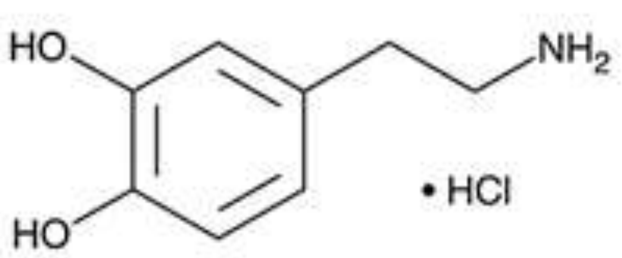

Figure 1. Chemical structure of Dopamine Hydrochloride.

Many medical applications focused on the assurance of dopamine hydrochloride, for example, a touchy and modest strategy is decided dopamine hydrochloride applications in potassium ferricyanide-Fe (III) using spectrophotometry technique [4]. In general, the spectrophotometric process is a good choice for-determining of specific drugs containing amino groups such as metoclopramide, mesalazine, and dopamine in drug preparations [5]. However, during these processes, the concentrations of dopamine in the drug suffer from overlapping in the absorbance especially when it is used with colour mixtures. Auxiliary retention spectra can recently showed a safe method and five subordinate conditions that are utilized for the concurrent assurance of ascorbic acid and dopamine in the UV locale, utilizing second and first auxiliary spectroscopy with high precision at pH assessment of 9.2 [6]. It can be emphasised that the potentiometric technique is created for the assurance of dopamine hydrochloride in the extensive samples used in medical props and there are a large amounts of medical sensors utilizing sodium salt of N-chloro-4-methylbenzenesulphonamide (chlora-mine-T or CAT) and hints of Copper (II) in a cushion vehicle of PH7 [7]. Plasticizer materials are very vital substances that can be considered in different potentiometric selective electrodes [8, 9]. In this paper, three electrochemical sensors were prepared depending on various plasticizer compounds at room temperature; it can promote ~~to~~ determine Dopamine hydrochloride in tablet form responses and is valuable in pharmaceutical applications.

2. Materials and Methods

2.1. Preparation of dopamine electrodes

The potential measurements were made with an adequate stirring. The body of the electrode was fabricated and immobilized with Dopamine-Molybdophosphoric acid (Dopamine-MPA) in a polyvinyl chloride (PVC) matrix membrane. The first step was to examine the chemical reagent grade with purity and used as received of high molecular weight; the (PVC), weighted 0.17 gm to act as a sensing membrane with 0.40 gm of plasticizers (DBPH. DOPH and DBP) and 0.04 gm of ion pair (Dopamine-MPA), 4-6 ml of (THF) was added with stirred, In 5 cm in diameter glass ring, the mixture was poured and allowed to evaporate for 24 hours [9]. By filling 3/4 glass of the tube with a solution of dopamine at a concentration of 0.1 M as an inner filling solution, the design and immobilization were made of the electrode. The membrane got ready by dipping in 0.1 M of Dopamine (standard solution) at a minimum of 2 hours before use for measurements [10, 11].

2.2. Chemical reagents

Standard medication of dopamine forms were applied from (Samara, IRAQ-SDI) drug industries and state companies and medical Appliance as a drug form for testing the electrochemical method. Tetrahydrofuran (THF) was prepared (99.8 % BDH), PVC polyvinyl chloride version Breon S110/10 B. P. Molybdophosphoric acid (PMA) used from (BDH). A Series of different concentrations of chloride salt ions were carried out 0. 1M NaCl, $NaNO_3$, $NaCO_3$, KCl, $CuCl_2$, $ZnCl_2$, $AlCl_3$, $FeCl_3$, starch and glucose corresponding dilute solutions used in various diluted quantities solutions.

2.3. Preparations of plasticizers

Di-n-butyl phosphate [DBP], Di-n-butyl phthalate [DBPH] and Di-octylphenyl phosphonate [DOPH] are chemical plasticizers that were supplied Fluka AG company, these substances are very desirable mechanical properties due to without crystallization and oxidation.

3. Results and Discussion

Three Dopamine-selective electrodes were prepared based on (Dopamine-MPA) in a PVC matrix. From data in figure 2 it can be seen that electrode (Dopamine - DEA and (Dopamine – DEB) electrodes have good agreements to Nernstain replay around 52.50 and 50.50 (mV/decade) for dopamine electrodes (DBPH) and (DOPH) plasticizers. The (Dopamine - DEA and (Dopamine – DEB) were recorded limit detection at 2.31×10^{-6}, 5.63×10^{-6} M respectively. While, Electrode (Dopamine – DEC) was given a non–Nernstain response, the negative responses could happen due to the neutrality of plasticizers, which incorporated as a long alkyl anchor focused on the phosphate gathering. Another issue could probably influence on ion exchange process and the internal and outer ions might be attributed to the effect of steric, which can gradually reduce the bond strength of the compound with an electroactive effect [12]. The data for the calibration curve of Dopamine electrodes can be described in table 1.

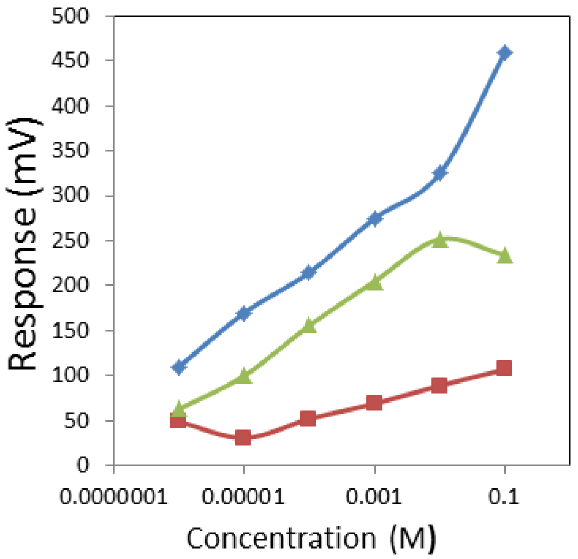

Figure 2. Calibration Curve for Dopamine Electrodes

Table 1. Characterizations of Dopamine Electrodes

Parameters	Electrode DEB	Electrode DEA	Electrode DEC
Slope (mV/decade)	50.50	52.50	19.10
LOD(M)	5.63×10^{-6}	2.31×10^{-6}	6.35×10^{-6}
Correlation Coefficient	0.9983	0.9973	0.9985
Linear Range(M)	4.3×10^{-5} to 1.0×10^{-2}	2.5×10^{-5} to 1.0×10^{-2}	2.2×10^{-5} to 1.0×10^{-1}
Regression (Y = mX + b)	Y=21.932× ln(x)+355	Y=22.8× ln(x)+430	Y=8.295× ln(x)+127.1

3.1. Effect of pH

The application of ion-selective electrodes is dependent on the pH scales to determine the efficiency of the constructed electrode. Here, the ability of electrodes was examined by using 1.0 ×10-3 M of CEX+ particles as a component of pH using HCl for acidic solutions and NaOH in alkane solution for higher than pH 7 to investigate the impact of acidity and alkalinity ions for sensors. The experimental results for pH scales showed that the electrode DBPH has a wider range of pH responses (2.5-7.5) than DEB and DEC electrodes, which were found around (2.5-6.0) and (2.5-4.5) respectively. All the examined solutions were represented in figure 3 and table 2.

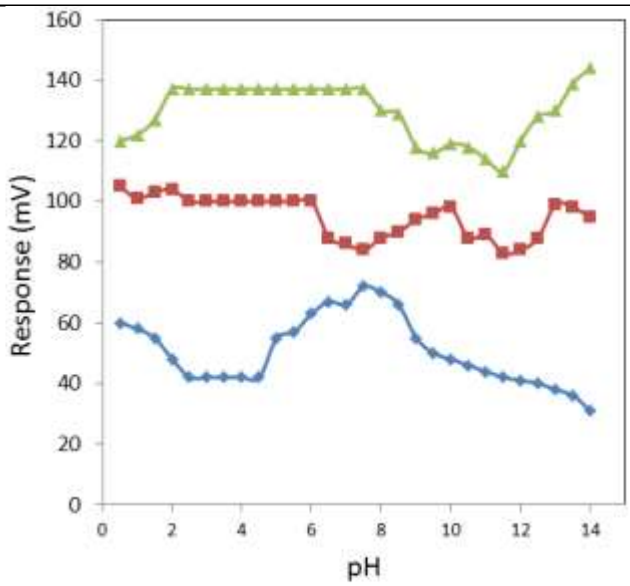

Figure 3. The pH ranges for dopamine electrodes by using 10-3M of dopamine solution

Table 2. Different pH scales for prepared Dopamine electrodes

Electrode type	plasticizers membrane	pH scale
DEA	DBPH	2.5-7.5
DEB	DOPH	2.5-6.0
DEC	DBP	2.5-4.5

3.2. Selectivity Coefficient

Selectivity is an important tool to measure the equilibrium constant for the reaction of displacement ions. Here, the performances of constructed electrodes were examined for different ions. This was assessed by applying the Matched Potential Method (MPM) to understand the ability for per Nernst reply. The applied selectivity coefficient can be seen in the equation below [13, 14]:

$$log(K_{pot}) = \left[\frac{(EB-EA)}{((2.303\,RT)/(zF))}\right] + \left(1-\left(\frac{zA}{zB}\right)\right) log(aA) \quad ...(1)$$

where, *aA, aB* refers to activities for the essential *A* and meddling *B* particles, *EA*, and *EB* the potentials, *zA, zB*=charge numbers, separately at *aA*= *aB*. Data in table.3 showed that mostly no interference for electrode replies and that all ion species were found to be a tiny slighter amount

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which has no influence on the efficiency of the electrode [15, 16].

3.3. Analysis of dopamine samples

The optimization properties of electrodes DEA and DEB were determined by deciding dopamine in different concentrations at 10-4 and 10-3 M [17, 18]. The standard addition method, multi-standard addition methods, titration and direct methods were applied to address the accuracy and performance of work sensors in the current study [19]. Excellent results were recorded in tables 4 and 5 for electrodes DEA and DEB.

Table 3. Selectivity coefficients for dopamine electrodes (DEA, DEB)

Interferences ion	Electrode DEB	Electrode DEA
K^{+1}	7.168×10^{-1}	6.738×10^{-1}
Na^{+1}	7.401×10^{-1}	7.134×10^{-1}
CO_3^{-1}	6.252×10^{-1}	7.292×10^{-1}
NO_3^{-1}	5.629×10^{-1}	7.753×10^{-1}
Cu^{+2}	6.789×10^{-3}	4.703×10^{-3}
Zn^{+2}	9.683×10^{-3}	4.327×10^{-3}
Al^{+3}	2.368×10^{-4}	3.963×10^{-4}
Fe^{+3}	8.432×10^{-4}	5.568×10^{-4}
Glucose	4.670×10^{-4}	3.743×10^{-4}
Starch	5.980×10^{-4}	3.695×10^{-4}

A normal plot for both electrodes DEA and DEB at grouping of concentration (10-3, 10-4) M can be seen in figures 4-7. Table 5 shows good recoveries for electrode (DEA) in direct standard expansion, multi-standard addition and potentiometric titration at 96.77, 97.48, 98.31 and 98.49, respectively, with relative errors nearby to -3.23,-2.52, -1.69 and-1.51, respectively. For dopamine electrode (DEA) relied upon DBPH as a plasticizer at fixed concentrations around 10-3 M and 10-4 M, the recoveries were near 96.64, 96.59, 98.32 and 98.52, respectively with relative errors around (-3.36,-3.51, -1.68 and -1.48). The experimental data in this sensor type can be considered as a useful electrode in different medical uses which also provides valid method in the same materials as other dopamine hydrochloride tables [20]. However, the recoveries of DEB electrodes based on DOPH were found to be around 97.94,97. 58, 97.55 and 98.11 respectively, with relative errors equal to -2.06,-2.42, -2.45 and -1.89 respectively. Furthermore, the examination of fixed concentrations assessed in dopamine solution at 10-3 M and 10-4 M, with recoveries given around 97.60,97.88,96.13 and 98.33 and relative errors equal to -2.40,-2.12, -3.87 and -1.67 as data shown in Table 6.

Table 4. Potentiometric performance for assay of Dopamine samples by using electrode DEA

	Sample	Reply by potentiometric method			
		Direct	SAM	SAMS	Titration
Electrode DEA	1×10^{-3} M	0.9677×10^{-3}	0.9748×10^{-3}	0.9831×10^{-3}	0.9849×10^{-3}
	RSD %	0.75	1.49	-	-
	Recovery %	96.77	97.48	98.31	98.49
	Error %	-3.23	-2.52	-1.69	-1.51
	1×10^{-4}	0.96×10^{-4}	0.96×10^{-4}	0.98×10^{-4}	0.98×10^{-4}
	RSD %	2.84	1.54	-	-
	Recovery %	96.64	96.59	98.32	98.52
	Error %	-3.36	-3.51	-1.68	-1.48

Table 5. Potentiometric performance for assay of Dopamine samples by using electrode DEB

	Sample	Reply by potentiometric method			
		Direct	SAM	SAMS	Titration
Electrode B	1×10^{-3}	0.9794×10^{-3}	0.9758×10^{-3}	0.9755×10^{-3}	0.9811×10^{-3}
	RSD %	0.69	0.98	-	-
	Recovery %	97.94	97.58	97.55	98.11
	Error %	-2.06	-2.42	-2.45	-1.89
	1×10^{-4}	0.9760×10^{-4}	0.9788×10^{-4}	0.9613×10^{-4}	0.9833×10^{-4}
	RSD%	0.42	0.85	-	-
	Recovery %	97.60	97.88	96.13	98.33
	Error %	-2.40	-2.12	-3.87	-1.67

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Table 6. Analysis data for tables in dopamine hydrochloride selective electrode with DOPH plasticizer by direct potentiometric method

Pharmaceutical tablets	**Zyprexa (coated table)**	**Rexapin**
Concentration DOH(prepared)	1.00×10^{-3}	1.00×10^{-3}
Concentration DOH (found)	0.9711×10^{-3}	0.9805×10^{-3}
Recovery %	97.11	98.05
Error %	-2.89	-1.95

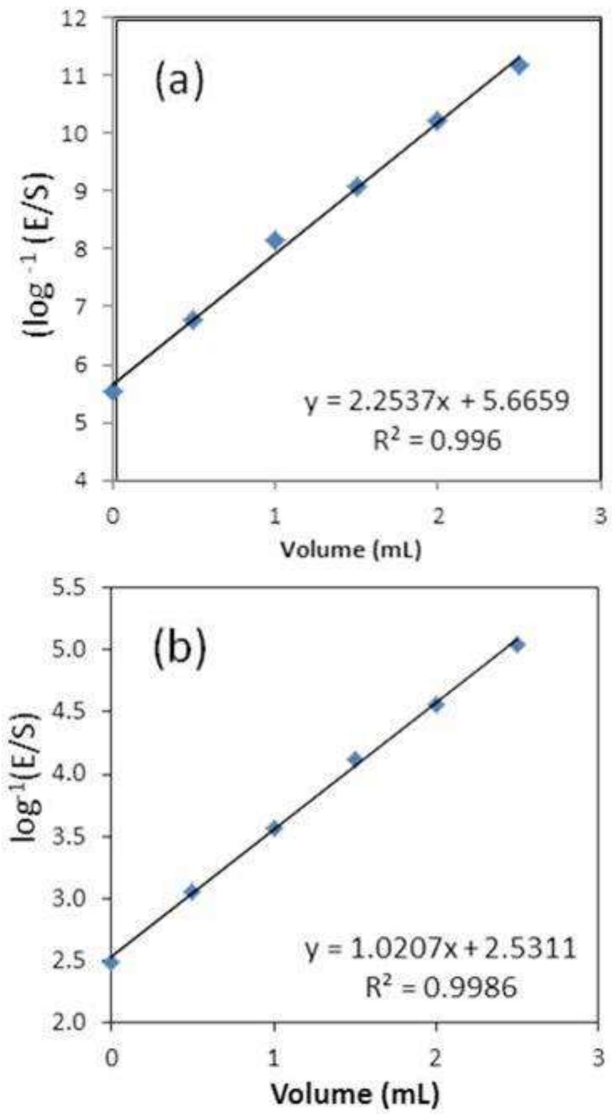

Figure 4. Addition of dopamine relative volumes of a) 10-3 M (b) 10-3 M vs. antilog (E /S) in DEA electrode

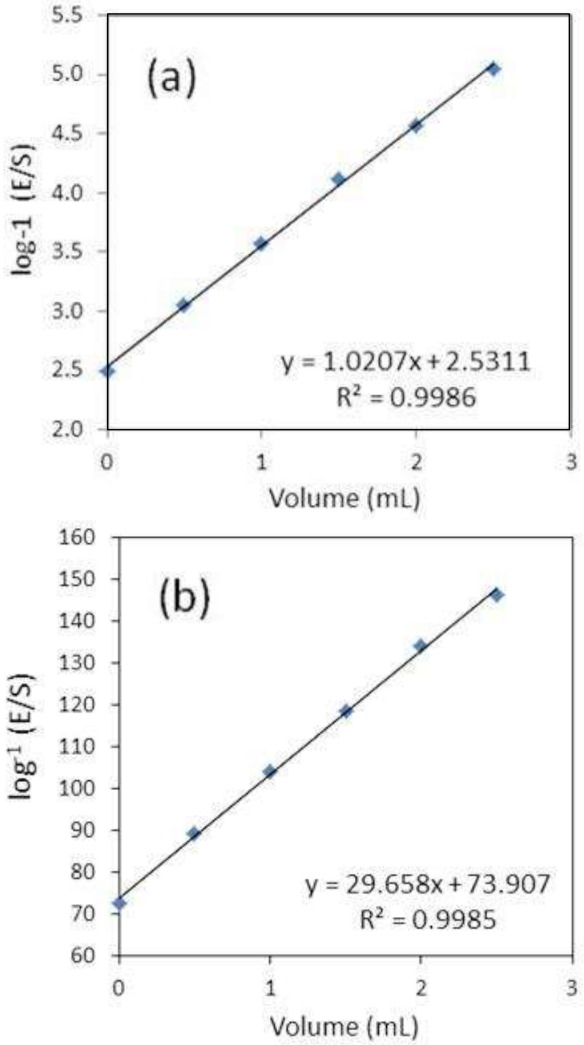

Figure 5. Addition of dopamine relative volumes of a) 10^{-3} M (b) 10^{-3} M vs. antilog (E /S) in DEB electrode

4. Conclusions

The ion Selective Electrodes process in this study is successfully synthesized as a chemical probe that can be easily applied to measure dopamine hydrochloride. The optimization of the electrochemical method provides an important sensor for three plasticizers and phosphomolybdic acid (PMA) to determine manufactured reliance on dopamine hydrochloride. The data showed that DOPH and DBPH electrodes are the most reliable probes than the third constructed electrode. The plasticizer materials achieved good results in potentiometric measurements with a very trace amount of blocks for interfering ions.

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Conflicts of Interest:
The authors declare no conflict of interest.

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