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The pH effect on Polarographic Potential wave of Carvediolol, Atenolol and Propranolol

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ABSTRACT

Reduction potential for carvedilol, atenolol and Propranolol was determined by polarographic style used. Hanging Mercury Dropping Electrode (HMDE), all these pharmaceutical compounds was electro active with half wave potential $E_{1/2}$ of 0.148, 0.112 and 0.118 V respectively, PH effect on the polarographic potential wave was study in phosphate buffer solution with a concentration of 0.98×10^{-5}, 1.12×10^{-5} and 1.15×10^{-5} M for carvedilol, atenolol and Propranolol respectively, the values of pH ranged at 5, 6, 7.4, 8. The result showed that the values of half wave potential $E_{1/2}$ inversely proportional with pH and diffusion current (id) is directly proportional.

KEY WORDS: HMDE, $E_{1/2}$, diffusion current, differential pulse polarography.

1. INTRODUCTION

Polarography is the first important voltammetric technique to be developed which used the dropping Mercury electrode as a working electrode. It is an electrochemical technique in which the current at an electrode is measured as a function of the potential, or voltage applied to the electrode. Polarography is the study of the electrolysis of solution of electrooxidizable and/or electroreducible substance between dropping mercury electrode (DME) and some reference electrode (RE). The potential between these electrodes are varied and the consequent change in the flow current is measured on a plotting the change in current flow versus the potential Variation, the obtaining i-E curve known as polarogram.

Carvedilol, atenolol and Propranolol all classified as beta blocker pharmaceutical compound, which are chemical substance have the ability to block the action of endogenous catecholamine such as adrenaline and noradrenalin upon β-adrenergic receptor, resulting in modifying the sympathetic nervous system activity. It were introduce in the 1960s, and widely used since in the treatment of cardiac disease and hypertension.

The different pharmacokinetic and pharmacodynamics properties of beta blockers classified these drugs into selective or nonselective on the β1 or β2 receptor and whether they do or not have the intrinsic sympathetic activity. Beta blocker with selective properties for the β1 receptor would bind to the cardiac receptor, whereas a nonselective beta blocker would bind to both β1 (cardiac) and β2 (vascular, bronchial smooth muscle and metabolic) receptor.

Although Beta –blocker are similar in its competitive antagonistic action on beta-adrenoreceptors (B1, B2 and B3), but they differ in their intrinsic sympathomimetic activity (ISA), receptor selectivity, vasodilating properties and metabolism and drug half-life. The receptor specificity also effect on the mechanism of the anti-hypertensive mechanism of beta blockers.

2. MATERIALS AND MEASUREMENTS

All chemicals used in this investigation were obtained from commercial sources. Device used was Polarographic analyzer model 797VA supplied from Metrohm made in Switzerland, which have two electrodes rotating disk electrode RDE & Multi - Mode Electrode MME having three modes: Dropping mercury electrode DME, Static mercury drop electrode SMDE and Hanging mercury drop electrode (HMDE). Polarographic cell consisting of three electrodes: a) Working Electrode: The dropping mercury electrode which is normally a cathode of the Polarographic cell, b) Reference Electrode: Silver - Silver chloride electrode immersed in a solution of potassium chloride 3M. (Ag / AgCl / KCl), c) Auxiliary Electrode: It is an inert electrode consist of platinum rod. Also, there is a tube in which the nitrogen gas passes through it into the Polarographic cell.

Preparation of buffer phosphate: Preparation of aqueous solutions of phosphate buffer was occurred by mixing a given volume of Monopotassium phosphate solution 0.0667 M and then complete the volume to 100 mL with Sodium phosphate dibasic dehydrate solution 0.0667M and then it was adjusting pH values by using pH meter.

Preparation of drugs solutions: Aqueous solutions of Carvedilol (M.Wt.=406.5 g/mol.), Atenolol (M.Wt=266.336 g/mol) and Propranolol (M.Wt=259.34 g/mol) were prepared with a concentration of 0.98×10^{-4} M, 1.12×10^{-4} M and 1.15×10^{-4} M by weighing 0.004, 0.003 and 0.003g respectively in 100 mL, as a stock solutions .

3. RESULTS AND DISCUSSION

Optimized polarographic condition was determined for all pharmaceutical compounds, the result showed at table 1, polarographic wave recorded before and after optimization figures 1, 2, and 3.

Table.1.The optimal conditions for DPP of pharmaceutical compounds

Instrumental Conditions	Values		
	Carvedilol	Atenolol	Propranolol
Initial purge time	300 Sec.	300 Sec.	300 Sec.
Drop size	9 mm^3	9 mm^3	9 mm^3
Deposition Time	70 Sec.	35 Sec.	35 Sec.
Equilibration Time	25 Sec.	60 Sec.	0 Sec.
Voltage Step	0.008 V	0.006 V	0.006 V
Voltage Step Time	1 Sec.	0.4 Sec.	0.2 Sec.
Pulse Amplitude	0.05 V	0.05 V	0.05 V
Pulse Time	0.02 Sec.	0.02 Sec.	0.02 Sec.
Initial Potential	- 0.4 V	- 0.4 V	- 0.4 V
Final Potential	+ 0.4 V	+ 0.4 V	+ 0.4 V

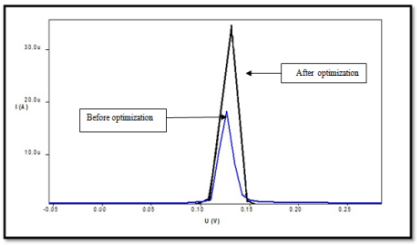

Figure.1. Carvedilol DPP polarogram before and after optimization

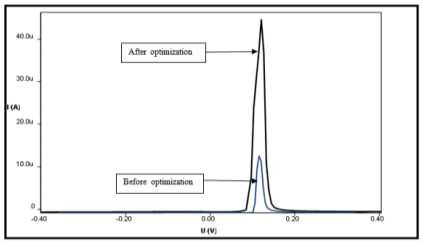

Figure.2.Atenolol DPP polarogram before and after optimization

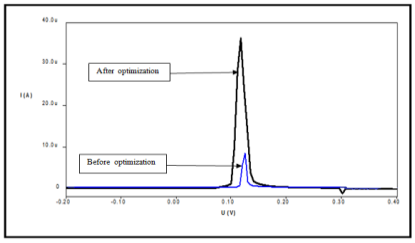

Figure.3. Propranolol DPP polarogram before and after optimization

pH effect on the polarographic potential wave: It is well known that the pH of the media is very important for electrochemical studies. The values of pH of the pharmaceutical compounds aqueous solutions (5.0, 6.0, 7.4 and 8.0) affect the peak current significantly. The influence of pH from 5.0 to 8.0 on E1/2 and Id was studied. For all the compounds, the values of E1/2 decreased with increasing pH value, while Id values increased. So half wave potential E1/2 inversely proportional with pH and diffusion current Id is directly proportional, the results reported in table 2, figures 4, 5 and 6.

Table.2. Effect of pH value on the $E_{1/2}$ and I_d of Carvedilol, Atenolol, Propranolol

pH	Carvedilol		Atenolol		Propranolol	
	$E_{1\backslash 2}$/V	Id/µA	$E_{1\backslash 2}$/V	Id/µA	$E_{1\backslash 2}$/V	Id/µA
5.0	0.187	15.2	0.201	14.7	0.207	14.2
6.0	0.163	17.6	0.159	23.7	0.159	23.4
7.4	0.148	36.4	0.112	42	0.118	36.9
8.0	0.139	38.3	0.104	45.4	0.112	39.2

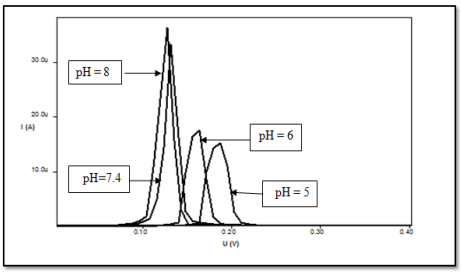

Figure.4. Effect of different pH values on Carvedilol

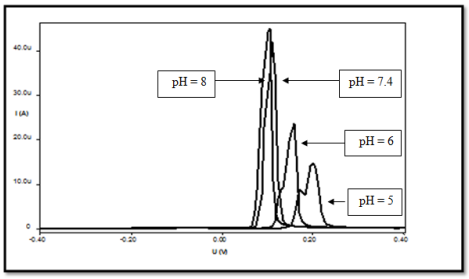

Figure -5: Effect of different PH value on Atenolol

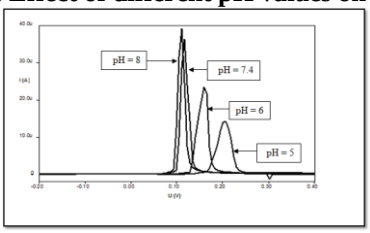

Figure.6. Effect of different pH values on Propranolol

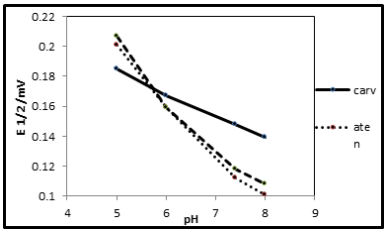

Figure.7. Half-wave potential, relationship with the function of acid

Plotting the E1\2 values vs. pH giving a straight line figure 7, according to the equation[8]

$E_{1\backslash 2} = E^0 + \frac{2.303RT}{nF} \text{ Log } [H^+]$ 1

Where:

pH =- Log [H+] ……..2

Thus:

$E_{1\backslash 2} = E^0 - \frac{2.303RT}{nF} PH$ 3

Replicate behavior can be observed for Atenolol and Propranolol, while Carvedilol has a unique behavior.

From all of the above noted that, the higher pH value was less positively potential value. This conformed to Nernst equation, due to the lower proton concentration.

In the basic media reduction process will be more difficult than in the acidic media, as a result of the little amount of protons in the basic media compared with acidic media. This fully explains the inverse proportionality of pH with the half-wave potential.

As noted above, as the pH of buffer solution increases, there is a gradual increase in the peak current (diffusion current), the peak height depend on the increasing of pH for the buffer solution of pharmaceutical compounds may be due to molecular associated in the basic media as a result of the limited number of protons as well as ease of oxidation process in that circumstance. This means that there are a large number of molecules reaching the electrode surface, leading to increased diffusion current. While in the acidic media, the solutions are in the form of a single mono molecules (Monomers) as a result of the abundance of the number of protons in the solution under study, as well as "for the oxidation process are more difficult, and this means that the number of molecules reaching the electrode surface are a few leading to a reduction limiting current.

4. CONCLUSION

The pH of solutions directly proportion with diffusion current value and reversely proportion with E1/2 value for all pharmaceutical compounds.

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