Voltammetric Studies of Enalpril maleate

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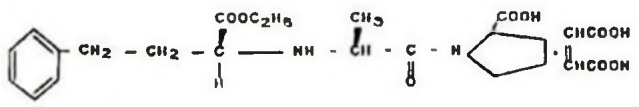
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Conditions for a voltammetric determination of enalpril maleate are optimised after ensuring reproducibility.

Many compounds of pharmaceutical importance (drugs) have been studied by voltammetric techniques [1]. Determination of the drug, enalpril maleate, has been standardised by other methods like HPLC and spectrophotometry [2]. The present communication reports the optimum conditions for the determination by voltammetry.

EXPERIMENTAL

All chemicals used were of AR grade. Solvents were purified by standard methods. Buffers used were made using sodium acetate, disodium phosphate, sodium borate, sodium carbonate and sodium hydroxide. The drug enalpril maleate procured from market, was extracted and recrystallised by established methods [3].



A series of solutions were prepared by weighing 0.01 to 0.1 g of the powdered drug accurately and dissolving in 10 ml of absolute alcohol. Test solutions were prepared by diluting 1 ml each of the above solution to 10 ml with supporting electrolyte (buffer) and used for voltammetric measurement.

BAS model CV-27 voltammograph was used with an X - Y recorder for recording voltammograms. The electrodes - Glassy carbon Model MF - 2012, saturated calomel & platinum - were procured along with the instrument. The GCE was held in triply distilled water. Before use, this was polished with fine grade emery paper followed by 0.5 μm alumina and washed. The instrument was standardised by comparing the ferricyanide-ferrocyanide voltammogram with the standard graph.

Repeated scans leave the electrode surface insensitive and affects the reproducibility of the results. So the electrode was regenerated between successive experiments by repeated scanning in clean water [5,6] followed by polishing with buff cloth on fine grade (0.05

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μm) alumina slurry [7]. The electrode was depolarised by holding at different potential for 2 mins to remove accumulated material off the electrode surface. Such depolarization in combination with repeated scan in clean water and polishing with alumina gave reproducible results.

RESULTS AND DISCUSSION

Only a single peak was obtained during negative scan (E_p = - 0.97 V) indicating a reduction step. No peak appeared in the reverse scan indicating non-reversibility of the electro-reduction. Wring *et.al.* [5] reported a similar behaviour in the case of all-trans retinol.

Repetitive cyclic scans resulted in fall in the peak current. But the i_p of the first scan could be correlated with the actual amount of the species accumulated at the electrode surface. So only i_p of single scan voltammograms are used in subsequent study.

Voltammetry was carried out by holding GCE at fixed known voltage (Accumulation Voltage - AV) in the test solution of the drug for a prefixed time (Accumulation time - AT). Then the potential of the electrode was varied linearly from AV towards negative potential; the direction of scanning was reversed and scanning continued in the positive direction thus completing one cycle.

Certain parameters (like pH, ionic strength, rate of scan, accumulation voltage and accumulation time) influenced the i_p value. These parameters were varied to give the optimum conditions for maximum i_p value.

Optimisation of Conditions for Voltammetry

Voltammogram in acetate buffer (pH 4.5) showed i_p practically equal to zero. The value increased with increase in pH to reach the maximum value at pH = 11.0 (carbonate buffer). At pH > 11, i_p decreased again. So carbonate buffer was used in subsequent studies. Using carbonate buffer and a constant concentration of analyte, the ionic strength in the medium was varied from 0.5 to 0.005M. The corresponding i_p value is listed in Table 1. It is observed that the i_p is maximum in 0.125 M ionic strength.

Table 1

Effect of Ionic Strength (I) of the Buffer on i_p
Buffer Carbonate; pH = 11

I (M)	0.005	0.05	0.075	0.125	0.20	0.35	0.50
i_p μA	0.4	1.4	1.5	1.7	0.1	0.2	0.0

Ionic strength of carbonate buffer is fixed at 0.125 M & the scan rate is varied from 10 to 100 $mV.sec^{-1}$. The plot of i_p *vs* $(\text{scan rate})^{1/2}$ is a straight line with co-relation coefficient (r) = +0.9435 and passes through the origin. However, beyond 80 $mV.s^{-1}$, there is a marked shift in E_p value from -0.97 V towards negative direction. Similar observation is reported by Wang [9] for reserpine &

rescinnamine. A scan rate of 80 $mV.s^{-1}$ is taken as optimum.

By varying accumulation voltage (AV) from -0.41 to -1.40 V, i_p was found to be maximum (1.2 μA) when the electrode was held at -0.68 V. With accumulation volatage of -0.68 V and different accumulation times (15, 20, 60, 300, 480 and 900 sec.) i_p was found to be 2.1, 2.7, 1.5, 1.3 and 0.5 μA respectively. The highest peak current (2.7 μA) was realised for accumulative voltage of -0.68 V held for 20 seconds before the voltammetric scan. Stirring during accumulation time did not give any useful data, so accumulation and voltammetry were carried out in unstirred solutions.

Thus the optimum conditions were 0.125 M aqueous sodium carbonate buffer of pH = 11. (1 ml drug solution in absolute alcohol + 1 ml absolute alcohol + made up to 10 ml with the buffer). The GCE maintained at -0.68 V for 20 sec and voltage scan at 80 $mV.s^{-1}$ gave the peak potential as -0.97 V.

Calibration Graph

Voltammetric study of solutions of different concentrations of the drug (0.001 - 0.01 g in 10 ml) have been carried out maintaining optimum conditions. Calibration graph shows a good linear relation with Pearson correlation coefficient of + 0.990. Enalpril maleate contents in unknown samples have been determined by voltammetric measurement on samples and the calibration graph.

Reproducibility was examined using six different samples (prepared for drugs of 3 different manufacturing companies) by repeating the measurement in each case six times with 6 different, fresh working

Table 2

Results of Statistical Treatment
(Results of Six Repetitive Measurements on Six different Samples)

Calculated Parameter		Batch Numbers 048	047	048	4004	4005	4011
Mean		2.4	2.6	2.3	2.0	2.8	0.6
Range		2.4	1.5	2.3	0.9	1.4	0.3
Mean Deviation		0.57	0.52	0.83	0.23	0.43	0.12
Variance		0.652	0.414	0.98	0.108	0.28	0.022
St. Deviation		0.807	0.643	0.99	0.328	0.529	0.148
95% Confidance Limits	+lim	3.247	3.275	3.339	2.344	3.355	0.755
	-lim	1.553	1.925	1.261	1.656	2.245	0.445
Confidance Interval		1.694	1.35	2.078	0.688	1.11	0.31

solutions. i_p values obtained in repetitive tests were treated statistically. Results are presented in Table 2. This shows the method has good level of accurancy and precision.

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