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Full Length Research Paper

Determination of prednisolone, dexamethasone and hydrocortisone in pharmaceutical formulations and biological fluid samples

K. Balaji, G. V. Raghunadha Reddy, T. Madhusudana Reddy and S. Jayarama Reddy*

Electrochemical Research Laboratories, Department of Chemistry, Sri Venkateswara University, Tirupathi-517502, India.

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A simple, sensitive and accurate voltammetric studies on prednisolone (PE), dexamethasone (DE) and hydrocortisone (HC) were carried out by using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) at bare carbon paste electrode (CPE) and -cyclodextrin modified carbon paste electrode (CDMCPE) in Britton-Robinson (BR) buffer solution. PE, DE and HC show marked enhancement of peak currents at CDMCPE when compared to CPE due to the inclusion complex between keto- group from the drug and -cyclodextrin (modifier) . All these compounds exhibit a well-defined single peak in the studied pH range which is attributed to the reduction of keto-group. BR buffer of pH 3.0 was found to be reliable supporting electrolyte for the analytical estimation of these compounds. CV studies indicate that the process was irreversible and adsorption controlled. The reduction peak currents at CDMCPE for PE, DE and HC changes linearly over the concentration range from 5.6 × 10^{-7} M to 2 × 10^{-5} M (PE), 4.1 × 10^{-7} M to 2 × 10^{-5} M (DE) and 4.2 × 10^{-7} M to 2.5 × 10^{-5} M (HC) with a correlation co-efficient of 0.9991, 0.9986 and 0.9995 for the respective compounds. DPV technique is used for the determination of PE, DE and HC in pharmaceuticals and biological fluid samples. For quantification, standard addition method was carried out in both pharmaceutical formulations and biological fluid samples.

Key words: Prednisolone, dexamethasone, hydrocortisone, β-cyclodextrin modified carbon paste electrode, pharmaceutical formulations, biological samples, voltammetric techniques.

INTRODUCTION

11 , 17 , 21-trihydroxy-1, 4-pregnadiene-3, 20-dione (prednisolone) (Noe, 1998), (11 , 16)-9-fluoro-11, 17, 21-trihydroxy-16-methylpregna-1, 4-diene-3, 20-dione (dexamethasone) (Jayaseelan, 2002) and 11 , 17 , 21-trihydroxy- 4-pregner -3, 20-dione (hydrocortisone) (Noe, 1998), are called as glucocorticoids and also as cortices-teroids which are used as anti-inflammatory agents. Generally they are used in veterinary medicine but in recent years these compounds are extensively used in clinical practices and therapy. These anti-inflammatory agents are available in the market in the form of tablets /capsules and injections. Glucocorticoids are adminis-tered to the people facing shock, skin-allergic reactions, Addison's disease, simmond's disease, tubercularmeni-gities and other meningitis. These compounds are very efficient over a better range of ocular, asthmatics, over whelming infections. Prednisolone (PE), dexamethasone (DE) and hydrocortisone (HC) are available in the form of in various concentrations for local administrations. Usually adults are preferred to take it as at about 0.5 - 10 mg (Drug index, 1999). Since glucocorticoids do not cure the fundamental cause of the disease by themselves and as a result of that, it can cause masking of the real disease for example an infection (Goodman, 1996; Litter 1996).

Different analytical methods mostly chromatographic techniques like reversed phase high performance liquid Chromatography (Deng, 2000), Micellar electrokinetic

*Corresponding author. E-mail: profsjr@gmail.com

capillary chromatography (Noe, 1998), micellar electrokinetic chromatography (Gallego, 2003) and gaschromatography-mass spectrometry (Mclaughlin, 1990; Park, 1990; Delahaut, 1997; Shibasaki, 1997; Polettini, !998; Wasch, 1998,) and liquid chromatographic-mass spectrometric (van den hauwe, 2002) were used to determine glucocorticoids in biological fluid samples. The ion spray mass spectrometry (Cirimele, 2000) and luminal chemiluminescences methods (Iglesias, 2002) were also utilized for the estimation of corticosteroids. Although above methods are widely used, these are time consuming or solvent-usage intensive. Therefore the widespread use of these compounds there is prerequisite for simple, sensitive and accurate analytical techniques to assay the presence of the steroid in pharmaceutical dosage forms and biological fluid samples. The advance in experimental electrochemical techniques in the field of pharmaceutical analysis is due to their simplicity, in most instances no need for extraction, evaporation or derivatization, short analysis time and less sensitive to matrix effects than other analytical techniques. Christine Jayaseelan and Joshi studied the electrochemical determination of dexamethasone sodium phosphate by differential pulse polarography using conventional electrodes (Jayaseelan, 2002).

The usage of modified carbon paste electrodes for electroanalytical measurements has increased day by day in world wide, because of its applicability to the determination of substances that undergo reduction reactions, a matter of rich importance in the field of clinical and pharmaceutical analysis. The -cyclodextirns (-CDs) are the most extensively studied examples of host molecules, which are adequate of forming inclusion complexes with a variety of guests by unifying them within the relatively non-polar cavity (Bender, 1977; Szejtli, 1988). β-CDs are cyclic carbohydrates with seven glucose units, which can hold the carbonyl group. The mole ratio of the host (CDs) to guest is usually 1:1 and 1:2. Due to these reasons there has been increasing interest in the utilization of -CDs as a modifier of organic electrode reactions. Determination of antidepressants imipramine, trimipramine, thioridazine and antihypertensive drug nitindipine has been studied at CDMCPE (Ferancova, 2000) . (Kutner, 1982; Souza, 1997; Petr, 1991) analyzed CD polymers (CDP) as modifiers of metal and carbon electrodes. The complexation abilities and analytical applications of working electrodes modified with cyclodextrin, reviewed by (Ferancova, 2001). The electrochemical behavior of CDs and CD-inclusion complexes were reviewed by (Bersier, 1991). Yoon-Be shim et al. has studied the derivatives of phenols with a β-cyclodextrin modified electrode (Kim, 1996).

The aim of this study was to develop cheap, fully validated, rapid, sensitive and selective voltammetric method for the direct determination of PE, DE and HC in spiked samples of biological fluids without any time consuming extraction or separation steps prior to steroid assay.

EXPERIMENTAL

Reagents and materials

Prednisolone (PE), dexamethasone (DE), and hydrocortisone (HC) are purchased from Sigma, USA, Graphite powder (1 – 2 μm particle size), paraffin oil from Aldrich India Ltd Bangalore. β-cyclodextrin was from Fluka India Ltd. Bangalore All chemicals for the preparation of buffers and supporting electrolytes were reagent grade.

The stock solutions of 1×10^{-3} M PE, DE and HC were prepared in methanol and kept in dark place. More dilute solutions were prepared daily with triple distilled deionized water just before use. The BR buffers were prepared using 0.04 M ortho phosphoric, acetic and boric acids. pH was adjusted by the addition of 0.2 M NaOH solution. The repeatability and reproducibility were checked in the same day (n = 5) and three different days (n = 5) over a week period. They were expressed precisely as standard deviation (SD).

Apparatus

Differential pulse voltammetric (DPV) and cyclic voltammetric (CV) measurements were carried out with a Metrohm 757 VA computrace (Herisau, Switzerland), controlled by electrochemical analysis software; output was a Hewlett Packard plotter. A 50 ml polarographic cell was assembled with bare Carbon Paste Electrode (CPE) or β-cyclodextrin modified carbon paste electrode (CDMCPE) as a working electrode. An Ag/AgCl and platinum wire were used as a reference and auxiliary electrodes respectively. pH measurements were carried out with Metrohm 632 pH meter. All the measurements were made at room temperature (21 ± 2 ^{O}C).

Preparation of modified electrode

Carbon paste electrode was prepared by thorough hand mixing of dry graphite powder and paraffin oil (1:1 w/w) in a mortar and pestle for 20 min. A modified carbon paste electrode was prepared in a similar manner, except that the appropriate amount of β-cyclodextrin was added to it. Both unmodified and modified pastes were packed into an electrode body, consisting of a polyethylene cylindrical syringe (4 mm, i.d.) equipped with a copper wire through the flank of the piston. To get prefect packing, the electrode body was pressed against a filter paper, then the surface of the electrode was smoothed onto the filter paper until it had a shiny appearance.

General analytical procedure

For the voltammetric determination of PE, DE and HC, the following procedure was proposed. The voltammetric cell contained 10 mL of Britton Robinson buffer of pH 3.0. A stream of oxygen free nitrogen gas was passed for 15 min and the blank voltammogram was recorded at pulse amplitude of 50 mV with a scan rate 10 mVs^{-1}. Required concentration of steroid sample was then added using a micro pipette, so that the final PE, DE and HC was varied between 2.1×10^{-7} M and 4.7×10^{-5} M. Solutions were purged with nitrogen (8 min) and voltammograms recorded at accumulation potential of -0.4V, (vs. Ag/AgCl) was applied to the -cyclodextrin modified and unmodified carbon paste electrode for a selected time period while the solution was stirred at 2000 rpm. At the end of the accumulation time period, the stirring was stopped, 10 s was allowed for the solution to become quiescent. Then, the voltam-mograms were recorded by scanning the potential towards the negative direction. All measurements were performed at room temperature 21 ± 2^{O}C.

Procedure for tablets

Commercial formulations of PE, DE and HC are Predigna-5 mg, Wysolone-5 mg, Decdan-5 mg, Ribosan-0.5 mg and Hisone-20 mg, respectively. Five tablets of each formulation of compounds are finely powdered by pestle in a mortar. All these samples are accurately weighed [10 mg (PE), 1 mg (DE) and 20 mg (HC)] and dissolved in methanol and transferred into 10ml calibrated flasks and diluted to the mark with triple distilled deionized water. The contents of the flasks were shaken for 20min and then allowed to settle. The contents are filtered, from this PE (2 to 10 µg/L), DE (0.2 to 1.0 µg/L) and HC (4 to 12 µg/L) were determined using the standard addition method the voltammograms were recorded followed by general analytical procedure.

Analysis of spiked serum samples

Serum samples were collected from healthy individuals (after having obtained their written consent) and stored frozen until assay, and then treated with 1 ml of acetonitrile as serum denaturing and precipitating agent. The samples were vortexed for 10 min and then centrifuged for 5 min at 2000 rpm to remove protein residues. The supernatant of the sample was taken carefully and an aliquot volume of serum sample was spiked with various concentration of steroid sample varied between 2 to 10 µg/L of PE, 0.2 to 1.0 µg/L of DE and 4 to 12 µg/L of HC individually. The voltammograms were recorded followed by the general analytical procedure.

Analysis of spiked urine samples

Blank urine samples were collected from healthy individuals for 24 h filtered through a cellulose acetate filter paper (0.2 µm per size) and were added to the voltammetric cell containing BR buffer of pH 3.0. The voltammograms were recorded for the blank urine sample, then 3 µg/L of PE, DE and HC was individually spiked each time and voltammograms were recorded after each addition followed by the general analytical procedure.

RESULTS AND DISCUSSION

Cyclic voltammetry

Figure 1 shows cyclic voltammograms for PE, DE and HC in BR buffer solution of pH 3.0 at bare CPE and CDMCPE, with accumulation times of 300 and 150s, at an accumulation potential of –0.4 V. All the three compounds yielded one peak on scanning in the potential direction from 0 to – 1.18 V (Vs. Ag/AgCl). The peak was due to the reduction of keto group in the drug by one electron process as described previously by Jayaseelan 2002, the absence of anodic peak in the reverse direction indicates that the reduction of all the three compounds were of irreversible process.

The CDMCPE has better efficiency for accumulating PE, DE and HC in comparison with bare CPE electrode. The reduction peak potentials at bare CPE was obtained at –1.07 V (PE), - 1.05V (DE), and -1.03V (HC), while for the CDMCPE the reductions peak potentials were shifted to more negative potentials about 1.15V (PE), - 1.34V (DE), and -1.08V (HC), which strongly indicates that the preconcentration was possibly due to the formation of complexation between -cyclodextrin and ketone group from the steroid which is in accordance with the Madhusudana Reddy, 2003).

Differential pulse voltammetry

Figure 2, indicates differential pulse voltammograms (DPVs) obtained at bare CPE and CDMCPE of PE, DE and HC in BR buffer of pH 3.0. From the obtained results the peak current obtained at CDMCPE was almost twice than compared with bare CPE of concentration 4×10^{-6} M. To reduce the risk of slight solubility nature of β-CD in water, paraffin oil is used as an organic binder because it lowers the solubility of β-CD. There by reducing the risk of instability of the CDMCPE during analysis of PE, DE and HC. Various quantities of β-CD contents were examined (0, 15 ,20, 25, 35, 40, 60% w/w) and was found that on increasing the β-CD content in the carbon paste, increases the peak current of PE, DE and HC, however above 60% of β-CD content in the electrode was not useful, due to low sensitivity by high resistance of the CDMCPE. So, for the analysis of PE, DE and HC, the net composition of β-CD was chosen as 50% in the carbon paste.

The stability of CDMCPE

A well defined peak of PE, DE and HC could be obtained after modification of the electrode with 50% w/w of β-CD at temperature (21 ± 2^{o}C), and the peak current remains the same after placing the electrode in the BR buffer solution of pH 3.0 for 3 h. The peak current (i_p) values were perceived every 30 min with a relative standard deviation of 6.4% (n=10), the results indicate that the electrode has good stability.

pH dependency

The effect of pH on the PE, DE and HC at CDMCPE was studied. The i_pVs pH plot

(Figure 3), reveals that peak current is maximum in the pH 3 - 3.8. The results from the overall the experiment stands that shapes of curves were nearly same in all cases, however the current intensity in BR buffer is higher than acetate and phosphate buffers. 0.04 M concentrations of the BR buffer of pH 3.0 were selected to carry out for further analysis. The peak potential (E_p) moved towards less negative values as the pH of the buffer is increased.

Effect of accumulation time

The effect of accumulation time was studied in BR buffer of pH 3.0 for 4×10^{-6} M concentration of PE, DE and HC (Figure 4). The DPV signal at CDMCPE increased linearly with an increase in the accumulation time up to

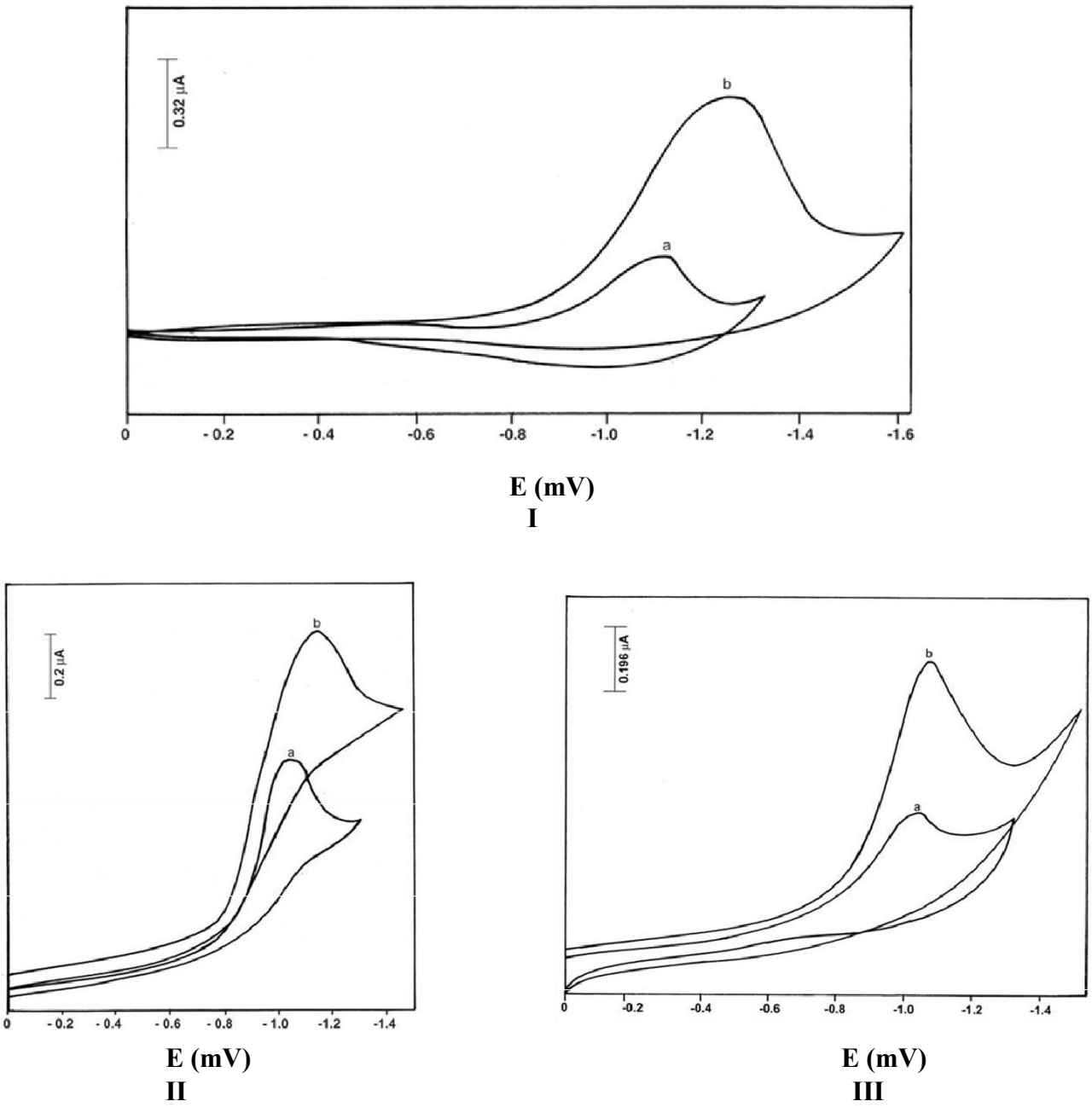

Figure 1. Typical CV of 4 × 10^{-6} M (I) Prednisolone (II) Dexamethasone (III) Hydrocortisone at (a) bare CPE; (b) CDMCPE in BR buffer of pH 3.0,) . Accumulation time 300 s at bare CPE and 150 s at CDMCPE, accumulation potential -0.4 V, rest time 30 s, stirring rate 2000 rpm and scan rate 10 mV/s.

150 s. As the time exceeds 150 s, the peak current showed deviation from linearity, indicating that complete coverage of the analyte on the surface of CDMCPE was obtained. The preconcentration time at bare CPE was 300 s and, at CDMCPE, 150 s. The maximum peak current was observed at CDMCPE, and, moreover, the uptake of the drugs at CDMCPE was faster than bare CPE. The accumulation time of 150s at CDMCPE was was selected for the three compounds for further studies.

Effect of accumulation potential

The effect of an accumulation potential on DPV peak current of PE, DE and HC with a preconcentration time of 150 s at CDMCPE was studied. The developed peak current was found at a potential of –0.4 V, this is due to

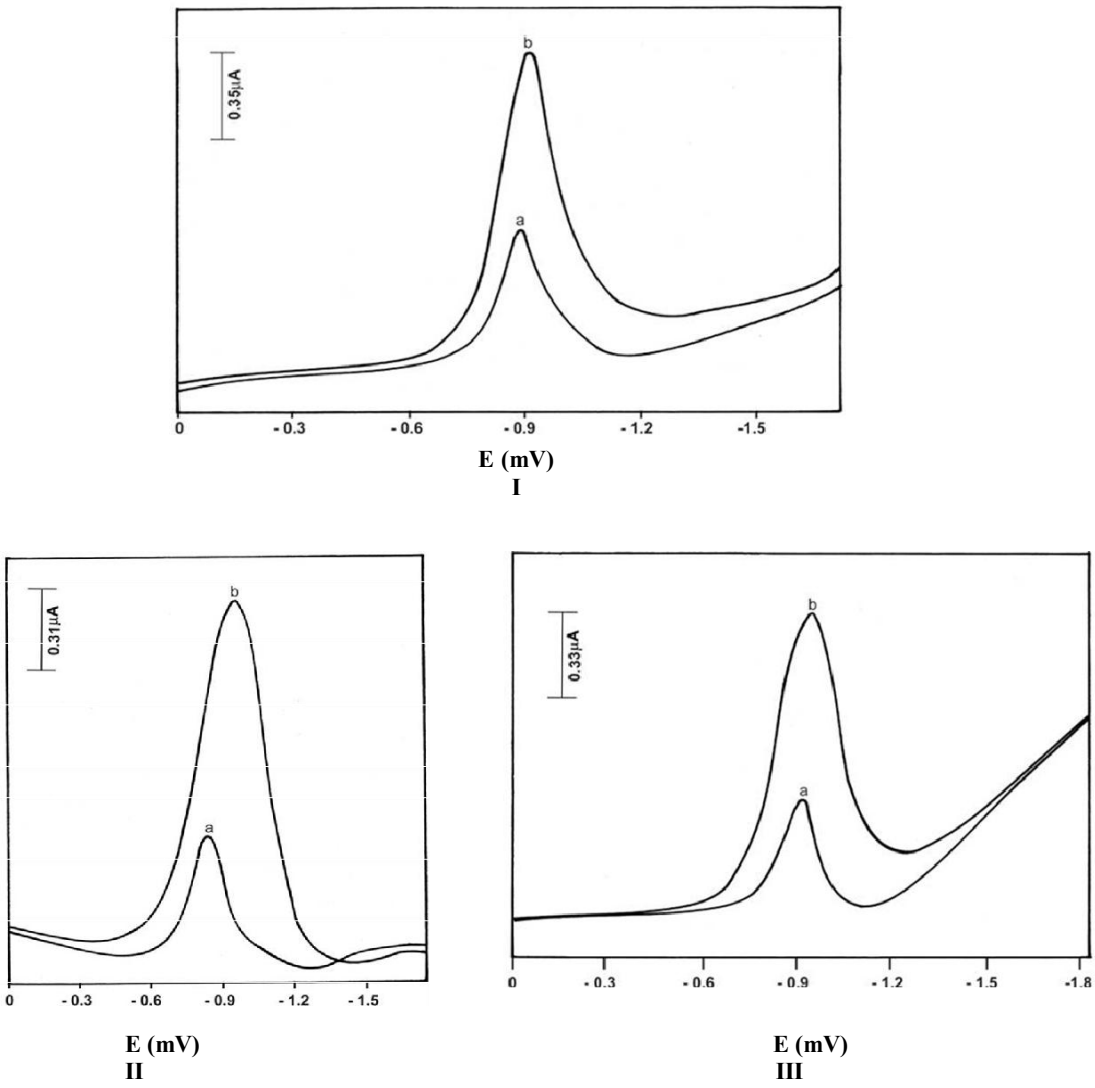

Figure 2. Typical DPV of 4 × 10^{-6} M (I) Prednisolone (II) Dexamethasone (III) Hydrocortisone at (a) bare CPE; (b) CDMCPE in BR buffer of pH 3.0. Accumulation time 300 s at bare CPE and 150 s at CDMCPE, accumulation potential -0.4 V, rest time 30 s, stirring rate 2000 rpm, pulse amplitude 50mV and scan rate 10 mV/sec.

the more favorable alignment of the molecules by the electric field at the electrode- solution interface. For the potentials higher than –0.4 V, the peak currents started decreasing. Hence the accumulation potential of –0.4 V was used throughout the experiment.

Instrumental parameters

The obtained peak currents in DPV depends on different instrumental parameters, those are scan rate, stirring rate and pulse amplitude. It was found that these parameters had interrelated effects on the peak current response and little effect on the peak potential. Table 1 shows the selected working conditions.

Determination of PE, DE and HC in pharmaceutical dosage forms

When working on standard solutions and according to the obtained validation parameters, results encourage the use of the proposed method described for the assay of glucocorticoids in pharmaceutical dosage forms and spiked biological samples. On the basis of above results, DPV technique was applied to the direct determination by using CDMCPE in pharmaceutical formulation forms, the accuracy of the method using CDMCPE was determined by its recovery during spiked experiments. The results for the standard addition procedure using DPV proposed method applied to these samples are shown in Table 2;

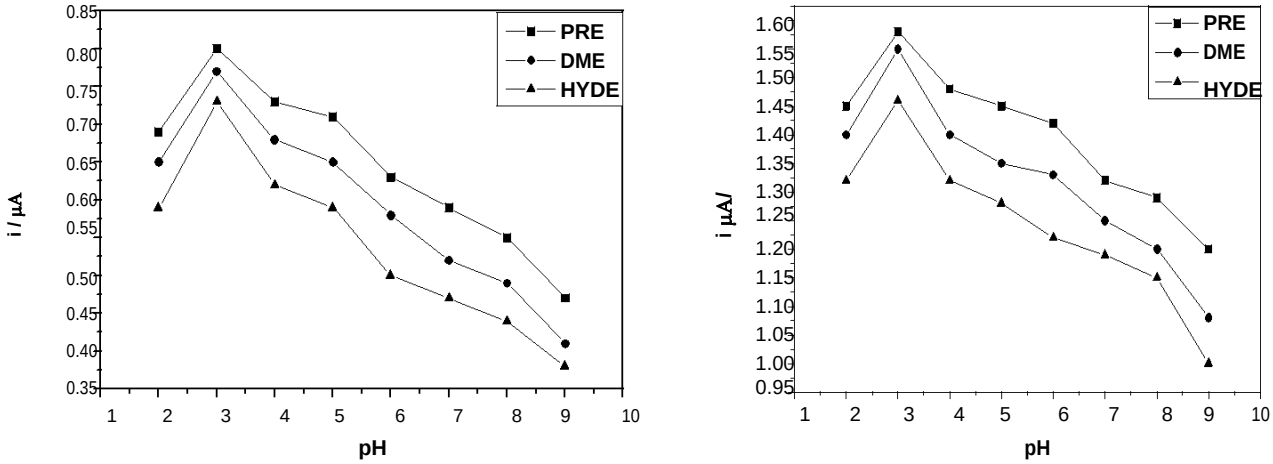

Figure 3. Effect of pH on the analytical signal of PE, DE and HC. Measurements taken in a 4×10^{-6} M of concentration solution (PE, DE and HC) in BR buffer at pH 3.0, remaining data from fig.3 at a bare CPE and CDMCPE.

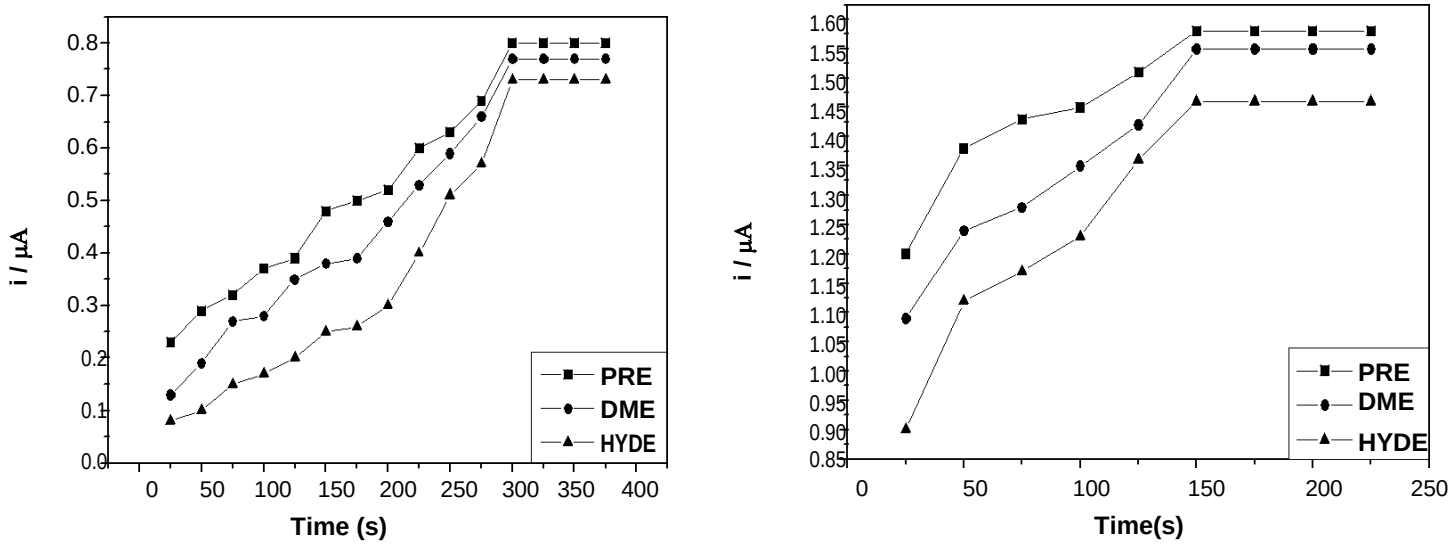

Figure 4. Effect of accumulation time on the analytical signal of PE, DE and HC. Measurements taken in a 4×10^{-6} M of concentration solution (PE, DE and HC) solution in BR buffer at pH 3.0, remaining data from Figure 3 at a bare CPE and CDMCPE.

Table 1. Selected experimental parameters and values

Parameters	Selected Values
pH	3.0
Buffer Volume (ml)	10.0
Temperature (^{0}C)	21±2
Purge Time (min)	8
Accumulation Potential (V)	- 0.4
Accumulation time (s)	150
Rest time (s)	10
Stirring rate (rpm)	2000
Scan rate (mVs^{-1})	10
Pulse amplitude (mV)	50

the recoveries of PE, DE and HC from the pharmaceutical samples are satisfactory with the mean of recoveries 97.79, 97.26 and 98.39%.

There was no interference found from the excipients in the tablets analyzed by the present method. The mean recovery values achieved with CDMCPE as a working electrode was found to be in close agreement with the values obtained by the MEKC and DPV method in pharmaceuticals for PEA and DSP (Mclaughlin, 1990; Jayaseelan, 2002).

This means that the proposed procedure should be applicable to the analysis of this and other similar type of formulation products that contain PE, DE and HC with great success.

Table 2. Analysis of pharmaceutical formulations by DPV in BR-buffer at pH 3.0

Name of the Glucocorticoids	Formulations	Labeled amount (mg)	Average amount (mg) n = 3	Recovery percentage (%)	± S.D
PRE	Predigna	2	1.97	98.5	± 0.2549
		4	3.90	97.5	± 0.2645
		6	5.98	99.66	± 0.2560
		8	7.80	97.5	± 0.2236
		10	9.8	98.0	± 0.2530
DME	Wysolone	2	1.95	97.5	± 0.2549
		4	3.88	97.0	± 0.2645
		6	5.92	98.66	± 0.2560
		8	7.85	98.12	± 0.2236
		10	9.7	97.0	± 0.2530
	Decdan	0.2	0.19	97.5	± 0.2550
		0.4	0.4	1.00	± 0.2000
		0.6	0.57	95.0	± 0.2555
		0.8	0.78	97.5	± 0.3000
		1.0	0.98	98.0	± 0.3536
		0.2	0.19	98.5	± 0.3262
HCE	Ribosan	0.4	0.39	97.5	± 0.3000
		0.6	0.58	96.66	± 0.3535
		0.8	0.79	98.75	± 0.2236
		1.0	0.97	97.0	± 0.2549
		4	3.97	99.25	± 0.2530
	Hisone	6	5.85	97.50	± 0.3535
		8	7.83	97.85	± 0.2828
		10	9.7	97.0	± 0.3464
		12	11.5	95.83	± 0.3540

n = mean of three experiments

Determination of PE, DE and HC in spiked serum samples

The differential pulse voltammograms of PE, DE and HC at CDMCPE in spiked serum samples are shown in Figure 5 and the recoveries are presented in Table 3. No extraction or pretreatment steps, except the centrifugal separation of protein were required prior to the assay of the glucocorticoids. The percentage recovery of PE, DE and HC was determined by comparing the peak currents of a known amount of drug concentration in serum with their equivalents in related calibration curves. The mean recovery of PE, DE and HC were found to be 96.44, 96.53 and 97.21%.

Determination of PE, DE and HC in spiked Urine samples

The DPV of a dilute urine sample (9:1, BR buffer/urine mixture) to which no PE, DE and HC was added for blank studies, then 1 – 9 μg/L of PE, DE and HC was added, and DPV was recorded. It was watched that the peak currents increase with increase in concentration of the analytes at the same time interference studies were obs erved and found no interferences of acids, urea, salts and metals which are generally present in urine. The average recovery of PE, DE and HC in spiked human urine was found to be 96.35, 96.50 and 97.03%. This confirms the good selectivity of the method.

Calibration plots and limit of detection of CDMCPE

The dependence of the DPV peak current on PE, DE and HC concentration for an accumulation time of 150 s at – 0.4 V in BR buffer, pH 3.0, shows a linear relationship from 5.6×10^{-7} M to 2×10^{-5} M for PE, 4.1×10^{-7} M to 2×10^{-5} M for DE and 4.2×10^{-7} M to 2.5×10^{-5} M for HC with the equations Y(μA) = 0.3055X-5 × 10^{-8} (PE), Y(μA) = 0.39386X-3 × 10^{-8} (DE) and Y(μA) = 0.364X-5 × 10^{-8} (HC) at CDMCPE. The LOD and LOQ were calculated using

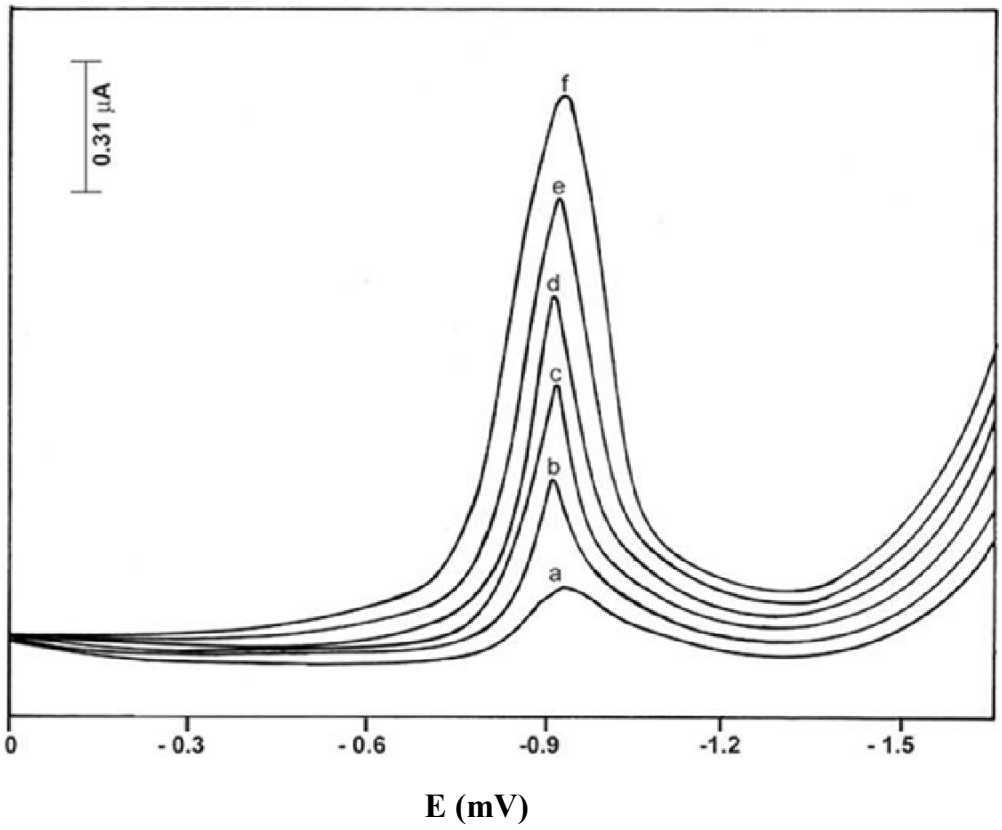

Figure 5. DPV of Prednisolone (4×10^{-6} M) in human serum sample of BR buffer pH 3.0 at CDMCPE (a) blank run (b-f each spike 2.5 µM) of prednisolone. Accumulation time 300sec at bare CPE and 150 s at CDMCPE, accumulation potential -0.4 V, rest time 30 s, stirring rate 2000 rpm, pulse amplitude 50 mV and scan rate 10 mV/s.

Table 3. Determination of PE, DE and HC in spiked human serum samples by DPV in BRB of pH 3.0 at CDMCPE

Name of the Glucocorticoids	Amount Spiked (µg/L)	Average amount found (µg/L) n=3	Recovery percentage (%)	± S.D
Prednisolone	2	1.95	97.50	± 0.2236
	4	3.92	98.00	± 0.2915
	6	5.75	95.88	± 0.2828
	8	7.75	96.87	± 0.2236
	10	9.40	94.00	± 0.2549
Dexamethasone	0.2	0.19	95.00	± 0.2236
	0.4	0.39	97.50	± 0.2345
	0.6	0.58	96.66	± 0.3000
	0.8	0.78	97.50	± 0.3000
	1.0	0.96	96.00	± 0.2549
Hydrocortisone	4	3.94	8.50	± 0.2236
	6	5.80	96.66	± 0.2915
	8	7.78	97.25	± 0.2738
	10	9.70	97.00	± 0.3000
	12	11.50	96.66	± 0.2236

n = mean of three experiments

Table 4. Experimental data of PE, DE and HC

Parameters	Prednisolone		Dexamethasone		Hydrocortisone	
	CPE	CDMCPE	CPE	CDMCPE	CPE	CDMCPE
Linearity range (M)	4×10^{-6} to 3×10^{-5}	5.6×10^{-7} to 2×10^{-5}	4×10^{-6} to 2×10^{-5}	4.1×10^{-7} to 2×10^{-5}	4×10^{-6} to 2×10^{-5}	4.2×10^{-7} to 2.5×10^{-5}
Calibration curve equation	Y(μA)=0.1362X+ 2×10^{-7}	Y(μA)=0.3055X- 5×10^{-8}	Y(μA)=0.167X- 1×10^{-7}	Y(μA)=0.39386X- 3×10^{-8}	Y(μA)=0.154X+ 1×10^{-7}	Y(μA)=0.364X-5 × 10^{-8}
Correlation coefficient	0.9950	0.9991	0.9915	0.9986	0.9998	0.9995
L.O.D (M)	1.0×10^{-6}	4.8×10^{-7}	1.5×10^{-6}	3.6×10^{-7}	0.7×10^{-6}	3.7×10^{-7}
L.O.Q (M)	0.333×10^{-5}	1.599×10^{-6}	0.50×10^{-5}	1.199×10^{-6}	0.2331×10^{-5}	1.233×10^{-6}
Repeatability of peak currents (%RSD)	6.24	6.54	6.21	6.44	6.26	6.59
Repeatability of peak potentias (%RSD)	0.54	0.42	0.56	0.44	0.53	0.46
Reproducibility of peak currents (%RSD)	6.48	6.54	6.50	6.56	6.44	6.53
Reproducibility of potentials (%RSD)	0.60	0.53	0.63	0.55	0.61	0.51
Numbers of assays	12	12	12	12	12	12

the equations, LOD = 3 S.D./m,LOQ = 10 S.D./m. Here 'S.D.' is the standard deviation of the peak currents and 'm' is the slope of the calibration curve. The precision of the methods were evaluated by repeating six experiments on the same day in the same standard solution (repeatability) and over 10 days from the different standard solutions and different electrodes of same composition (repro-ducibility) repeating the experiments for 12 times. To study these experiments the selected concentration of the stock solution was 4×10^{-6} M. The statistical parameters are shown in Table 4. Stock solutions of PE, DE and HC show same peak current values even after a month without any appreciable change; which confirms the stability of the solutions.

Conclusions

In conclusion, an effective accumulation of the glucocorticoid molecules in β-CDs as the electrode modifier has been found. The CDMCPE represents an inexpensive sensor well fitted for the simple and sensitive voltammetric determination of organic keto group forming inclusion complexes with the supported host. The elected electroanalytical method (DPV) proved to be suitable for the selective measurements of PE, DE and HC in pharmaceutical formulations, and biological fluid samples, without any preliminary treatment. The procedure was precise; it did not require time-consuming extraction or pretreatment steps prior to the drug assays, other than the centrifugal separation of protein from human serum samples.

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