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SHORT COMMUNICATION

Voltammetric Determination of Piroxicam after Incorporation within Carbon Pastes

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ABSTRACT

An accurate voltammetric method for the piroxicam determination at solid state, with a detection limit of 0.47 mg/g, is described. The method is based on the incorporation and oxidation of piroxicam within a carbon paste matrix bound with a nonconducting solvent. The method was successfully applied to the analysis of several pharmaceutical formulations.

KEY WORDS: Piroxicam, Voltammetry at solid state, Carbon paste electrode.

INTRODUCTION

The carbon paste electrode was introduced by Adams in 1958 [1]. Actually, this electrode can be utilized in two approaches: (1) with conducting binder and (2) with nonconducting binder. The first one is focused on the total electrochemical transformation of the incorporated substance and the second one on the partial electrochemical transformation [2,3]. For example, superconductor samples were analyzed after their incorporation within carbon pastes.

In this article, new method for pharmaceutical formulation analysis is described; incorporation of samples at solid state, within a carbon paste bound with a nonconducting solvent, such as Nujol oil, yielded voltammetric peaks whose heights were proportional to the active drug mass contained in the sample. As the excipient of these formulations is generally lactose, there was no matrix interference, and the analysis was achieved very rapidly, as there was no sample preparation.

According to Viré et al.[5] and based on our experiments [6,7], piroxicam is polarographically reductible, as well as voltammetrically oxidizable, at solid electrodes materials (such as Pt or C). Its reduction mechanism was explored by Kauffmann et al. [8] by using electrochemical and spectrometric techniques. Several studies have been devoted to piroxicam-determination methods, including electrochemical ones [5,9,10] and the spectrophotometric and chromatographic ones [1–17].

The method carried out and proposed in this article allows one to determine piroxicam, accurately and rapidly in the following capsules: Vitaxicam, Sasulen 20, Piroxicam Salvat, Feldene, Doblexam, and Improntal. Its principles are illustrated below.

EXPERIMENTAL

Reagents and Samples

All reagents were of analytical grade and the water employed was deionized by the Barnstead system (nanopure grade).

Piroxicam (pure form) was kindly supplied by Pfizer (Spain), and pharmaceutical formulations were supplied by different Spanish commercial firms.

Apparatus

An Amel 551 potentiostat-galvanostat, in connection with an Amel 566 function generator, and an Amel 560 interface unit and a Linseis LY 17000 recorder were used to obtain the *i-E* curves.

A carbon paste electrode with Nujol oil as binder (using a modified "ad hoc" insulin syringe [3] as paste supplying system) as working electrode, a saturated calomel electrode Ingold 10303-3024 as reference electrode, and a cylindrical Pt Ingold 10805-3007 F X 3641 as auxiliary electrode, were utilized.

In order to control the temperature, pH, weight, and volume, a Tamson TC 3 Thermostat, Crison 501 digital pH-meter, Sartorius balance, and Pipetman micropipette were utilized, respectively.

Procedures

In order to study the influence of several parameters, such as pH, scan rate, and temperature, a carbon paste electrode was prepared as follows: 0.3 g of graphite

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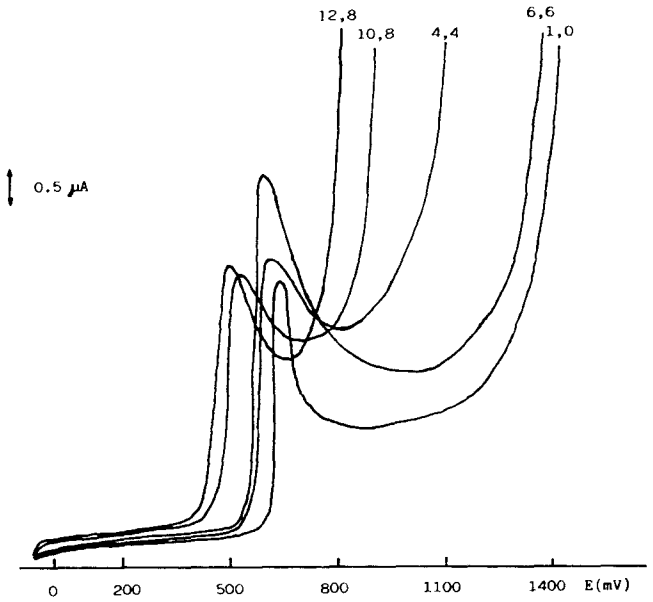


FIGURE 1. Influence of pH on the height and the potential of voltammetric peaks obtained with 1.4 mg of piroxicam + 0.3 g of graphite powder + 200 μl of Nujol oil; scan rate, 50 mV/s.

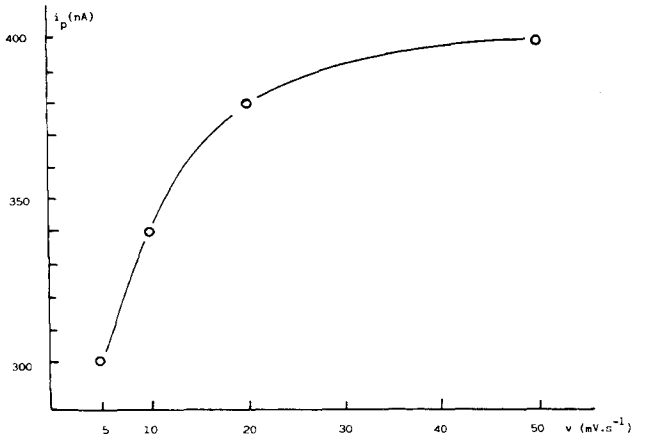


FIGURE 2. Influence of scan rate on voltammetric peak heights of piroxicam utilizing an electrode prepared as in Figure 1.

powder + 200 μl of Nujol oil + 1.4 mg of pure piroxicam were well mixed in an agate mortar to obtain a paste that was introduced in the insulin syringe and utilized as the working electrode after cutting its tip [3]. The supporting electrolyte of the electrolytic cell was 0.1 M KNO_3 and the corresponding pH buffer prepared with several reagents (H_2SO_4, $H_2PO_4^-/HPO_4^{2-}$, and KOH).

RESULTS AND DISCUSSION

In order to study the pH influence on piroxicam electrochemical oxidation, several voltammograms obtained in different buffer solutions contained in the electrolytic cell were plotted in Figure 1. As can be seen in this figure, the best voltammogram is the one obtained at pH 6.6 and recorded at 50 mV/s. In this series of voltammograms, it can be observed that E_o decreases with pH; therefore, the higher the pH, the easier was the piroxicam electrochemical oxidation, probably due to the following electrochemical reaction:

According to Viré et al. [5], electrochemical oxidation of piroxicam involves the enol function, giving a quinone in a bielectronic process. We think that the reaction could be the one proposed above, because the carbenium ion can be stabilized by resonance due to the basicity of the adjacent nitrogen.

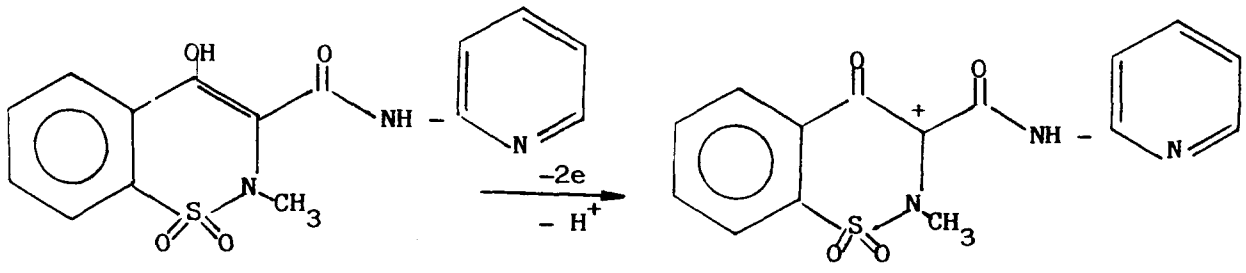
In order to study the scan rate influence on peak height, a series of voltammograms, where this parameter has varied between 5 and 50 mV/s, was plotted in Figure 2. In this figure, the scan rate from 20 mV/s does not have a great influence on peak height.

By maintaining constant the pH and the scan rate (at 20 mV/s), a study of reversibility of the piroxicam electrochemical reaction was carried out. In all of the obtained voltammograms, plotted in Figure 3, the reduction peak absence indicated the piroxicam irreversible behavior in acidic, neutral, and basic conditions (pH 1.03, 6.64, and 12.8).

The temperature influence on the peak height was also studied; the higher the temperature was, the higher was i_p, in accordance with the following equation (correlation coefficient, 0.968):

$$i_p = -1.32 + 0.2331T$$

The variation study of i_p with the amount of piroxicam incorporated into the electrode was carried out. In this case, the electrode was prepared as follows: 1.4 mg of pure piroxicam and increasing the carbon and Nujol mass, although maintaining constant the carbon (g)/Nu-



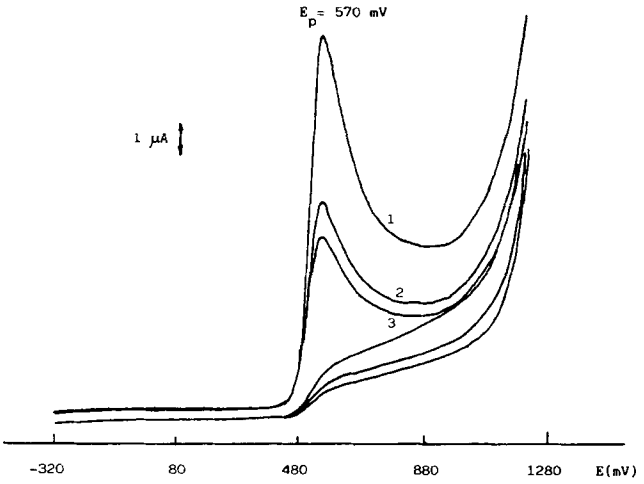


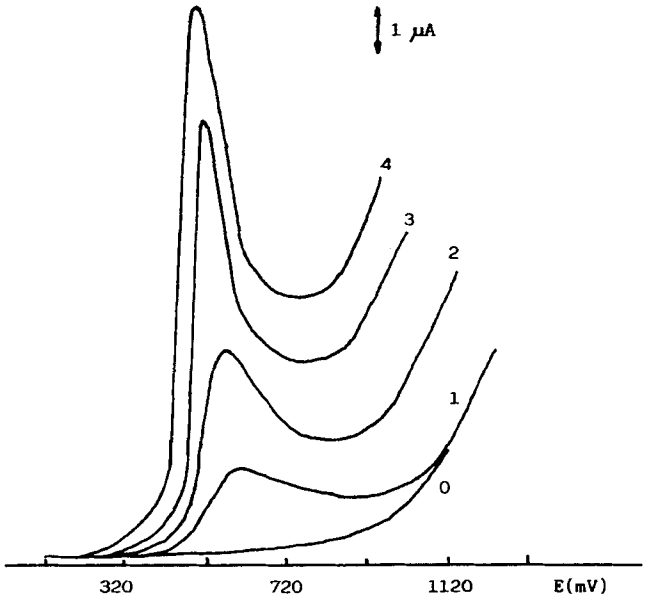
FIGURE 3. Voltammograms obtained at pH 6.4, at different piroxican mass (mg)/C mass (g) ratios; scan rate, 20 mV/s.

jol (μl) ratio. The obtained voltammograms were plotted in Figure 4, in which voltammogram 4 corresponds to the highest Piroxicam mass/C mass ratio. Accordingly, to obtain the calibration plot of this method, several electrodes, loaded with the same amount of piroxicam but increasing both the amount of carbon and Nujol oil, were prepared (Table 1).

By plotting the i_p values versus piroxicam (mg)/carbon (g) ratio, a straight line according to

$$i_p = -0.58 + 2.78C$$

FIGURE 4. Influence of piroxicam mass (mg)/C mass (g) ratio: (1) 0.93, (2) 1.56, (3) 2.3, and (4) 4.7, on voltammetric peak heights; scan rate, 50 mV/s.



was obtained, where i_p denotes the peak heights in μA and C the piroxicam (mg)/carbon (g) ratio, whose correlation coefficient and detection limit were 0.999 and 0.47 mg/g C, respectively.

Analytical Applications

In order to check the application of our method, the following drugs in capsules were analyzed Vitaxicam (Robert Laboratories), Sasulen 20 (Andreu Laboratories), Piroxicam Salvat (Salvat Laboratories), Feldene (Pfizer Laboratories), Doblexam (Organon-Hermes Laboratories), and Improntal (Fides Laboratories). The procedure was the following: the three capsule contents of each drug were in an agate mortar, where the powder was well ground. Subsequently, an amount of this powder equivalent to 1.4 mg of pure piroxicam was mixed with carbon and Nujol oil to make the corresponding paste and introduced into the insulin syringe. The carbon/Nujol ratio was 0.3 g/200 μl.

The electrolytic cell solution composition was 0.1 M KNO_3 and 0.1 M $H_2PO_4^-/HPO_4^{2-}$ (pH 6.64), and the scan rate was 50 mV/s. After plotting the voltammograms and utilizing the obtained calibration plot (equation $i_p = -0.58 + 2.78C$), the piroxicam content in each drug sample was determined.

The results obtained after the analysis of all of the drugs are summarized in Table 2.

The results were in good agreement with the values declared by the manufacturers; therefore, the proposed method is suitable to analyze these types of samples, because no separation and solubilization are necessary, taking into account that the excipient does not interfere.

CONCLUSIONS

The electrochemical behavior of piroxicam at solid state by using voltammetric techniques with a carbon paste electrode as the working electrode was studied. By studying several parameters, such as pH of the external solution, temperature, scan rate, etc., a well-defined oxidation peak over all of the pH range [16] was obtained. By plotting i_p of these voltammograms versus piroxicam mass added into the electrode, a suitable calibration plot with a detection limit of 0.47 mg/g C was obtained. This method to determine piroxicam in drug solid samples without any previous solubilization is proposed because the excipient does not interfere.

The proposed method was applied to the analysis of six commercial drugs based on piroxicam (capsules) with lactose as excipient. Very good results were obtained. As the excipient of the other pharmaceutical formulations is also lactose, this method could be applied to the piroxicam determination in tablets or pills.

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TABLE 1 Preparation of Carbon Paste Electrode with Different Piroxicam/Carbon Ratios in Order to Establish a Calibration Graph for Piroxicam (Each Result is the Average of Five Measurements)

Piroxicam (mg)	*Carbon (mg)*	*Nujol (μl)*	i_p *(μA)*	*+/− S*
1.4	300	200	12.35	0.02
1.4	600	400	4.90	0.01
1.4	900	600	4.10	0.03
1.4	1,200	800	2.48	0.04
1.4	1,500	1,000	2.02	0.02
1.4	3,000	2,000	0.61	0.01

TABLE 2 Results Obtained in the Piroxicam Determination in Several Commercial Antiinflammatories by Scan Voltammetry within a Carbon Paste Electrode with a Nonconducting Binder (Five Measurements)

	Piroxicam (mg)/Carbon (g)			
Samples	*Label Values*	*Found Values*	*+− S*	*% Error*
Vitaxicam 20	3.00	3.02	0.01	+0.67
Sasulén 20	3.30	3.31	0.02	+0.31
Piroxicam Salvat	2.30	2.28	0.01	−0.90
Doblexam	2.80	2.78	0.03	−0.72
Improntal	1.61	1.63	0.02	−1.21
Feldene	4.00	3.97	0.01	+0.75

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