Effect of Maxima Suppressors on Polarographic Anodic Waves of Paracetamol

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Abstract. The aim of the present study is to study effect of maxima suppressors on polarographic anodic waves of paracetamol so that these data can be utilized for development of procedures for their quantitative estimations and applications to various pharmaceutical preparations. The maxima suppressor capacity of gelatin, fuchsin, methyl red, bromocresol green, cellosolve, salicylic acid, thymol blue, methyl thymol blue, bromophenol red on polarographic wave of paracetamol in presence of different supporting electrolytes viz., HClO₄, CH₃COOH, HCl, Borate buffer, H₂SO₄ and NNO₃ were studied. Decomposition oxidation potential is found to remain constant (~600 – 700 mV). Paracetamol produces good sigmoid anodic waves when solution of fuchsin, methyl red, thymol blue, bromocresol green are used as maxima suppressors at their optimum concentration and 0.1 M CH₃COOH as supporting electrolyte. Cellosolve, salicylic acid, methyl thymol blue and bromophenol red do not show any suppressor capacity. Similarly, well defined oxidation wave of paracetamol are obtained when solution of fuchsin/methyl red, thymol blue/bromocresol green are used as maxima suppressors at their optimum concentration and HCl is used as supporting electrolyte. Fuchsin at its optimum concentration is also found to be the good maxima suppressor in presence of supporting electrolytes, viz., borate buffer pH 10, 1 M H₂SO₄, 0.1 M HNO₃ and 0.1 M HClO₄. An optimum concentration of gelatin in some cases gives good result with 0.1 M HClO₄ and 0.1 M CH₃COOH as supporting electrolyte. Decomposition oxidation potential is found to remain constant (~600 – 700 mV).

Keywords: paracetamol, fuchsin, gelatin, methyl red, thymol blue, bromocresol green

1. Introduction

A flow injection-spectrophotometric determination of paracetamol, the influence of foreign species and the determination of paracetamol in several pharmaceutical formulations were reported [1]. A flow-injection spectrofluorimetric determination of paracetamol, the influence of foreign species and the determination of paracetamol in several pharmaceutical formulations are also reported [2]. A polarographic procedure was described for the determination of paracetamol and salicylamide after treatment with nitrous acid and different experimental parameters affecting the derivatization process and the polarographic analysis were studied and the procedure was applied to the analysis of some pharmaceutical dosage forms [3]. After a large drug scanning, the system Luminol–H₂O₂–Fe (CN)₆³⁻ was proposed for first time for the indirect determination of paracetamol and The influence of foreign compounds was studied and, the method was applied to determination of the drug in three different pharmaceutical formulations [4]. The utility of different techniques for quantification of paracetamol content in pharmaceutical formulations and biological samples were evaluated [5]. Many methods for determination of paracetamol had been described in literature, including chromatography (RP - HPLC) [6], chemometric-assisted spectrophotometric [7], spectroscopy [8]-[10]. The review was described about some quantitative estimation of Paracetamol and Lornoxicam in bulk and tablet formulation. The quantitation was carried out by simultaneous equation method, absorption ratio method, stability indicating reversed phase high performance liquid chromatographic method, Reverse Phase High Performance Liquid Chromatographic method, and High Performance Thin Layer Chromatography.
method. All the methods were validated [11]. A simple, selective, accurate RP-HPLC method was developed and validated for the analysis of paracetamol, phenylephrine hydrochloride and loratadine in commercially available tablet formulations [12].

Paracetamol is a common analgesic and antipyretic drug their determination in pharmaceuticals is of paramount importance, since an overdose of paracetamol can cause toxic effects. The aim of the present study is to study effect of maxima suppressors on polarographic anodic waves of paracetamol so that these data can be utilized for development of procedures for their quantitative estimations and applications to various pharmaceutical preparations.

2. Methodology

The maxima suppressor capacity of gelatin, fuchsin, methyl red, bromocresol green, cellosolve, salicylic acid, thymol blue, methyl thymol blue, bromophenol red on polarographic wave of paracetamol in presence of different supporting electrolytes viz., HClO₄, CH₃COOH, HCl, Borate buffer, H₂SO₄ and NNO₃ were studied. Systems were prepared containing an aliquot of paracetamol solution, a supporting electrolyte and different amount of maxima suppressors. 50 ml total volume was maintained for each measurement. Polarogram of each system were recorded on D.C. Recording polarograph with OmniScribe recorder between 400 to 1400 mV using Rotating Platinum micro Electrode (RPE) as anode and Saturated Calomel Electrode (S.C.E.) as cathode.

3. Results and Discussion

Paracetamol the name approved by the British Pharmacopoeia Commission (para-acetaminophenol; N-acetyl-para-aminophenol (APAP); acetaminophen, para-acetamidophenol; para-hydroxyacetanilide), is the most extensively used analgesic and antipyretic drug. It exerts analgesic and antipyretic activity, however it do not exert significant anti-inflammatory activity. It is used for relief of mild pain and antipyresis. The influence of various concentrations of surface acting material, viz, fuchsin, gelatin, methyl red, thymol blue, and bromocresol green on the anodic wave of paracetamol in presence of different supporting electrolytes are shown in Fig. 1 to 13. Plot of E against log (id-i) /i for the wave of 8.0 x10⁻⁵ M Paracetamol in 0.1 M HClO₄ with various concentrations of Fuchsin is shown in Fig 14.

Fig. 1: Effect of Fuchsin concentration on the anodic wave of 8.0 x 10⁻⁵ M Paracetamol in 0.1 M HClO₄
Fig. 2: Effect of Fuchsin concentration on the anodic wave of $5.0 \times 10^{-5}$ M Paracetamol in 0.1 M CH$_3$COOH.

Fig. 3: Effect of Fuchsin concentration on the anodic wave of $1.0 \times 10^{-4}$ M Paracetamol in 0.1 M HCl.
Fig. 4: Effect of Fuchsin concentration on the anodic wave of $2.0 \times 10^{-4}$ M Paracetamol in Borate buffer of pH 10

Fig. 5: Effect of Fuchsin concentration on the anodic wave of $2.0 \times 10^{-5}$ M Paracetamol in $0.1 \text{ M} \text{H}_2\text{SO}_4$
Fig. 6: Effect of Fuchsin concentration on the anodic wave of $6.0 \times 10^{-5}$ M Paracetamol in 0.1 M HNO$_3$

Fig. 7: Effect of Gelatin concentration on the anodic wave of $3.0 \times 10^{-5}$ M Paracetamol in 0.1 M CH$_3$COOH
Fig. 8: Effect of Methyl red concentration on the anodic wave of $8.0 \times 10^{-5}$ M Paracetamol in 0.1 M CH$_3$COOH

Fig. 9: Effect of Methyl red concentration on the anodic wave of $1.0 \times 10^{-4}$ M Paracetamol in 0.1 M HCl
Fig. 10: Effect of Thymol blue concentration on the anodic wave of $1.0 \times 10^{-4}$ M Paracetamol in 0.1 M CH$_3$COOH

Fig. 11: Effect of Thymol blue concentration on the anodic wave of $1.0 \times 10^{-4}$ M Paracetamol in 0.1 M HCl
Fig. 12: Effect of Bromocresol green concentration on the anodic wave of $3.5 \times 10^{-4}$ M Paracetamol in 0.1 M CH$_3$COOH

Fig. 13: Effect of Bromocresol green concentration on the anodic wave of $1.0 \times 10^{-3}$ M Paracetamol in 0.1 M HCl
Paracetamol produces good sigmoid anodic waves when optimum concentration of fuchsin, methyl red, thymol blue and bromocresol green as maxima suppressors and 0.1 M CH$_3$COOH as supporting electrolyte are used. Cellosolve, salicylic acid, methyl thymol blue and bromophenol red do not show any suppressor capacity. Similarly, well defined oxidation wave of paracetamol were obtained when optimum concentration of fuchsin/methyl red/thymol blue/bromocresol green and HCl systems are used. Fuchsin at its optimum concentration was also found to be the good maxima suppressor in presence of several other supporting electrolyte, e.g. borate buffer pH 10, 1 M H$_2$SO$_4$, 0.1 M HNO$_3$ and 0.1 M HClO$_4$. In some cases gelatin at its optimum concentration gives good result with 0.1 M HClO$_4$ and 0.1 M CH$_3$COOH as supporting electrolyte.

3.1. Effect of various concentrations of Fuchsin on the Anodic wave of Paracetamol in different supporting electrolytes

The effect of varying concentrations of fuchsin (Basic fuchsin is used throughout the studies) on the paracetamol wave in 0.1 M perchloric acid is evident from Fig. 1. It is found that slope of the wave becomes flatter, which is being typical of an irreversible reaction, and well-defined limiting current is observed with increasing fuchsin concentration. When the concentrations the fuchsin is very small the wave almost coincides with that obtained without fuchsin. Apparently, at these small concentrations the fuchsin does not form an adsorbed layer on the aqueous side of the electrode-solution interface which resists compression hence fuchsin is unable to prevent the steaming movement of the diffusion layer at the interface. Thus more depolarizer particles are brought to the surface of the electrode than can be transported by diffusion alone, hence the current increases but no limiting current is observed making the slope much steeper. Depending on the concentration of fuchsin the current decreases due to the change in viscosity caused by the addition of the fuchsin. Paracetamol was found to decompose at a potential of about 600 mv (vs S.C.E.) at all concentrations of fuchsin. 3.75 x 10$^{-4}$ % Fuchsin concentration is choosen for further studies in fuchsin-perchloric acid system. Higher concentrations of fuchsin distort the wave form and round maximum is noticeable probably due to catalytic currents. The catalyst is regenerated during the catalytic oxidation, this may also involve adsorption processes. Hence a small concentration of the catalyst can cause high limiting currents. Catalytic waves are characterized by a non-linear dependence on catalyst concentration.

Plot of E against log (id-i) / i give straight lines (Fig. 14), which, however, do not have the theoretical slope. For example, in the analysis of the wave in 0.1 M perchloric acid – 2.5 x 10$^{-5}$% fuchsin systems the slope was found to be 0.227 instead of 0.030. With increasing fuchsin concentrations the slope became closer to the theoretical value but did not become equal to it (Table 1). With 2.5 x 10$^{-3}$% fuchsin (Catalytic maximum of adsorptive character appeared) a slope of 0.069 was found. From the above it is evident that
the oxidation of paracetamol at the rotating platinum micro-electrode is not thermodynamically reversible. Since the plot of E against log( i_r-i)/i yields a straight line, it can be inferred that the half-wave potential should change with the concentration of paracetamol, other conditions remaining the same.

The effect of fuchsin on the anodic wave of paracetamol in 0.1 M CH₃COOH medium shown in Fig 2. Fuchsin is found to suppress the wave height with well defined limiting current region. Decomposition oxidation potential is found to remain nearly constant to 600 mV and no catalytic maxima appeared, as observed in case of 0.1 M HClO₄ at higher concentration of fuchsin. In case of 0.1 M HCl as supporting electrolyte, the diffusion current of paracetamol decreases markedly with increasing fuchsin concentration and better limiting current region is obtained as in Fig. 3 without any catalytic effect.

Table 1: Inconstancy of the Half-wave Potentials of 8.0x10⁻⁵ M Paracetamol at various concentrations of Fuchsin in 0.1 M HClO₄.

<table>
<thead>
<tr>
<th>Concentration of Fuchsin, %</th>
<th>Diffusion Current at 1100 mV</th>
<th>E1/2, mV</th>
<th>Value of Slope</th>
<th>Value of n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Theoretical</td>
<td>Experimental</td>
</tr>
<tr>
<td>0</td>
<td>6.475</td>
<td>872.5</td>
<td>0.03</td>
<td>0.201</td>
</tr>
<tr>
<td>2.5x10⁻⁵</td>
<td>6.3</td>
<td>905</td>
<td>0.03</td>
<td>0.227</td>
</tr>
<tr>
<td>1.25x10⁻⁴</td>
<td>5.075</td>
<td>897.5</td>
<td>0.03</td>
<td>0.19</td>
</tr>
<tr>
<td>2.5x10⁻⁴</td>
<td>3.05</td>
<td>857.5</td>
<td>0.03</td>
<td>0.179</td>
</tr>
<tr>
<td>3.75x10⁻⁴</td>
<td>0.9</td>
<td>812.5</td>
<td>0.03</td>
<td>0.142</td>
</tr>
<tr>
<td>5x10⁻⁴</td>
<td>0.85</td>
<td>797.5</td>
<td>0.03</td>
<td>0.094</td>
</tr>
<tr>
<td>2.5x10⁻³</td>
<td>0.85</td>
<td>762.5</td>
<td>0.03</td>
<td>0.069</td>
</tr>
</tbody>
</table>

In case of borate buffer pH 10, with time, solutions contain free sodium hydroxide which convert red form or fuchsin to the colourless carbinol form but this also serve to suppress the wave (Fig. 4). The diffusion currents are found to decrease markedly with increasing concentration of fuchsin in presence of 1 M H₂SO₄. Improvement in wave can be obtained when diffusion current is low. With lower concentrations (<1.25 x 10⁻²%) of fuchsin the apparent diffusion currents of paracetamol increase with increasing applied e.m.f. as in Fig. 5. This is due to the increase of the residual current with increasing applied e.m.f. and when the proper correction is applied for the residual current the corrected diffusion current is found to be practically constant. Depolarization potential was found to remain constant at a potential of 675 mV. In case of 0.1 M HNO₃, the influence of concentration of fuchsin is found to be similar to that of 0.1 M HClO₄. At lower concentrations (< 2.5 x 10⁻⁴%) of fuchsin, current increases as shown in Fig. 6. Apparently at this small concentration the fuchsin is unable to prevent the streaming phenomenon. With increasing concentrations of fuchsin the adsorption of it is apparently favored, and dependent on the concentration of fuchsin, the current decreases. Higher concentrations of it results in a round catalytic maximum of adsorptive nature.

3.2. Effect of various concentrations of Gelatin on the anodic wave of Paracetamol in 0.1 M Acetic acid

Maxima suppressor capacity of gelatin on 3.0 x 10⁻⁵ M paracetamol wave in presence of 0.1 N CH₃COOH is shown in Fig. 7. Gelatin is found to suppress the wave height, slightly, may be due to increase in viscosity by the addition of the gelatin. Decomposition potential (700 mV) and nature of polarogram remains practically constant.

3.3. Effect of various concentrations of Methyl red in 0.1 M Acetic acid and Hydrochloric acid

Effect of methyl red concentration on the anodic wave of paracetamol in the presence of 0.1 n acids (CH₃COOH and HCl) are similar to those obtained in case of fuchsin. When concentration of methyl red is very small the initial portion of the wave almost coincides with the wave obtained in the absence of methyl red. With increasing methyl red concentration adsorption of it is favored, and the diffusion current decreases. Well defined diffusion current was obtained with 1.0 x 10⁻³ M paracetamol in 0.1 M CH₃COOH in presence of 1 x 10⁻³ % methyl red and with 1.0 x 10⁻⁴ M paracetamol in 0.1 M HCl – 2.5 x 10⁻⁴ % methyl red system (Fig. 8 and 9).
3.4. **Effect of various concentrations of Cellosolve, Salicylic acid, methyl thymol blue and Bromophenol red on the anodic wave of Paracetamol in 0.1 M Acetic acid**

Cellosolve, salicylic acid, methyl thymol blue and bromophenol red do not show any significant suppressor capacity on anodic wave of paracetamol. Even at sufficient high concentration of it diffusion current and limiting current region is indistinct.

3.5. **Effect of various concentrations of Thymol blue and Bromocresol green on the anodic wave of Paracetamol in 0.1 M Acetic acid or Hydrochloric acid**

Paracetamol produces good sigmoid anodic waves when 1.5 x 10^{-3} \% (1.25 x 10^{-3} \%) thymol blue/2.5 x 10^{-2} \% (3.78 x 10^{-3} \%) bromocresol green is used as maxima suppressors and 0.1 M CH₃COOH (0.1 M HCl) as supporting electrolyte. It is observed that the limiting current region is not well defined when lower concentration of thymol blue or bromocresol green is used (Fig. 10 to 13). The apparent diffusion currents of paracetamol increases markedly with increasing applied e.m.f. This may be due to the increase of the residual current with applied e.m.f. Residual current measured at 1050 mv with the different concentrations of bromocresol green in 0.1 M CH₃COOH is found to decrease with small concentrations of bromocresol green but later on at higher concentrations of it residual current increases markedly.

4. **Conclusion**

Paracetamol produces good sigmoid anodic waves when solution of fuchsin, methyl red, thymol blue, bromocresol green are used as maxima suppressors at their optimum concentration and 0.1 M CH₃COOH as supporting electrolyte. Cellosolve, salicylic acid, methyl thymol blue and bromophenol red do not show any suppressor capacity. Similarly, well defined oxidation wave of paracetamol are obtained when solution of fuchsine/methyl red, thymol blue/bromocresol green are used as maxima suppressors at their optimum concentration and HCl is used as supporting electrolyte. Fuchsin at its optimum concentration is also found to be the good maxima suppressor in presence of supporting electrolytes, viz., borate buffer pH 10, 1 H₂SO₄, 0.1 M HNO₃ and 0.1 M HClO₄. An optimum concentration of gelatin in some cases gives good result with 0.1 M HClO₄ and 0.1 M CH₃COOH as supporting electrolyte. Decomposition oxidation potential is found to remain constant (~600 – 700 mV).

5. **References**


