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Short communication

Spectrophotometric determination of some catecholamine drugs using sodium bismuthate

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Abstract

A novel spectrophotometric method is described for the determination of epinephrine (EP) and norepinephrine (NE). The method is based on the development of a red colour with sodium bismuthate, as a sensitive chromogenic reagent, in aqueous medium at pH 3. Oxidation of these catecholamines produces aminochrome derivatives which can be measured spectrophotometrically at 486.0 nm. Calibration graphs are linear in the range 4.8–800 (μmol l^{-1}) for epinephrine bitartarate and 4.8–600 (μmol l^{-1}) for norepinephrine bitartarate with detection limits of 0.26 (μmol l^{-1}) and 2.46 (μmol l^{-1}) for epinephrine and norepinephrine bitartarate salts, respectively. The method has successfully been applied to determination of these catecholamines in pharmaceutical preparations.

Keywords: Sodium bismuthate; Spectrophotometry; Epinephrine; Norepinephrine; Catecholamine

1. Introduction

Catecholamine drugs are widely used in the treatment of bronchial asthma, hypertension, heart failure associated with organic heart disease, myocardial infarction, and cardiac surgery [1]. The amounts of catecholamines in body tissues and fluids are very small, thus sensitive methods are required for their determination. Several analytical procedures have been proposed for catecholamine drugs and their dosage forms [2]. They include titrimetry [3], fluorimetry [4,5], radioimmunoassay [6,7], gas chromatography [8], liquid chromatography [9], and spectrophotometry [10–16] methods.

In the present work, sodium bismuthate was investigated as a sensitive chromogenic reagent for the spectrophotometric determination of two commonly used catecholamine drugs (epinephrine and norepinephrine) in the drug substances as well as in dosage forms. In this work

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acetaldehyde was added to combine with the common antioxidant sodium metabisulphite; and the effect of the sodium bismuthate, reaction time and temperature, and solution pH was examined.

2. Experimental

2.1. Apparatus

UV-visible spectra and absorbance measurements were recorded with a UV-265 FW spectrophometer (Shimadzo, Japan). Matched quartz cells with a 1 cm path length and a thermostatically controlled water bath were used.

2.2. Reagents

Stock solutions of EP (1.36×10^{-3} M) and NE (7.412×10^{-4} M) bitartarate salts (Aldridge Chemical Company) were prepared by dissolving 0.0228–0.0125 g, respectively in 50 ml of 0.1% aqueous sodium metabisulphite solution. Reagents and solvents used were analytical grade.

2.3. Procedures

Standard solutions of EP and NE were prepared by pipetting adequate volume of stock solution into a 10 ml flask containing 1 ml acetaldehyde and 5 ml of ethanol. After letting to stand for 5 min, 0.02 g sodium bismuthate was added and it was made up to volume with water. The solution was shaken for 1 min, centrifuged, and the absorbance of the supernatant solution was measured at 486–482 nm for EP and NE, respectively.

Commercial pharmaceutical EP (Darou-Pakhsh Medication system, Iran) or NE (Sanofi Winthrop Medication system, England) sample solution was prepared by mixing the contents of 3 ampoules, labelled to contain 1 mg EP or NE per ml, and diluting five times. 1 ml of this sample was taken and the procedure was followed as for the standard solutions.

3. Results and discussion

EP and NE was found to react with bismuthate to form red products which exhibit absorption peak at 486–482 nm for EP and NE respectively (Fig. 1). For EP and NE the red colour is developed immediately at room temperature (20–25°C) and remains stable for at least 60 min. Heating the solution causes a decrease in absorbance (Fig. 2).

Maximum colour intensity was obtained with 2 mg ml $^{-1}$ sodium bismuthate in the final reaction mixture (Fig. 3). It was found that in assay of ampoules acetaldehyde must be added to combine with the common antioxidant sodium metabisulphite; the optimum quantity of acetaldehyde was found to be 1 ml per 10 ml of the reaction mixture, with a standing time of not less than 5 min for the masking reaction to take place.

The intensity of the red colour depends on the solution pH. Therefore the effect of solution pH was also studied. Tests with suitable buffers (pH range 1–11) showed that the maximum colour intensity and stability were obtained with acetate buffers of pH 3–6 (Fig. 4).

The calibration plots are linear over the concentration ranges 4.8–800 (μmol l^{-1}) for EP and 4.8–600 (μmol l^{-1}) for NE. Equations for the calibration curves are: $\text{Abs} = -2.757 \times 10^{-3} + 3731.4\ C$ and $\text{Abs} = -7.612 \times 10^{-4} + 3329.512\ C$ for EP and NE, respectively.

The limit of detection based on three times standard deviation of the blank signal for processing water was 0.26 (μmol l^{-1}) and 2.46 (μmol l^{-1}) for EP and NE, respectively.

The limit of Quantification based on 10 times standard deviation of the blank signal for processing water was 1.47 (μmol l^{-1}) and 1.64 (μmol l^{-1}) for EP and NE, respectively and the precisions for eight replicate measurements at the level of 5.56×10^{-5} and 1.297×10^{-4} mol l^{-1} NE were calculated to be 1.58 and 0.84% RSD, respectively and the precisions for eight replicate measurements at the level of 1.02×10^{-4} and 2.39×10^{-4} mol l^{-1} EP were calculated to be 1.66 and 1.01% RSD, respectively.

The proposed method was successfully applied to the determination of EP and NE bitartarate

salts in marketed pharmaceutical formulations. The results are shown in Table 1. It was found that there is no significant difference between the results of the proposed and official method [17].

No interference effect was observed for the drugs analyzed with the proposed method.

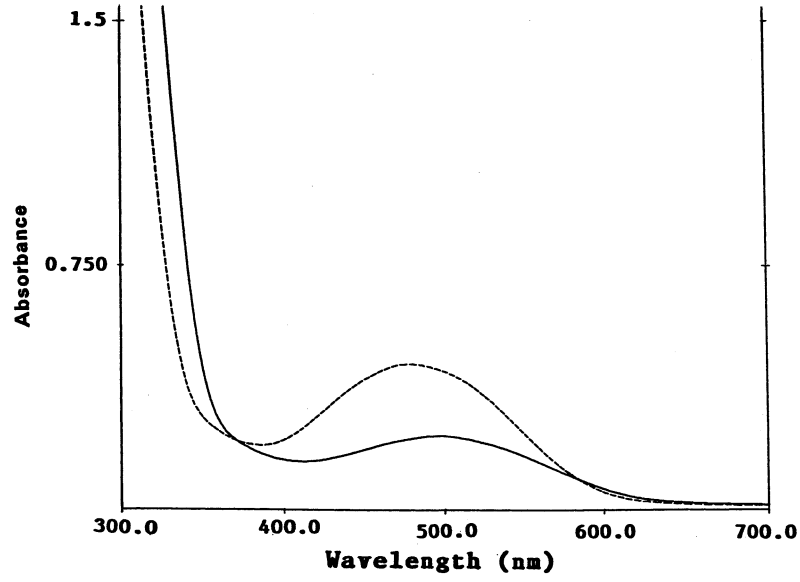

Fig. 1. Absorbance spectra of the reaction products of bismuthate 2 mg ml^{-1} with (---) Epinephrine (EP), 1.36×10^{-4} mol l^{-1} and (—) Norepinephrine (NE), 7.412×10^{-5} mol l^{-1} (pH 3) at room temperature.

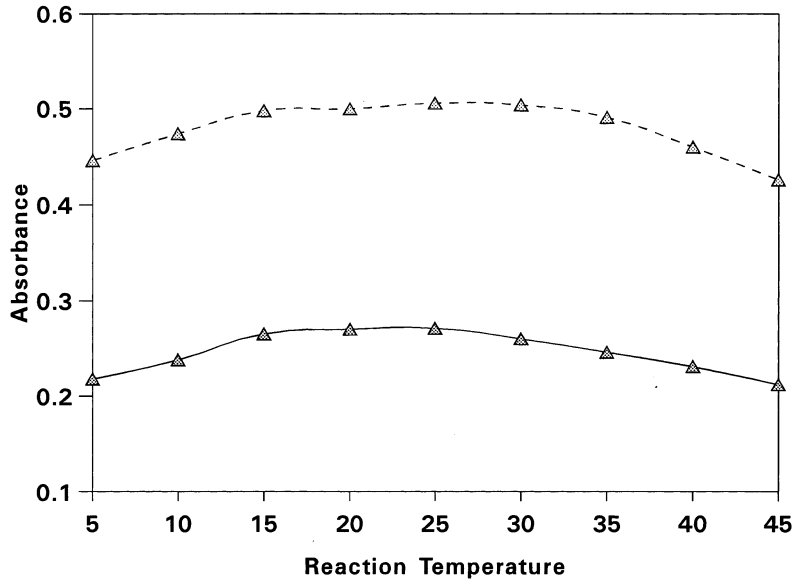

Fig. 2. Influence of temperature on colour formation (pH 3) for (---) Epinephrine (EP), 1.36×10^{-4} mol l^{-1} and (—) Norepinephrine (NE), 7.412×10^{-5} mol l^{-1} with bismuthate 2 mg ml^{-1}.

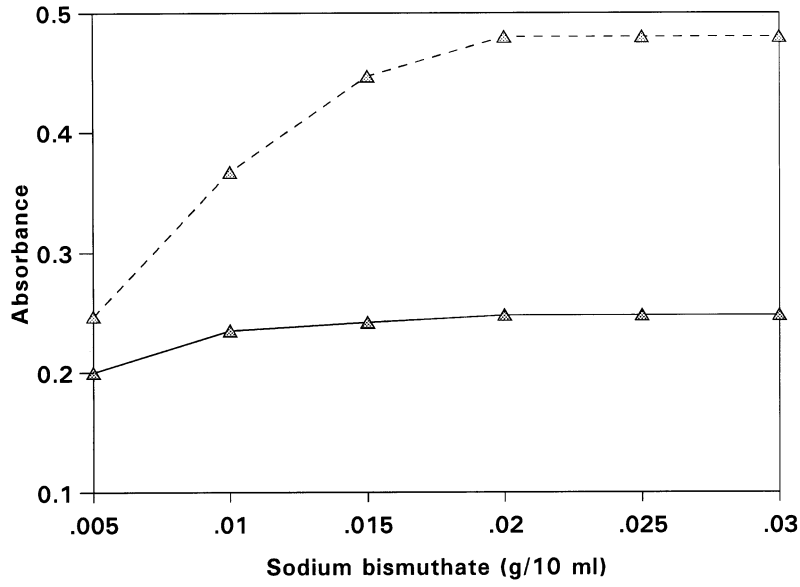

Fig. 3. Influence of bismuthate quantity on the colour intensity for (---) Epinephrine (EP), 1.36×10^{-4} mol l^{-1} and (—) Norepinephrine (NE), 7.412×10^{-5} mol l^{-1} at room temperature.

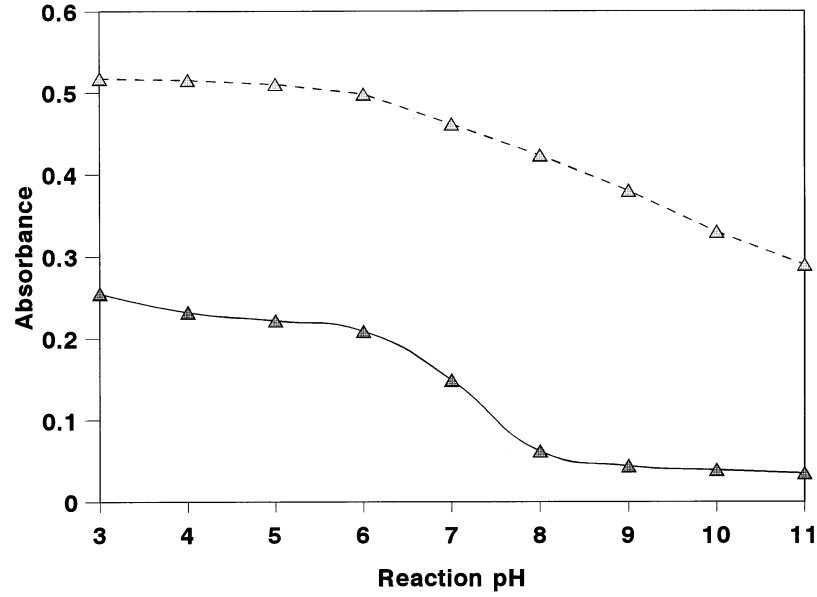

Fig. 4. Influence of solution pH on the colour intensity of (---) Epinephrine (EP), 1.36×10^{-4} mol l^{-1} and (—) Norepinephrine (NE), 7.412×10^{-5} with bismuthate at room temperature.

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Table 1
Determination of norepinephrine and epinephrine

Catecholamine	Recovery% ± RSD	
	Proposed method[a]	Official method[b]
Epinephrine	99.79 ± 1.90	99.94 ± 0.52
Norepinephrine	99.79 ± 1.35	99.94 ± 0.10

[a] Number of determinations 7.
[b] Number of determinations 4.

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