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Quantitative Estimation of Sodium benzoate and Caffeine in the Binary Mixture Using First Order Derivative Spectrophotometry

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Abstract: The mixture of sodium benzoate and caffeine can be estimated by recording absorbance values at two different wavelengths λ 227 and 273nm and by solving the two simultaneous equations. The first order derivative spectrophotometry has been reported here for the quantitative estimation of the mixture of sodium benzoate and caffeine. The zero crossing wavelength in the dA/dλ vs λ plot was found to be 223.3nm for sodium benzoate and 244nm for caffeine. The dA/dλ value at 223.3nm was used to calculate caffeine concentration and that at 244nm was used to calculate sodium benzoate concentration.

Key Words: First Order Derivative Spectrophotometry; sodium benzoate; caffeine.

1. INDRODUCTION

A binary mixture of drugs can be estimated quantitatively by determining the absorbance values at two different analytical wavelengths in UV-VIS range and solving the two simultaneous equations[2]. First and second order derivative spectrophotometry for individual & simultaneous determination of amoxicillin and cephalexin has been reported by Sarmad B. Dikran[1]. Caffeine is used as a central nervous system stimulant and sodium benzoate as the pharmaceutical aid (preservative). Tablets containing the mixture of these two components are available in the market. The first order derivative spectrophotometric method for the estimation of this binary mixture has not been reported. A quantitative method using first order derivative spectrophotometry has been developed and reported here for the analysis of the mixture of sodium benzoate and caffeine.

2. MATERIALS AND METHODS

Spectrophotometer: Model V-630 Jasco.
Sodium benzoate (S.D.Fine chemicals).
Caffeine (S.D.Fine chemicals)

Method: The zero order spectrum, that is, absorbance (A) versus wavelength (λ) plot for sodium benzoate in distilled water using distilled water as the reference was recorded for the solution of known concentration (15 µg/ml) of sodium benzoate (Fig.1). The first order derivative spectrum was also recorded (Fig.2). The zero crossing wavelength for sodium benzoate was found to be 223.3nm.

The zero order spectrum of caffeine in distilled water using distilled water as the reference was recorded for the solution of known concentration (10 µg/ml) (Fig.3). The first order derivative spectrum was also recorded (Fig.4). The zero crossing wavelength for caffeine was found to be 244nm.

The first order derivative spectra of sodium benzoate solutions in the concentration range 5-15 µg/ml were recorded and the dA/dλ values were determined at 244nm from the plots, which is zero crossing wavelength for caffeine. Similarly, the first order derivative spectra of caffeine solutions in the concentration range 5-15 µg/ml were recorded and the dA/dλ values were determined from the plots, at 223.3nm, which is zero crossing wavelength for sodium benzoate. All the solutions were prepared in distilled water and distilled water was used as the reference to record the spectra. The dA/dλ value at 244nm was found to be proportional to the concentration of sodium benzoate and that at 223.3nm was proportional to the concentration of caffeine. The data is given in Table 1.

The analysis of the mixture of sodium benzoate and caffeine is possible because the dA/dλ value at 244 nm is independent of the concentration of caffeine and the dA/dλ value at 223.3nm is independent of the concentration of sodium benzoate in the mixture.

Mixture of Sodium benzoate and caffeine:

The UV Zero Order Spectrum of the mixture of sodium benzoate (3 µg/ml) and caffeine (10 µg/ml) was recorded using distilled water as the reference (Fig.5). The corresponding first order derivative spectrum also was recorded for the mixture (Fig.6).

The dA/dλ value at 244 nm was measured and used to calculate the concentration of sodium benzoate in the solution. The dA/dλ value at 223.3 nm was used to calculate the concentration of caffeine in the solution. The data is summarized in the Table 2.

RESULT: The concentration of caffeine and sodium benzoate present in the mixture are in close agreement with the values determined from the first order derivative spectrophotometry (Table 2). The data in the table was calculated from the plots in the Fig.2,Fig.4 and Fig.6.

From the standard plot for sodium benzoate give in the Fig.2, at 244nm dA/dλ value of 0.028 ≡ 15 µg/ml (sodium benzote) . Hence dA/dλ value (Fig.6) of 0.0058 ≡ 3.1 µg/ml (sodium benzoate). This is the concentration of sodium benzoate in the given mixture.

Similarly, from the standard plot for caffeine given in the Fig. 4, at 223.3nm, dA/dλ value of 0.032 ≡ 10 µg/ml (caffeine). Hence dA/dλ value (Fig.6) of 0.0315 ≡ 9.8 µg/ml (caffeine). This is the concentration of caffeine in the given mixture.

CONCLUSION: The first order derivative spectrophotometric method of analysis can be used for the quantitative estimation of the mixture of sodium benzoate and caffeine in the concentration range of 5µg/ml to 15 µg/ml.

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Table 1: The dA/dλ values recorded from First Order Derivative Spectra of Sodium benzoate and Caffeine.

Sodium Benzoate		Caffeine	
Concentration µg/ml	dA/dλ values at 244 nm	Concentration µg/ml	dA/dλ values at 223.3 nm
5	0.009	5	0.017
7.5	0.014	10	0.032 (Fig.4)
15	0.028 (Fig.2)	15	0.048

Table 2: Comparison between the concentrations of sodium benzoate & caffeine in the mixture (given) and determined by First Order Derivative Spectrophotometry.

Sr.No.	Conc. of sodium benzoate & caffeine in the mixture (given) µg/ml		Conc. of sodium benzoate & caffeine in the mixture (determined) µg/ml		Refer
	Caffeine	Sodium benzoate	Caffeine	Sodium benzoate	
1.	10	3	9.8	3.1	Fig.6
2.	10	6	10	5.58	

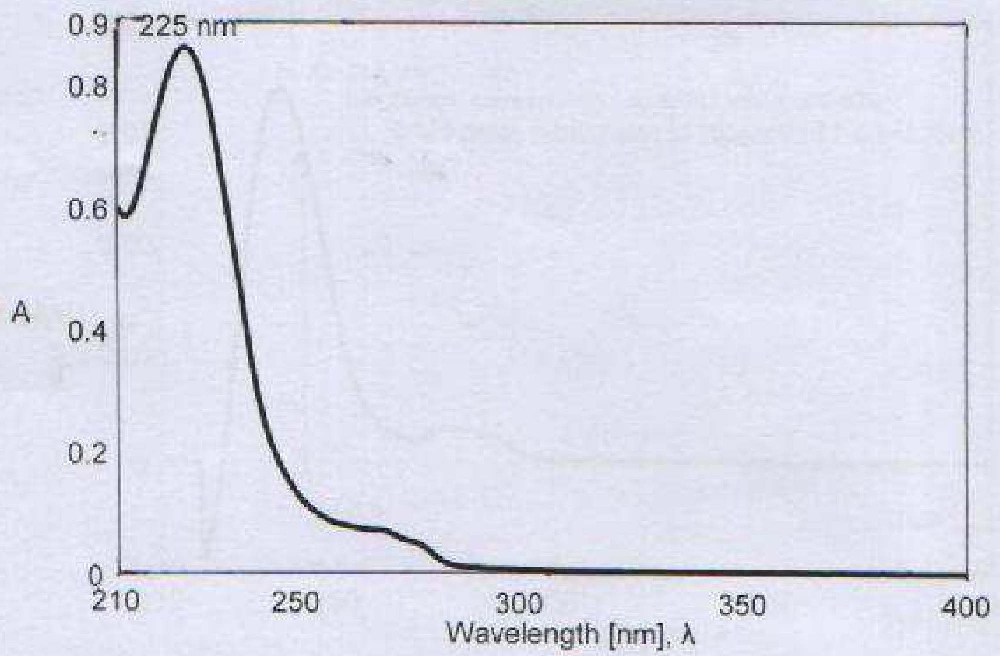

Fig.1: Zero order spectrum (absorbance A vs. λ) of Na-benzoate in distilled water (15μg/ml)

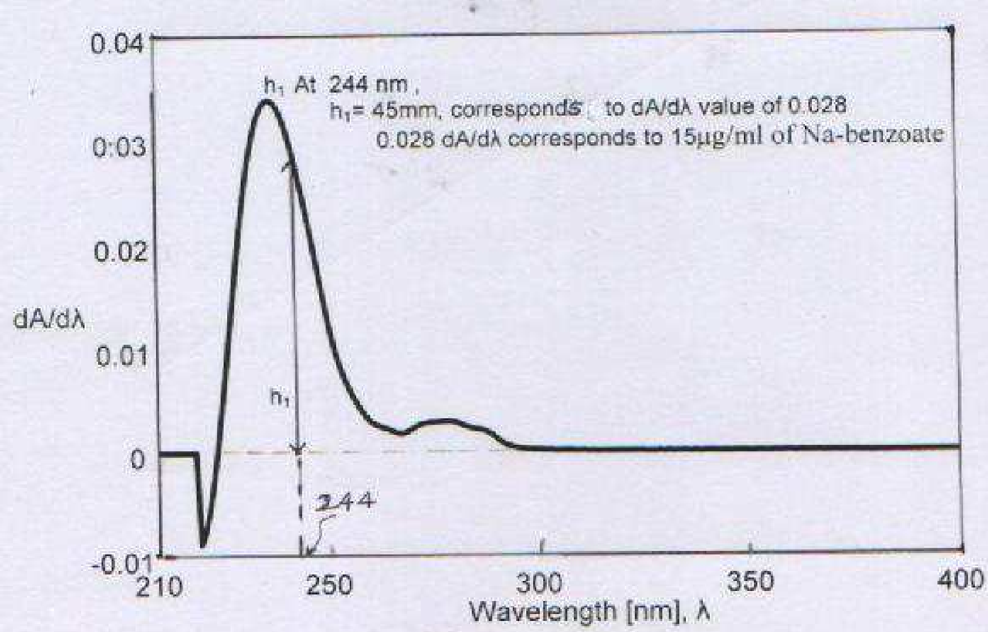

Fig.2: First order derivative spectrum of Na-benzoate in distilled water (15μg/ml)

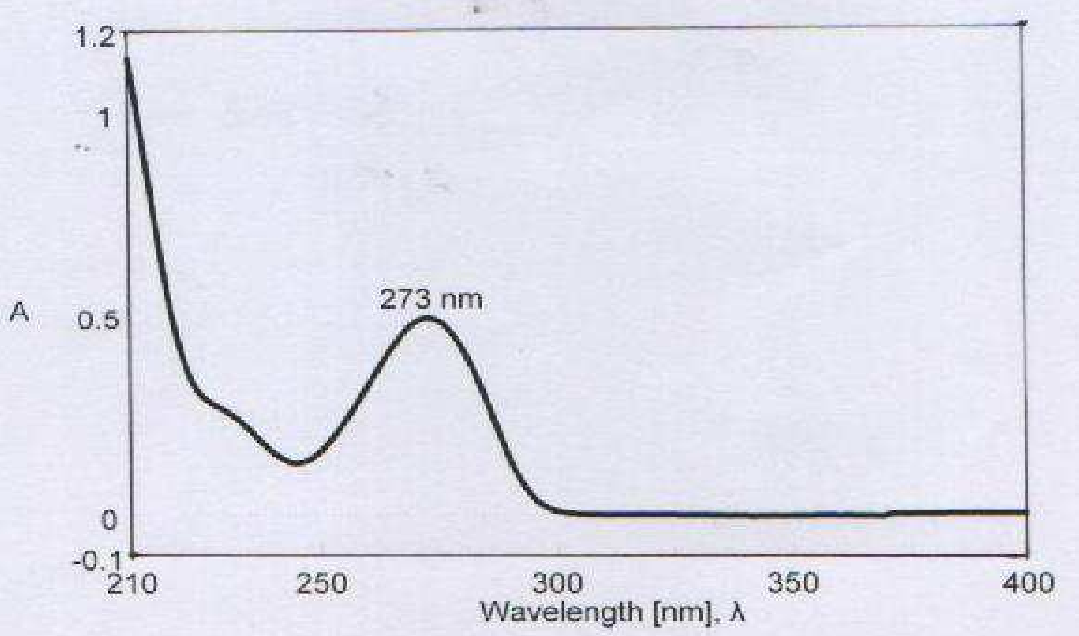

Fig.3: Zero order spectrum (absorbance A vs λ) of caffeine in distilled water (10 μg/ml)

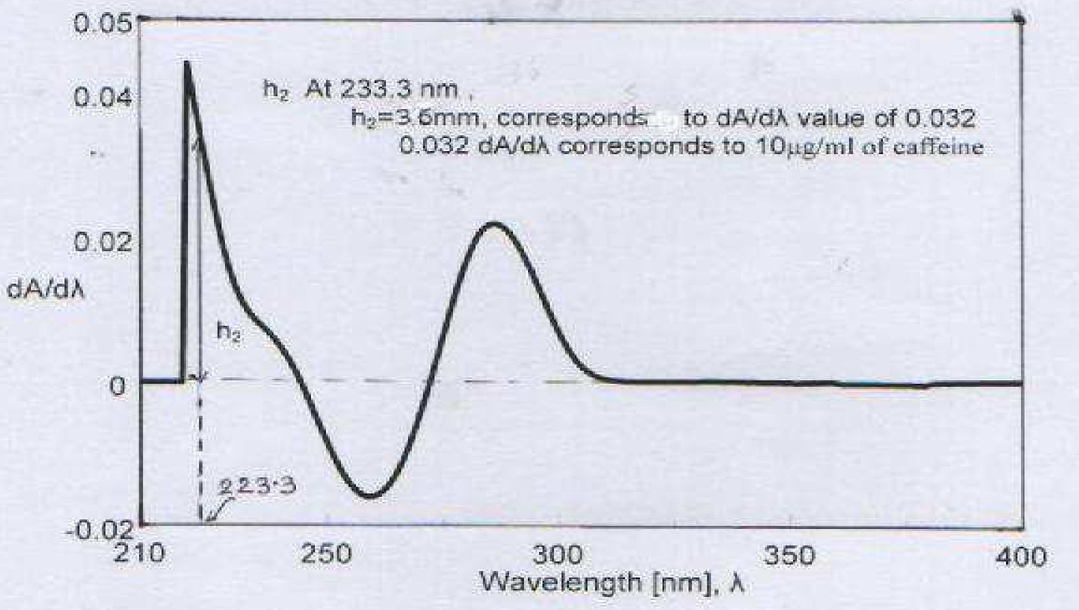

Fig.4: First order derivative spectrum of caffeine in distilled water (10μg/ml)

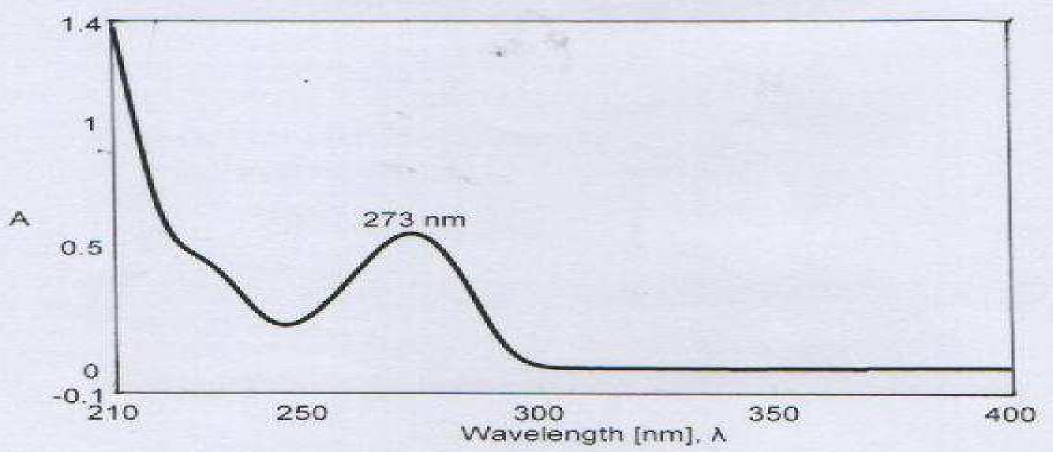

Fig.5: Zero order spectrum (absorbance A vs λ) of mixture (Na-benzoate 3μg/ml + caffeine 10μg/ml) in distilled water

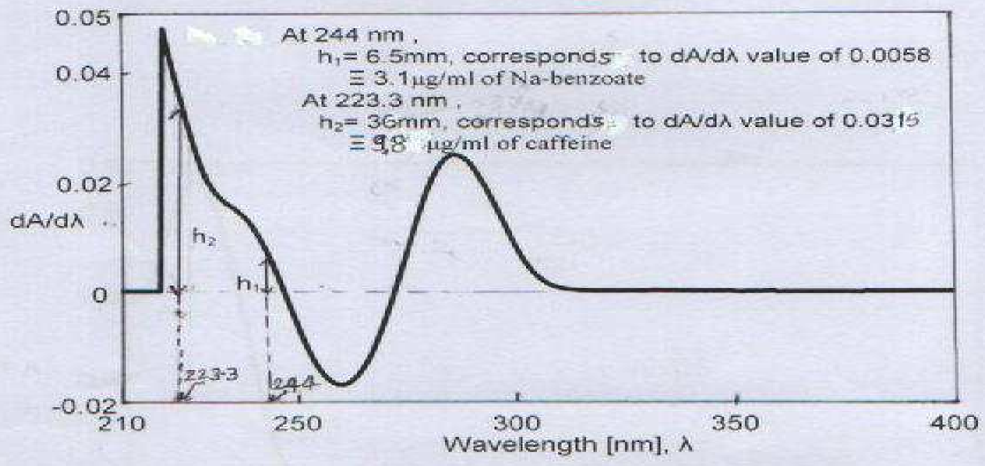

Fig.6: First order derivative spectrum of mixture (Na-benzoate3 μg/ml + caffeine 10μg/ml) in distilled water

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