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Research Article

Quantitative Determination of Sodium Benzoate by UV- Spectroscopy and Evaluation of Preservative

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ABSTRACT

Sodium benzoate is widely used as an antimicrobial preservative in pharmaceutical and cosmetic preparations, making its quantitative control important for product quality. The present study aimed to develop and validate a simple, economical UV-Visible spectrophotometric method for estimating sodium benzoate in a cold cream formulation. A sodium benzoate stock solution was prepared in distilled water and serially diluted to obtain working standards. The ultraviolet absorption spectrum was examined over 200–400 nm, and a wavelength in the 225–227 nm region was identified as the absorption maximum; 227 nm was selected for quantitative measurements. A calibration curve was constructed over 2.5–20 µg/mL using absorbance measurements at 227 nm. The calibration data gave the regression equation $y = 0.060195x + 0.081951$, with an R^2 value of 0.9903. The developed method was applied to the cold cream sample, and the sodium benzoate content was estimated as 0.0175% w/w. Accuracy was evaluated by standard addition at 80%, 100%, and 120% levels, with individual recoveries ranging from 98.69% to 100.75% and an overall mean recovery of 99.71%. The findings indicate that the proposed UV-Visible spectrophotometric procedure is straightforward, rapid, economical, and suitable for routine estimation of sodium benzoate in cold cream formulations, subject to completion of the remaining validation parameters required for formal analytical-method validation.

INTRODUCTION

Pharmaceutical and cosmetic preparations that contain water are susceptible to microbial contamination, making the appropriate selection and control of

preservatives an important aspect of product quality. Sodium benzoate is a widely used benzoate preservative with activity that is influenced by the formulation environment, particularly pH. Its broad use in food, pharmaceutical, and cosmetic products has also led to

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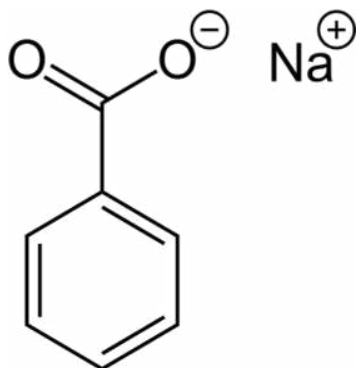
continued interest in reliable analytical procedures for its determination. 1,2,3

Ultraviolet–Visible (UV–Visible) spectrophotometry is a convenient analytical technique for quantitative measurements when the analyte absorbs in the ultraviolet or visible region. The technique is comparatively simple, economical, and suitable for routine laboratory use. In pharmaceutical analysis, calibration-based UV methods can provide a practical alternative when a rapid determination is required. 4,5

The present work was undertaken to develop a simple UV–Visible spectrophotometric procedure for the quantitative determination of sodium benzoate used as a preservative in a cold cream formulation. The study included determination of the analytical wavelength, preparation of a calibration curve, estimation of sodium benzoate in the formulation, and evaluation of accuracy by standard-addition recovery studies.

DRUG PROFILE

SODIUM BENZOATE



Molecular formula: C₇H₅O₂Na

Molecular weight : 144.10 g/mol.

Physical state: Freely soluble in water, sparingly soluble in ethanol.

MATERIALS AND METHODS

Study design and materials

The study used sodium benzoate as the analytical standard and a laboratory-prepared cold cream formulation containing sodium benzoate as preservative. The formulation described in the supplied final copy contained borax (0.4 g), beeswax (10 g), liquid paraffin (25 g), rose water q.s., sodium benzoate (0.1 g), and distilled water q.s. The source document does not specify the study site or experimental year; these details should be inserted from the laboratory record before submission.

Preparation of standard solution

A 100 mg quantity of sodium benzoate was accurately weighed and dissolved in 100 mL of distilled water to obtain a nominal stock solution. A working solution was prepared by diluting 10 mL of the stock solution to 100 mL with distilled water. Serial dilutions corresponding to 2.5, 5, 10, 15, and 20 µg/mL were prepared for calibration.

Determination of absorption maximum

The standard sodium benzoate solution was scanned over 200–400 nm using a UV–Visible spectrophotometer. The absorption maximum was observed in the approximately 225–227 nm region. A wavelength of 227 nm was selected for quantitative analysis, consistent with the measurement used for the reported calibration data.

Calibration curve

The absorbance of the sodium benzoate standards at 227 nm was recorded. A plot of absorbance against concentration was prepared, and linear regression was applied to obtain the calibration equation.

Preparation of cold cream

The oil phase was prepared by heating liquid paraffin and beeswax in a borosilicate glass beaker at approximately 75 °C. In a separate vessel, borax, distilled water, and sodium benzoate were heated to approximately the same temperature to obtain the aqueous phase. The aqueous phase was gradually incorporated into the heated oil phase with vigorous mixing until a smooth

cream was formed. Rose oil was added as fragrance, and the cream was worked on a slab using geometric mixing to obtain a uniform consistency.

Sample preparation and UV analysis

For the quantitative determination reported in the supplied final copy, 0.2 g of the cold cream sample was transferred to a volumetric flask and treated with 20 mL of 0.1 N sodium hydroxide. One millilitre of the prepared solution was further diluted with 10 mL of

distilled water. The solution was filtered through a 0.45 μm syringe filter before measurement. Absorbance was measured at 225–227 nm, with 227 nm used for the reported quantitative result. Sodium benzoate concentration was calculated from the regression equation.

Tabulate the Regression Data

To calculate the slope (m) & intercept (b) using the least-squares method. Compute the necessary statistical components (Σx , Σy , Σx^2 , & Σxy) from the raw data.

Table 1: Regression Data

Std	x ($\mu\text{g/ml}$)	(y) Abs	x^2	xy
Std 1	2.5	0.184	6.25	0.46000
Std 2	5.0	0.399	25.00	1.9950
Std 3	10.0	0.731	100.00	7.3100
Std 4	15.0	1.012	225.00	15.1800
Std 5	20.0	1.244	400.00	24.8800
Sum (Σ)	52.5	3.570	756.25	49.825

Number of points (n) = 5

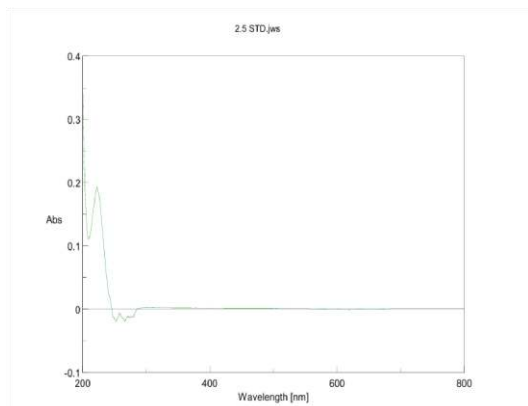


Figure 1: Standard 1 (2.5Mg/ml)

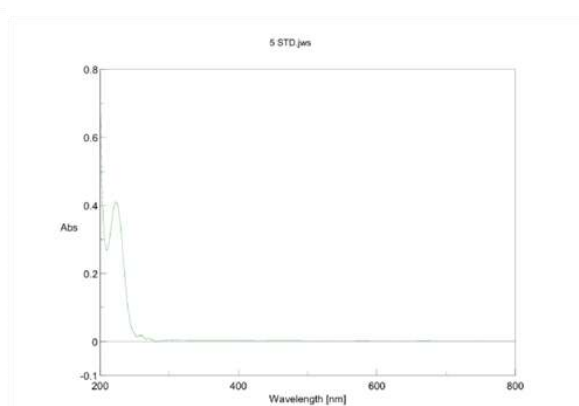


Figure 2: Standard 2 (5Mg/ml)

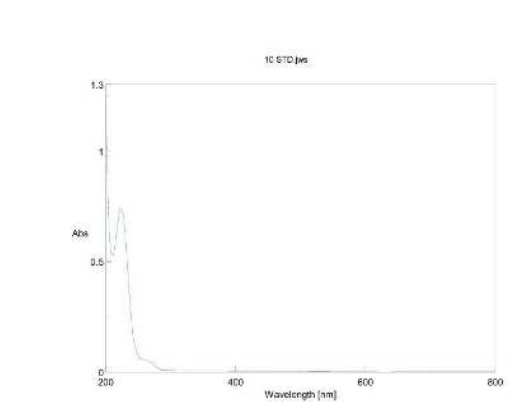


Figure 3: Standard 3 (10Mg/ml)

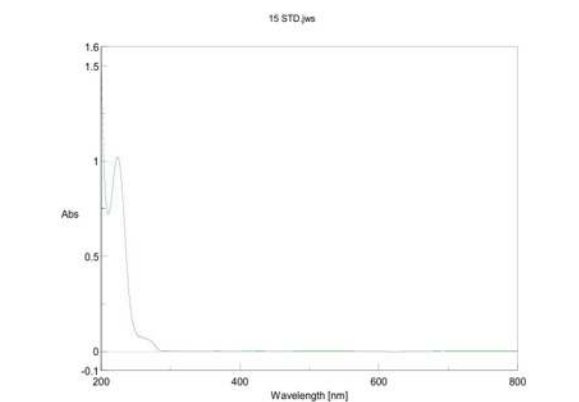


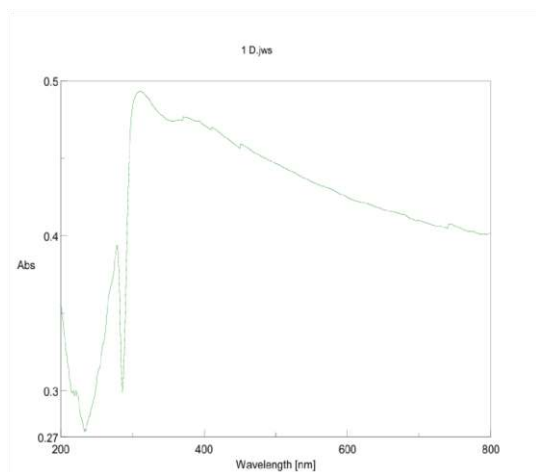
Figure 4: Standard 4 (15Mg/ml)

Sample Dilution:

- Take 0.2 gm sample and add 20 ml of 0.1N Sodium Hydroxide in a volumetric flask.
- Take 1 ml from the prepared stock solution and add 10ml of distilled water and measure the absorbance at 225nm.

UV - Analysis:

1. Filter the sample solution using 0.45 µg syringe filter to remove any residual particulate matter.
2. Calibration curve (10-15ppm).
3. Measure the absorbance 225-227 nm using UV-Vis spectrophotometer.

**Figure 5: Sample Graph****Calculations****1. Calculate the slope (m)**

The slope represents the sensitivity of spectrophotometer system. Use the linear regression formula.

$$m = \frac{[n \sum(xy) - \sum x \sum y]}{[\sum(x^2) - (\sum x)^2]}$$

Substitute the calculated values into the formula:

$$m = \frac{[5 (49.825) - (52.5) (3.570)]}{[3781.25 - 2756.25]}$$

$$m = 61.7 / 1025 = 0.060195$$

2. Calculate the Intercept (b)

The y-intercept represents the background absorbance (or) baseline threshold of the blank solution. Use the intercept formula:

$$b = (\sum y - m \sum x) / n$$

Substitute the calculated values and unrounded slope into the formula:

$$b = \frac{[3.570 - (0.06019512 \times 52.5)]}{5}$$

$$b = \frac{(3.570 - 3.160244)}{5}$$

$$b = 0.409756 / 5 = 0.081951$$

Slope m = 0.06020

y intercept b = 0.08195

3. Calculate the Concentration:

Using standard calibration curve equation ($A = m C + b$) we rearrange the formula to isolate Concentration (C):

$$C = \frac{(A - b)}{m}$$

Where:

Measured Absorbance A = 0.293

Slope m = 0.06020

Intercept b = 0.08195

Substitute the values using the precise unrounded regression numbers from data:

$$C = \frac{(0.293 - 0.08195122)}{0.060195}$$

$$C = 0.21104 / 0.06019 = 3.50 \mu\text{g/ml}$$



4. Apply the Percent weight/weight (% w/w)

Mass of sod. benzo found in
10ml flask
= 0.000035g

Initial wt sample
= 0.2g

$$\% \text{ w/w} = [\text{Mass of sod. benzoate (g)} / \text{Initial wt. (g)}] \times 100$$

Substitute values:

$$\% \text{ w/w} = (0.000035061 \text{ g} / 0.2 \text{ g}) \times 100$$

$$\% \text{ w/w} = 0.0001753 \times 100 = 0.0175\%$$

% Conc of sod. benzoate in sample = 0.0175% (Acceptable limit)

5. Total mass in 10ml soln

$$\text{Total mass} = \text{Conc} \times \text{Final volume}$$

$$\text{Total mass} = 3.5061 \mu\text{g/ml} \times 10 = 35.061 \mu\text{g}$$

Convert micrograms to grams ($\div 1,000,000$):

$$35.061 \mu\text{g} = 0.000035061 \text{ gm}$$

The regression equation was expressed as $A = mC + b$, where A is absorbance, C is sodium benzoate concentration, m is the slope, and b is the intercept. The concentration of sodium benzoate in the sample solution was calculated from $C = (A - b)/m$. The reported sample absorbance was 0.293, giving an estimated

concentration of approximately 3.50 $\mu\text{g/mL}$ and a calculated sodium benzoate content of 0.0175% w/w.

Method validation

Linearity and Accuracy

Accuracy was evaluated by the standard-addition method at 80%, 100%, and 120% levels, using three independent replicates at each level. Percentage recovery was calculated as the ratio of measured concentration to true concentration multiplied by 100. The source document also states that intraday precision was assessed; however, the numerical precision dataset was not included in the supplied final copy and is therefore not reported as a numerical result in this manuscript.

- **Linearity:** Confirms proportionality of absorbance to concentration.
- **Accuracy:** Verified by recovery studies.

RESULTS

Wavelength selection and linearity

Scanning of sodium benzoate in the UV region showed maximum absorption in the approximately 225–227 nm region. The quantitative wavelength was selected as 227 nm. The absorbance increased progressively from 0.184 to 1.244 as the standard concentration increased from 2.5 to 20 $\mu\text{g/mL}$. Linear regression of the five calibration points produced the equation $y = 0.060195x + 0.081951$, with $R^2 = 0.9903$.

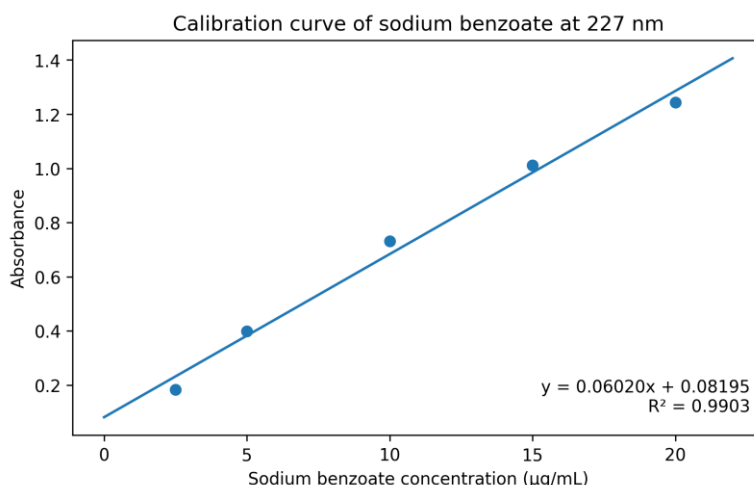


Figure 6: Calibration Curve of Sodium Benzoate at 227 nm.



Accuracy of sodium benzoate in cold cream

The reported absorbance of the prepared cold cream sample was 0.293. Using the calibration equation, the calculated concentration was approximately 3.50

µg/mL. Based on the dilution and sample-weight calculations presented in the source document, the sodium benzoate content of the cold cream was estimated as 0.0175% w/w.

Table 2: Accuracy/recovery results for sodium benzoate.

Addition level	Replicate	True concentration (µg/mL)	Found concentration (µg/mL)	Recovery (%)
80%	R1	1.60	1.595	99.69
80%	R2	1.60	1.612	100.75
80%	R3	1.60	1.579	98.69
100%	R1	2.00	1.994	99.70
100%	R2	2.00	2.011	100.55
100%	R3	2.00	1.978	98.90
120%	R1	2.40	2.410	100.42
120%	R2	2.40	2.393	99.71
120%	R3	2.40	2.376	99.00

Recovery values for the nine determinations ranged from 98.69% to 100.75%. The mean recovery calculated from the reported individual values was 99.71%. The recovery results therefore indicate close agreement between the added and measured sodium benzoate concentrations under the reported experimental conditions.

DISCUSSION

The study demonstrates the practical use of UV–Visible spectrophotometry for quantitative estimation of sodium benzoate in a cold cream matrix. Sodium benzoate is an established preservative, and its antimicrobial activity is affected by the chemical environment of the formulation. Previous literature has described its widespread use and the importance of suitable analytical procedures for its determination. 1,2,5,6

The calibration experiment showed an increasing absorbance response with increasing sodium benzoate concentration across the 2.5–20 µg/mL range. The regression equation, $y = 0.060195x + 0.081951$, and R^2 of 0.9903 indicate a strong linear relationship within the tested range. The method therefore provided a usable calibration model for estimating sodium benzoate in the prepared sample.

The estimated sodium benzoate content of the cold cream was 0.0175% w/w. Accuracy assessment by standard addition produced recoveries close to 100% at

all three investigated levels. These results support the suitability of the procedure for the tested formulation. The method also has practical advantages because UV–Visible instruments are commonly available in pharmaceutical analysis laboratories and the measurement procedure is relatively straightforward.

CONCLUSION

A UV–Visible spectrophotometric procedure was developed for the estimation of sodium benzoate in a cold cream formulation. Quantitative analysis was performed at 227 nm using a calibration range of 2.5–20 µg/mL. The calibration model showed an R^2 value of 0.9903, while standard-addition studies gave recoveries of 98.69–100.75%, with a mean recovery of 99.71%. The sodium benzoate content of the analysed cold cream was estimated as 0.0175% w/w. On the basis of the supplied experimental results, the method is simple and economical and can be useful for routine estimation of sodium benzoate in the tested formulation. Thus, the developed method has the advantage of being solvent free, cost effective and involving relatively simple sample preparation. The developed validated method can be useful for the routine quality control analysis of Sodium Benzoate in cosmetics with desired precise and accuracy.



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CONFLICT OF INTEREST

The authors declare no conflict of interest

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