

**ANALYTICAL METHOD DEVELOPMENT AND VALIDATION OF MARKETED LIQUID
BANDAGE SPRAY USING UV SPECTROSCOPY**¹*Miss. Dhanshri Subhash Jadhav, ²Dr. Sagar E. Tambe., ³Miss. Asmita A. Hulawale^{1,2,3}Department of Pharmacy, Samarth Institute of Pharmacy, Belhe, Pune.***Corresponding Author: Miss. Dhanshri Subhash Jadhav**

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ABSTRACT

The present study focuses on the development and validation of a simple, economical, and reliable UV spectroscopic method for the analysis of marketed liquid bandage spray formulation. Topical spray formulations are increasingly preferred because of their ease of application, rapid drying property, and ability to provide localized therapeutic action. Accurate analytical evaluation of such formulations is essential to ensure quality, efficacy, and safety during pharmaceutical manufacturing and routine quality control. The calibration curve demonstrated good linearity with correlation coefficient close to 0.999, confirming adherence to Beer-Lambert's law. The developed method was validated according to ICH guidelines for parameters including linearity, accuracy, precision, robustness, limit of detection (LOD), and limit of quantification (LOQ). The percentage recovery values were found within acceptable limits, indicating accuracy of the developed method. Precision studies showed low %RSD values, confirming reproducibility of the analytical procedure. The developed UV spectroscopic method was found to be simple, rapid, cost-effective, and suitable for routine pharmaceutical quality control analysis of marketed liquid bandage spray formulations. The method can also be applied in academic laboratories and industrial analytical studies for quantitative estimation of topical pharmaceutical preparations.

KEYWORDS: UV spectroscopy, liquid bandage spray, analytical method development, validation, calibration curve, pharmaceutical analysis.**1. INTRODUCTION**

Topical drug delivery systems are widely employed in pharmaceutical and healthcare applications because they provide localized therapeutic action with minimal systemic side effects. These dosage forms are intended for external application on the skin surface and include creams, gels, ointments, lotions, aerosols, sprays, and transdermal patches. In recent years, liquid bandage spray formulations have gained considerable importance because of their convenience, ease of application, flexibility, and rapid film-forming property. Such formulations form a thin protective coating over wounds, cuts, and abrasions, thereby protecting the affected area from microbial contamination and environmental exposure.

Liquid bandage sprays are increasingly preferred over conventional adhesive bandages because they are easy to apply on irregular surfaces, provide transparent

protection, and reduce discomfort during removal. Their water-resistant nature and rapid drying behaviour improve patient compliance and wound protection. Owing to their increasing pharmaceutical and cosmetic applications, analytical evaluation of these formulations has become essential for ensuring product quality, safety, efficacy, and stability.

Analytical method development is an important aspect of pharmaceutical research and quality assurance. A suitable analytical method should provide accurate, reproducible, precise, and economical results during routine pharmaceutical analysis. Analytical procedures are extensively used during formulation development, stability testing, assay determination, dissolution studies, and quality control applications.

Among various instrumental analytical techniques, UV-Visible spectroscopy remains one of the most commonly

employed methods because of its simplicity, affordability, rapid analysis, and satisfactory sensitivity. UV spectroscopy is based on the absorption of ultraviolet radiation by molecules containing chromophoric groups. The amount of radiation absorbed by the analyte is directly proportional to its concentration according to Beer-Lambert's law.

$$A = \epsilon bc$$

Where:

A = absorbance

E = molar absorptivity

B = path length

C = concentration

UV spectroscopic methods are widely used for quantitative estimation of pharmaceutical compounds because they require relatively simple instrumentation and minimal sample preparation. Several researchers have successfully developed validated UV spectroscopic methods for pharmaceutical formulations including creams, gels, emulsions, topical sprays, and nanocarrier systems.

Validation of analytical methods is another important requirement in pharmaceutical analysis. According to International Council for Harmonisation (ICH) guidelines, analytical methods should be validated for parameters such as linearity, precision, accuracy, robustness, specificity, limit of detection, and limit of quantification. Method validation ensures that the analytical procedure is reliable and suitable for its intended purpose.

The present research work aims to develop and validate a simple UV spectroscopic method for quantitative analysis of marketed liquid bandage spray formulation. The developed method is expected to provide a rapid, reliable, and cost-effective analytical approach suitable for pharmaceutical quality control and academic research applications.

2. LITERATURE REVIEW

2.1 Review of Previous Research

Rawool and Sharannavar (2026): Developed and validated a UV spectrophotometric method for estimation of mupirocin in marketed topical formulations. The method complied with ICH guidelines and demonstrated satisfactory linearity, precision, and recovery values. Their study confirmed the suitability of UV spectroscopy for routine quality control analysis of topical pharmaceutical products.

Mukherjee et al. (2021): Reviewed different UV spectroscopic methods used in pharmaceutical analysis. The authors discussed derivative spectroscopy, simultaneous equation methods, and absorbance ratio techniques. The study highlighted the importance of UV spectroscopy because of its rapid analysis, simplicity, affordability, and reliability in pharmaceutical quality control laboratories.

Rapalli et al. (2020): Reported a UV spectroscopic method for characterization of curcumin-loaded nanostructured lipid carriers intended for topical delivery. The analytical method exhibited good sensitivity, linearity, and reproducibility. Their findings demonstrated that UV spectroscopy is highly useful for quantitative analysis and evaluation of topical drug delivery systems.

Lasure et al. (2020): Developed and validated a UV spectrophotometric method for estimation of acyclovir in pharmaceutical dosage forms. The method showed acceptable accuracy, precision, and robustness according to ICH validation guidelines. The authors concluded that UV spectroscopy provides economical and reliable analytical results for pharmaceutical formulations.

Dinç and Yazan (2018): Reviewed pharmaceutical applications of UV spectroscopy and emphasized its importance in routine drug analysis. The study discussed advantages such as rapid analysis, minimal solvent consumption, affordability, and simple instrumentation. The authors concluded that UV spectroscopic methods remain widely preferred in pharmaceutical analytical laboratories.

Kaur et al. (2017): Developed and validated a UV spectrophotometric method for estimation of hydroquinone in marketed cream formulations. The method demonstrated excellent linearity, precision, and recovery within the selected concentration range. Their study confirmed that UV spectroscopy is suitable for routine analysis of topical pharmaceutical dosage forms.

Mishra et al. (2014): Developed a UV spectrophotometric method for estimation of metronidazole benzoate in pharmaceutical formulations. The analytical procedure showed satisfactory reproducibility, sensitivity, and linearity. The study confirmed that UV spectroscopy is a simple and economical method for quantitative pharmaceutical estimation.

Jain et al. (2011): Developed a validated UV spectrophotometric method for determination of terbinafine hydrochloride in pharmaceutical dosage forms. The developed method exhibited good accuracy and precision with low percentage relative standard deviation values.

Sethi (2008): Discussed quantitative analysis of pharmaceutical formulations using UV spectroscopic techniques. The author explained principles of Beer-Lambert's law, calibration curve preparation, and analytical validation. The study highlighted the importance of UV spectroscopy in pharmaceutical quality control because of its simplicity, sensitivity, and cost-effectiveness.

Kedor-Hackmann et al. (2006): Developed a first-derivative UV spectrophotometric method for determination of ketoconazole in pharmaceutical emulsions. The study demonstrated satisfactory precision and reproducibility. Their findings confirmed that UV spectroscopy is highly effective for analytical estimation of topical pharmaceutical formulations and emulsions.

3. AIM AND OBJECTIVES

AIM

To develop and validate a simple UV spectroscopic method for pharmaceutical analysis of marketed liquid bandage spray formulation.

Objectives

1. To determine λ_{max} of the drug using UV spectroscopy.
2. To prepare calibration standards and calibration

4.2 Instruments Used

Table 1: Instruments and its Specifications.

Instrument	Specification
UV-Visible Spectrophotometer	Shimadzu UV-1900
Quartz Cuvette	1 cm path length
Analytical Balance	Digital balance
Volumetric Flask	10 mL and 100 mL
Pipettes	Standard laboratory pipettes

4.3 Determination of λ_{max}

Accurately prepared standard drug solution was scanned in the wavelength range of 200–500 nm using methanol as blank. The wavelength showing maximum absorbance was selected as λ_{max} . The λ_{max} was observed at 425 nm.

4.4 Preparation of Stock Solution

Accurately weighed 10 mg of drug was transferred into a 100 mL volumetric flask. The drug was dissolved in methanol and the volume was made up to 100 mL with methanol to obtain a stock solution of concentration 100 $\mu\text{g/mL}$.

4.5 Preparation of Calibration Standards

Aliquots of stock solution were diluted with methanol to prepare concentrations ranging from 10–50 $\mu\text{g/mL}$.

Table 2: Calibration Data.

Aliquot Taken	Diluted To	Final Concentration
1 mL	10 mL	10 $\mu\text{g/mL}$
2 mL	10 mL	20 $\mu\text{g/mL}$
3 mL	10 mL	30 $\mu\text{g/mL}$
4 mL	10 mL	40 $\mu\text{g/mL}$
5 mL	10 mL	50 $\mu\text{g/mL}$

4.6 Measurement of Absorbance

Absorbance of prepared calibration standards was measured at 425 nm using methanol as blank.

curve.

3. To apply Beer-Lambert’s law for quantitative estimation.
4. To validate the developed analytical method according to ICH guidelines.
5. To estimate drug content in marketed liquid bandage spray formulation.
6. To evaluate linearity, accuracy, precision, robustness, LOD and LOQ.

4. MATERIALS AND METHODS

4.1 Materials

The marketed liquid bandage spray formulation was procured from the local pharmaceutical market. Methanol of analytical grade was used throughout the study. Distilled water and other laboratory reagents used were of analytical grade.

Table 3: Absorbance Data.

Concentration ($\mu\text{g/mL}$)	Absorbance
10	0.21
20	0.39
30	0.58
40	0.77
50	0.95

4.7 Preparation of Sample Solution

Marketed liquid bandage spray sample was extracted using methanol. Approximately 20–30 mL methanol was added and the solution was shaken for 5–10 minutes. The solution was filtered to obtain clear filtrate. One millilitre of filtrate was diluted to 10 mL with methanol and analyzed at 425 nm.

Calculation of Concentration of Sample	
Regression equation, $y = 0.0185x + 0.02$ Where, $y = \text{Absorbance of sample} = 0.43$ $c = \text{Intercept} = 0.02$ $m = \text{Slope} = 0.0185$ $x = (y - c) / m$ $x = (0.43 - 0.02) / 0.0185$ $x = 22.16 \mu\text{g/mL (in diluted sample)}$	Dilution factor = 10 Actual concentration in sample $= 22.16 \times 10$ $= 221.6 \mu\text{g/mL}$

Fig. 4: Calculation for Sample Concentration

5. Method Validation

5.1 Linearity

The calibration curve showed good linearity within concentration range of 10–50 µg/mL. Regression equation: $y = 0.0185x + 0.02$
Correlation coefficient: $R^2 = 0.999$

5.2 Precision

Precision was evaluated by measuring absorbance of sample solution three times.

Table 4: Precision Data (Intra-day).

Trial	Absorbance	Mean± SD	%RSD
1	0.579	0.579 ± 0.0015	0.26%
2	0.581		
3	0.578		

The %RSD value was found below 2%, indicating good precision.

5.3 Accuracy

Accuracy of developed method was evaluated by recovery studies.

Table 5: Accuracy Data.

Level	Amount Added	Amount Found	% Recovery
80%	8 mg	7.95 mg	99.37
100%	10 mg	10.02 mg	100.20
120%	12 mg	11.96 mg	99.66

5.4 Limit of Detection and Limit of Quantification

Table 6: LOD and LOQ Data.

Parameter	Value
LOD	0.14 µg/mL
LOQ	0.43 µg/mL

5.5 Robustness

Table 7: Robustness Data.

Parameter Changed	Observation
$\lambda_{max} \pm 2$ nm	No significant change
Methanol variation	Stable absorbance

6. RESULTS AND DISCUSSION

The developed UV spectroscopic method demonstrated satisfactory analytical performance for estimation of marketed liquid bandage spray formulation. The λ_{max} of the drug was observed at 425 nm using methanol as blank solvent. Calibration standards prepared within concentration range of 10–50 µg/mL exhibited linear increase in absorbance values, confirming compliance with Beer-Lambert’s law.

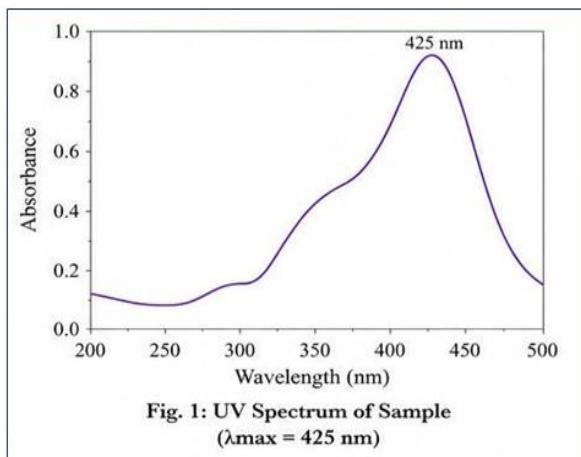


Fig. 1: UV Spectrum of Sample ($\lambda_{max} = 425$ nm)

The calibration curve showed excellent linearity with correlation coefficient value of 0.999. The developed

method was found suitable for quantitative analysis because absorbance values remained within acceptable analytical range.

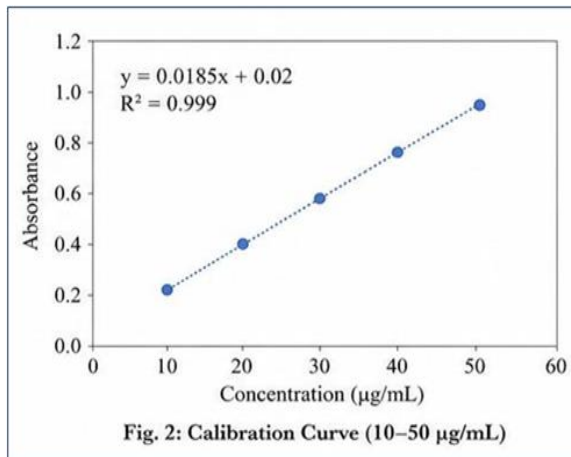


Fig. 2: Calibration Curve (10–50 µg/mL)

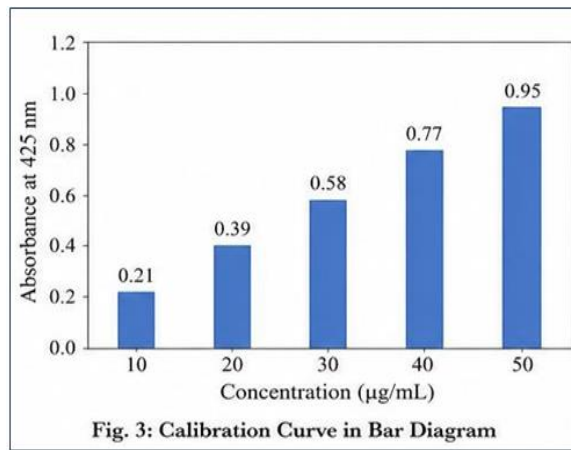


Fig. 3: Calibration Curve in Bar Diagram

Precision studies demonstrated low %RSD values, indicating reproducibility and reliability of the analytical procedure. Accuracy studies showed percentage recovery values close to 100%, confirming absence of analytical interference and suitability of the developed method for

pharmaceutical estimation.

The LOD and LOQ values indicated adequate sensitivity of the method for routine quality control applications. Robustness studies confirmed that minor variation in wavelength and solvent conditions did not significantly affect absorbance values.

Drug content analysis of marketed formulation demonstrated acceptable assay values within pharmaceutical limits. The developed method was found economical, rapid, and easy to perform compared to advanced chromatographic methods requiring expensive instrumentation and complex sample preparation.

Calculation of % Drug Content
Expected concentration = 220 µg/mL
Found concentration = 221.6 µg/mL
% Drug Content = (Actual Found / Expected) × 100
= (221.6 / 220) × 100
= 100.72 %

Fig. 5: Calculation for % Drug Content

The overall study confirmed that UV spectroscopy is highly suitable for routine pharmaceutical analysis of topical spray formulations.

7. Advantages of Developed Method

1. Simple analytical procedure.
2. Economical and cost-effective.
3. Rapid analysis.
4. Minimal solvent requirement.
5. Good accuracy and precision.
6. Suitable for routine quality control.
7. Minimal sample preparation.
8. Applicable in academic and industrial laboratories.

8. CONCLUSION

The present study successfully developed and validated a simple UV spectroscopic method for pharmaceutical analysis of marketed liquid bandage spray formulation. The method demonstrated good linearity, accuracy, precision, robustness, and sensitivity according to ICH validation guidelines.

The developed analytical method was found suitable for routine quality control analysis because of its simplicity, rapidness, and economical nature. The method can be effectively applied in pharmaceutical industries and academic laboratories for quantitative estimation of topical spray formulations.

The study confirms that UV spectroscopy remains a

reliable and widely applicable analytical technique for pharmaceutical research and quality evaluation of topical drug delivery systems.

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