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Review Paper

Recent Developments in UV-Visible Spectrophotometry for Sodium Benzoate Analysis in Beverages

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ABSTRACT

Sodium benzoate's antibacterial properties make it an extensively used beverage preservative. For its quantification, UV-visible spectrophotometry persists as one of the most popular and efficient approaches to analysis. Recent innovations have enhanced the approach's sensitivity, accuracy, and selectivity, strengthening reliability for routine analysis. Novel approaches for the preparation of samples, chemometric procedures, and sensor integration are among the most recent innovations in spectrophotometry using ultraviolet (UV) light for sodium benzoate estimation that will be discussed in this review.

INTRODUCTION

A popular food preservative that prolongs the shelf life of beverages by inhibiting bacterial growth is sodium benzoate [1]. Because regulatory bodies like the FDA and EFSA have set acceptable limits for sodium benzoate in beverages, precise and trustworthy analytical techniques are required [2]. Because of its ease of use, affordability, and non-destructive characteristics, UV-visible spectrophotometry has become a standard technique [3].

2. Principles of UV-Visible Spectrophotometry

The basic principle of UV-visible spectrophotometry is the way sodium benzoate absorbs light in the UV spectrum, that is normally between 230 and 250 nm [4]. The method correlates absorbance with concentration in accordance with Beer-Lambert's law [5]. To maximize the absorbance properties and improve detection sensitivity, a variety of solvent solutions and pH changes have been investigated [6].

3. Recent Methodological Advances

3.1. Sample Preparation Techniques To enhance the sensitivity and selectivity of UV-Vis spectrophotometry, effective sample preparation methods such cloud point extraction (CPE) and solid-phase extraction (SPE) have been developed [7]. Analysis time and environmental effect have

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decreased with the use of green solvents and minimal sample handling [8].

3.2. Chemometric Approaches To improve the precision of sodium benzoate quantification, recent research has used chemometric methods such partial least squares regression (PLSR) and principal component analysis (PCA) [9]. By resolving overlapping spectra, these techniques reduce interference from additional beverage ingredients [10].

3.3. Sensor Integration and Automation Smartphone-based detection in inadequate, compact UV-visible spectrophotometers has made them a viable tool for on-site analysis [11]. Real-time monitoring and quality control have been made easier by integration with artificial intelligence (AI) technologies [12].

4. Applications in Beverage Analysis The effectiveness of UV-visible spectrophotometry for sodium benzoate analysis in various beverage matrices, such as fruit juices, energy drinks, and soft drinks, has been shown in a number of studies [13]. To lessen matrix effects and increase accuracy, sophisticated matrix-matching calibration methods have been created [14].

5. Challenges and Future Prospects Matrix interference, detection limits, and regulatory compliance are among the issues that still exist despite tremendous progress [15]. For improved specificity and sensitivity, future studies should concentrate on hybrid analytical methodologies that integrate chromatographic and electrochemical methods with UV-visible spectrophotometry [16].

CONCLUSION:

UV-visible spectrophotometry is still a useful method for analyzing beverages for sodium benzoate. Recent advancements in sensor technology, chemometrics, and sample preparation have increased the technique's utility and dependability. Its function in beverage quality control is anticipated to be strengthened by additional research in automation and hybrid approaches.

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