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Review

Enantiomeric separation of drugs by HPLC

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Abstract

The need to separate drug enantiomers isn't just a technical challenge it s a crucial aspect of making medicines safer and more effective. High-Performance Liquid Chromatography (HPLC) has proven itself as a reliable tool for achieving precise and reproducible enantiomeric separations. This review explores various strategies for enantiomeric separation via HPLC, from the use of chiral stationary phases to clever tweaks in the mobile phase. We ll also dive into real-world applications, the hurdles researchers face, and how the field is evolving.

Keywords: Enantiomeric separation, CSPs, HPLC, Chirality in pharmaceuticals, Drug purity.

1. INTRODUCTION

Chirality is at the heart of how many drugs work. Because enantiomers molecules that are mirror images of each other can behave very differently in the body, it's critical to separate them accurately. One enantiomer might have therapeutic effects, while the other could be inactive or even harmful. That's where HPLC shines, offering a high-resolution, flexible method for separating enantiomers in pharmaceuticals.

2. Principles of Enantiomeric Separation by HPLC

HPLC separates enantiomers by creating a chiral environment, usually with a chiral stationary phase (CSP) or by converting enantiomers into diastereomers. Several factors influence how well the separation works:
- Chiral stationary phases (CSPs)
- Mobile phase composition
- Temperature
- Flow rate
- Detection methods

3. Chiral Stationary Phases (CSPs)

The CSPs are the backbone of enantiomeric separation using HPLC. They work by interacting differently with each enantiomer, leading to their separation. Common types include:

- Polysaccharide-based CSPs (e.g., cellulose and amylose derivatives) [1].
- Protein-based CSPs (e.g., albumin, 1-acid glycoprotein) [2].
- Cyclodextrin-based CSPs [3].
- Crown ether-based CSPs [4].
- Macrocyclic glycopeptide CSPs [5].

Each type offers unique interactions like hydrogen bonding or - interactions that allow them to distinguish between enantiomers.

4. **Mobile Phase Modifications**

The mobile phase isn't just a carrier; it's a critical part of making enantiomeric separation work. Researchers often fine-tune solvents like alcohols, water, and organic modifiers to enhance resolution. Factors like pH, ionic strength, and additives can make or break a separation [6].

5. Derivatization Techniques

When direct separation isn t working, chemists often turn to derivatization chemically modifying enantiomers to turn them into something easier to separate, like diastereomers. Common reagents include chiral acids and amines that interact with analytes through covalent or ionic bonds [7].

6. Detection Methods

Choosing the right detection method is essential. Options include:

- Ultraviolet (UV) Detection
- Fluorescence Detection
- Mass Spectrometry (MS)
- Polarimetric Detection
- Circular Dichroism Detection [8].

7. Applications in Pharmaceutical Analysis

HPLC-based enantiomeric separation is invaluable for:

- Ensuring drug purity and quality [9].
- Conducting pharmacokinetic studies [10].
- Profiling metabolites [11].
- Detecting impurities [12].

8. Challenges and Future Perspectives

Despite all the progress, challenges remain. High costs of CSPs, lengthy analysis times, and limited compatibility with different compounds still present hurdles. Researchers are continually seeking cheaper, faster, and greener alternatives to improve enantiomeric separation [13].

9. CONCLUSION

HPLC remains a go-to technique for separating enantiomers, especially in the pharmaceutical industry. As new technologies and methods emerge, we can expect even more efficient and cost-effective approaches to tackle this complex problem.

Author Contributions

Mohd Baqir, Shubham Singh & Kulbir Singh have written the draft and revised review, editing, & rewriting & Finalized the manuscript,&Tanya sharma was responsible for editing. supervision of the manuscript. All authors approved the manuscript.

Competing interests

The authors declare no conflicts of interest.

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