IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 1, July 2024

Reverse Phase HPLC: A Critical Review of its Role in Pharmaceutical and Biomedical Analysis

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Abstract: *Reverse Phase High-Performance Liquid Chromatography (RP-HPLC) stands as a fundamental analytical technique in both pharmaceutical and biomedical research. This review provides an overview of RP-HPLC's principles, technological advancements, applications, challenges, and future prospects. RP-HPLC plays a crucial role in drug development and quality control by enabling precise separation and quantification of active pharmaceutical ingredients (APIs), impurities, and biomarkers in complex matrices. Its versatility extends to biomedical analysis, where it facilitates the study of biomarkers, metabolites, and proteins in disease diagnosis and therapeutic monitoring. Technological advancements in RP-HPLC, such as miniaturization, microfluidic systems, and advanced column technologies, have enhanced analytical capabilities by improving sensitivity, resolution, and throughput. Integration with sensitive detection methods like mass spectrometry further enhances RP-HPLC's utility in detecting trace-level analytes and complex biological samples. Despite its strengths, RP-HPLC faces challenges such as sample preparation complexities, matrix effects, and limitations in sensitivity for low-abundance compounds. Looking forward, ongoing research aims to optimize RP-HPLC methods, explore novel applications, and integrate with emerging technologies to overcome current limitations. These efforts position RP-HPLC at the forefront of analytical sciences, driving innovation in pharmaceutical development, biomedical research, and personalized medicine, with potential implications for improving healthcare outcomes globally.*

Keywords: RP-HPLC, pharmaceutical analysis, biomedical analysis, chromatography, method development.