JOURNAL OF APPLIED SCIENCE AND SOCIAL SCIENCE
eISSN 2229-3113 pISSN 2229-3205
Volume 15 Issue 03, March 2025
Impact factor: 2019: 4.679 2020: 5.015 2021: 5.436, 2022: 5.242, 2023: 6.995, 2024 7.75

THE ROLE OF THIN-LAYER CHROMATOGRAPHY IN BIOTECHNOLOGY

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Abstract: Thin-layer chromatography (TLC) is a widely used analytical technique in biotechnology for the separation, identification, and analysis of biomolecules. Its simplicity, cost-effectiveness, and versatility make it an essential tool in various biotechnological applications, including pharmaceutical research, food safety, and genetic engineering. This paper discusses the principles, methodologies, and significance of TLC in biotechnology.

Key words: Thin-layer chromatography (TLC), biotechnology, chromatographic techniques, analytical chemistry, separation methods, bioanalysis, stationary phase, mobile phase, Rf value, sample identification

Introduction: Biotechnology relies on various analytical techniques to isolate and analyze biomolecules such as proteins, nucleic acids, and metabolites. Thin-layer chromatography is one such technique that provides a rapid and efficient means of separating components based on their affinity for a stationary and mobile phase. Its applications in biotechnology range from drug analysis to the detection of contaminants in biological samples.

Principles of Thin-Layer Chromatography: TLC is based on the principle of differential migration of analytes along a stationary phase, typically a silica gel or alumina-coated plate, under the influence of a mobile phase (solvent system). The separation occurs due to differences in polarity, molecular size, and interactions between the analytes and the stationary phase. After the chromatographic run, visualization techniques such as UV light, staining, or chemical reagents help detect and quantify separated components.

Applications of TLC in biotechnology: Pharmaceutical and drug analysis-TLC is extensively used in the pharmaceutical industry for the quality control of antibiotics, alkaloids, and other bioactive compounds. Protein and peptide analysis-separation and identification of peptides and proteins are crucial in proteomics and biomedical research. TLC aids in analyzing enzymatic digests and amino acid composition. Food and agricultural biotechnology-detection of mycotoxins, pesticides, and food additives ensures food safety. TLC provides a cost-effective method for screening these contaminants. Genetic and molecular biology-although less commonly used for nucleic acids, TLC can assist in analyzing small molecules involved in genetic engineering, such as nucleosides and nucleotides. Environmental biotechnology-monitoring pollutants and analyzing microbial metabolites are critical for environmental protection, where TLC plays a vital role in detecting organic contaminants.

Advantages and Limitations: TLC offers several advantages, including ease of use, rapid analysis, and low operational costs. However, it has limitations in resolution and quantification compared to advanced chromatographic techniques like high-performance liquid chromatography (HPLC). Nevertheless, it remains an invaluable tool in preliminary analyses and screening purposes in biotechnology.

Conclusion: Thin-layer chromatography continues to be a fundamental technique in biotechnology due to its simplicity, affordability, and effectiveness. While newer and more sophisticated methods are available, TLC remains a preferred choice for preliminary screening and qualitative analysis. Further advancements in TLC methodologies, such as high-performance TLC (HPTLC), will likely enhance its applicability in modern biotechnological research.

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