



## Liquid Chromatography: Methods and Utilizations

Eden Rayan\*

*Department of Biomolecules, University of Calgary, Calgary, USA*

### DESCRIPTION

Fluid chromatography stands as a dynamic separation technique with wide-ranging applications across scientific and industrial sectors. It encompasses a diverse set of chromatographic methods reliant on the movement of a mobile phase through a stationary phase to effectively separate and analyze intricate mixtures. This study presents an inclusive overview of fluid chromatography encompassing its techniques and applications. Liquid chromatography ranks as the most prevalent form of fluid chromatography. It employs a liquid mobile phase typically comprising a solvent or solvent mix to transport through a stationary phase. This phase can be either packed into a column or coated onto a solid support. High-Performance Liquid Chromatography (HPLC), Ultra-High-Performance Liquid Chromatography (UHPLC) and Ion Chromatography (IC) are all subsumed under LC techniques. These methods excel in delivering high resolution, sensitivity and adaptability for separating and quantifying an extensive array of compounds.

Gas Chromatography despite its association with gas as the mobile phase gas chromatography can also incorporate a liquid stationary phase. GC entails separating volatile compounds based on their partitioning behavior between the mobile and stationary phases. The sample is vaporized and introduced into a heated column where it interacts with the stationary phase. GC boasts high efficiency and widespread application in the analysis of volatile and semi-volatile organic compounds including hydrocarbons, pesticides and pharmaceuticals. Supercritical Fluid Chromatography (SFC) employs a supercritical fluid typically carbon dioxide as the mobile phase. By manipulating temperature and pressure carbon dioxide is rendered supercritical showcasing characteristics of both gases and liquids. SFC offers distinct advantages such as low viscosity high diffusivity and compatibility with a diverse range. This technique finds utility in the separation of pharmaceuticals, natural products, chiral compounds, and thermally sensitive substances.

Size Exclusion Chromatography (SEC) Known as Gel Permeation Chromatography (GPC) or Gel Filtration Chromatography (GFC), SEC segregates based on their sizes. It utilizes a porous stationary phase allowing smaller molecules to

access pores leading to extended retention times. Conversely larger molecules do not enter these pores and thus elute earlier. SEC is widely employed to characterize polymers, proteins and biomolecules. Fluid chromatography immense significance in pharmaceutical analysis facilitating the identification and quantification of Active Pharmaceutical Ingredients (APIs), impurities and degradation products. It plays a vital role in quality control for pharmaceutical products and ensuring adherence to regulatory standards. High-Performance Liquid Chromatography (HPLC) and Supercritical Fluid Chromatography (SFC) are extensively applied in drug discovery, formulation development and pharmacokinetic studies.

Fluid chromatography techniques feature extensively in environmental monitoring to detect and quantify pollutants and contaminants. These methods analyze diverse samples such as water, air, soil, and biological specimens to ascertain the presence of pesticides, heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs) and other environmental pollutants. Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC) are commonly utilized, offering sensitive and selective analysis. Fluid chromatography plays a vital role in the analysis of food and beverages, guaranteeing product quality, safety and regulatory compliance. It aids in the identification and quantification of additives, preservatives, pesticide residues, mycotoxins and other contaminants. Moreover these techniques enable the characterization and authentication of food items, such as determining the origin and composition of wines and spirits. Fluid chromatography techniques have revolutionized separation science offering robust tools for analytical and preparative applications. Whether it's liquid chromatography, gas chromatography, supercritical fluid chromatography or size exclusion chromatography each technique brings distinct advantages Customized to specific applications. The wide spectrum of applications spanning pharmaceutical analysis, environmental monitoring, food and beverage analysis and forensic science underscores the versatility and profound impact of fluid chromatography across diverse scientific and industrial domains. As technology advances and methods evolve, fluid chromatography continues to contribute significantly to scientific progress and societal well-being.

**Correspondence to:** Eden Rayan, Department of Biomolecules, University of Calgary, Calgary, USA, E-mail: rayan@gmail.com

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