APPLICATIONS OF SUPERCRITICAL FLUID CHROMATOGRAPHY

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ABSTRACT:
Supercritical fluid chromatography is a combination of High Performance Liquid Chromatography and Gas Chromatography. The technique uses material that can be either liquid or gas used in state above critical temperature or critical pressure where gases and liquid can coexist, hence it is known as Supercritical Fluid Chromatography. The principle is based on supercritical fluid. It is a technique of separation of mixture by a technique that is characteristically a hybrid of both gas and liquid chromatography. Advantages of supercritical fluids over carrier gases and liquid mobile phases are its solubility properties, physical properties, and detector compatibility. It can also be further divided on the basis of the medium of separation. Aim of the present review is to analyse the applications and properties of supercritical fluid chromatography.
Keywords: chromatography, supercritical fluid, separation, application

INTRODUCTION:

Supercritical fluid chromatography (SFC) is a subset of high-performance liquid chromatography (HPLC), which uses the same instrumentation and methodology. The individual components of complex mixtures are separated from each other based on the difference in interaction between a stationary and mobile phase, which is common to all chromatographic technique. SFC uses a relatively dense, compressible fluid as the mobile phase, which acts as a solvent. Based on the instrumentation, the prime difference between HPLC and SFC is the presence of a back pressure regulator downstream of most detectors which blocks the compressed mobile phase from expanding to a gas till the separation is finished. Supercritical fluid chromatography (SFC) plays a major role in industrial purpose for separation of chiral molecules. SFC commonly utilizes chiral separation and purification which has several advantages in pharmaceutical industries. Also this technique has several special applications like they had been used in petroleum industry for the separation process (1). Supercritical fluid chromatography is used for the identification of opiates, Cannabinoids, cocaine and other stimulant amphetamines-sedatives (2). Supercritical fluid chromatography used in the development of SFC improved detection capabilities to use small board columns (3). Search led to rapid efficient cost effective analytical measurements introduced for practical fluid chromatography done in field analytical chemistry (4,5). Supercritical fluid chromatography coupled with microscale supercritical fluid chromatography permits the characterisation of small samples such as portions of single seeds and extractables from single live insects (6).

Previous study investigation is necessary to develop better physical understanding on the supercritical fluid chromatography (7). SFC is employed for the separations involving nonvolatile or thermally labile species which are unable to separate by gas or liquid chromatography. Supercritical mobile phase, typically CO2, have solute diffusivities and viscosities that are intermediate between those for gases and liquids. Supercritical CO2 is generated by subjecting the gas to high pressures. Supercritical fluid chromatography has more advantage over gas chromatography separation at lower volatile rate (1).

Numerous researches have been conducted by our team in various fields. Studies have been conducted in cancer biology, which includes breast cancer(8), hepatic carcinoma(9), laryngeal cancer(10), oral cancer(11)(12), and thyroid cancer(13) etc. Studies are also focussed on metabolic disorders(14)(15), herbal medicines(16)(17), active constituents(18) (19), nanoparticles(20)(21) and protein characterization(22). This review was written in an effort to highlight the various applications of supercritical fluid chromatography. This technique has applications

FOOD INDUSTRY

A technology based on metabolomics for lipid profiling based on SFC coupled with mass spectrometry was applied for analyzing lipids of soybean. By PCA assay, triacylglycerol (TAG) was found as the main variable for discrimination of soybean cultivars. Therefore, a high-throughput and high-resolution TAG profiling method by SFC/MS was developed to more effective discrimination (23). Thus, although the composition of food is complex, SFC remains a powerful tool in food analysis with some simple sample pretreatment techniques, such as liquid–liquid extraction and solid-phase extraction (7,24). Analytical methods like pesticide detection and lipid analysis, new method of eliminating hexane -soybean . Supercritical fluids in the food industry are divided into six different areas: modeling of supercritical fluids, separation of extracted material, supercritical carbon dioxide as a solvent for extraction, supercritical fluids and analytical uses, and supercritical fluids and novel methods of food processing. Total extraction and fractionation of foodstuffs employing SCFs are compared and are illustrated by using multiple fluids and unit processes to obtain the desired food product. Some of the additional prophylactic benefits of using carbon dioxide as the processing fluid are explained and illustrated with multiple examples of commercial products produced using SCF media (25).

INDUSTRIAL APPLICATIONS

SFC employs carbon dioxide as a common supercritical fluid at lower critical temperature (26). SFC is useful in the faster analysis of thermally labile, non-volatile materials, ethoxylated alcohols, inositol triphosphate, peroxidase, tri glycerine, saturated fatty acids etc. (27). Superficial and pressurised liquid extraction frequently involves complex sample matrices where the theoretical advantage of superficial liquid extraction and pressurised liquid extraction may not be fully realized due to rate limiting matrix effects. In petroleum industry simulated distillation is used to to provide the hydrocarbon distribution of the sample in weight percent versus the boiling range of the fraction. The hydrocarbons are separated by saturated olefin aromatic bands and saturated colour less olefin bands (28). SFC is used to separate chiral molecules and in the purification of pharmaceutical products. It is also used to quantify the chiral molecule in drugs. The interface included provisions for maintaining SFC oven temperature to the ion source region and for independent heating of the flow restrictor terminus (29). SFC has important advantages for the separation of low-volatile or thermally unstable substances, it is used for various special applications and preparative separations. All these make SFC an effective many separation processes in the industry. Supercritical fluids are already applied in several processes developed to commercial scale in pharmaceutical, food and textile industries (30).

METABOLITE ANALYSIS

SFC is a useful separation for hydrophobic metabolites (31) which is established by fingerprinting, profiling, diverse lipids in SFC (13). SFC is a high-resolution technique that is suitable for non-targeted profiling aimed at the simultaneous analysis of many components. Next, targeted lipid profiling by SFC/MS is described. SFC is useful for the separation of lipids, such as carotenoids and triacylglycerols, which have numerous analogs with similar structures (32). This technique is involved in the separation of not only nonpolar but also for polar compounds. There is no surface tension in a supercritical fluid, as there is no liquid/gas phase boundary. Solubility in a supercritical fluid tends to increase with density of the fluid. Since density increases with pressure, solubility tends to increase with pressure (31). At constant density, solubility will increase with temperature. Good solubilizing and penetrating property. Inert to the product, Easy separation from the product, Cheap, Low CP because of economic areas. chains. SFC is a useful separation technology for hydrophobic metabolites, which are difficult to be separated by HPLC. Sensitive and selective detection is crucial in metabolite analysis (33). The SFC/MS system can be an alternative approach to liquid chromatography, as can metabolite analysis using packed-column SFC in biosamples. SFC can also be used to perform high-precision biomolecular analysis, especially for hydrophobic metabolites, because of the low polarity of supercritical CO2. The use of a mass spectrometer with SFC can widen the scope of application of SFC to bioanalysis (34).

PHARMACEUTICAL ANALYSIS

Determination of drugs in formulations of bio fluids in advanced SFC that is supercritical fluid chromatography. Availability that are reliable, efficient, and essential and requirements that make up a solvent to the best compromise that exhibited good detection on sensitivity (12,16). Use of supercritical fluids, particularly carbon dioxide, results in an effective reduction in the use of organic solvents, and has cost efficient , health, and safety benefits (35). Supercritical fluid chromatography is an adequate tool for small molecules of pharmaceutical interest: synthetic intermediates, active pharmaceutical ingredients, impurities, or degradation products. Due to high advantages of SFC in terms of kinetic performance and its complementarity to LC, advanced packed-column SFC represents today an additional strategy in the toolbox of the analytical scientist, which may be particularly interesting in pharmaceutical analysis (28). The SFC screen allows resolution of compounds that were partially separated by NPLC or not separated at all by RPLC, demonstrating the utility of implementing complementary chromatographic techniques. The SFC screen is currently an integral part of our analytical support to discovery chemical programs (36). Packed column SFC has been extensively used in clinical and pharmaceutical laboratories, especially for separation of nonpolar and chiral drugs. Use of carbon dioxide as the mobile phase in SFC offers many advantages including high flow rate, short equilibration time as well as low solvent consumption (37).

DISCUSSION

Mini separation by this method is carried out with the supercritical carbon dioxide. Although the carbon dioxide has practical advantages including its near-ambient critical temperature (23). Which closely correlates with our present study and previous studies. The minimal interference With spectrometric detection, the use of other supercritical fluid on addition of modifiers to carbon dioxide may extend the application of this technique. Despite some major potential advantages of this supercritical fluid chromatography are generally only now beginning to be considered by the mainstream of the community but still does not enjoy their popularity comparable to those gas or liquid chromatography. The other limitation of this Technology is difficulty in maintaining pressure , Back Pressure regulation. The future scope of this present study is the proper application of this supercritical Fluid Chromatography Technique Appropriate manner in respective industries (38).

The complexity of the behaviour-supercritical fluid in the chromatographic systems when the temperature pressure and the composition changes. The present study has some limitations with limited adoption of SFC that is the supercritical fluid Chromatography technology, its operating conditions, higher pressure, expensive and bulky vessels, Special materials are often needed to avoid-dissolving gaskets, o-Ring, supercritical fluid. Various studies on cancer biology have been done previously in our department (39).

CONCLUSION:

SFC can be used on an analytical scale. It is a combination of High performance liquid chromatography HPLC and Gas chromatography can be used with non-volatile and thermally labile analytes, can be used with the universal flame ionization detector, is important to producing narrower peaks due to rapid diffusion and It is important for the chiral separations and analysis of high-molecular-weight hydrocarbons. Supercritical fluids are suitable as a substitute for organic solvents in a range of industrial and laboratory processes.Supercritical fluid chromatography is sometimes called Convergence chromatography .The applications and methodology received the time factor and most common competition to choose for preparation of chromatography process. Although their efforts continued to develop Ready to models for the selection of operating conditions.

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