Trends Phytochem. Res. 4(4) 2020 201-202

Trends in Phytochemical Research (TPR)

Journal Homepage: http://tpr.iau-shahrood.ac.ir

Guest Editorial

Droplet Counter Current Chromatography (DCCC) in herbal analysis

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About half a century ago, the separation science was blessed with the introduction of a new liquid-liquid separation technique called droplet counter current chromatography (DCCC) that combined principles of counter current distribution and counter current chromatography, and employed a liquid stationary phase held in a cluster of vertical glass columns connected in series (Fig. 1) (Tanimura et al., 1970; Hostettmann et al., 1980; McAlpine et al., 2012). In fact, DCCC is based on the partitioning of solutes between a constant stream of droplets of mobile phase and a column of surrounding stationary phase (Hostettmann et al., 1979). Simply, as the mobile phase passes through the stationary phase, compounds more soluble in the mobile phase are eluted quicker than compounds that are more soluble in the stationary phase. The separation occurs because of partitioning of compounds between the two liquid phases. The advantage of this method relies on the fact that it does not use any solid stationary phase, and thus is free from any irreversible adsorption of compounds on the stationary phase.

DCCC has been developed as an efficient separation tool for the isolation of various components from herbs and herbal products. It has appeared as an ideal method for separation of predominantly polar compounds. However, the use of DCCC in the isolation of less polar, medium polarity or even non-polar compounds (e.g., β-carotene and lutein) from herbal matrices has also been exemplified in the published literature (Hostettmann et al., 1977; Francis and Isaksen, 1989). Among the earlier applications of DCCC in the isolation of natural products from plant sources, the purification of four bioactive saponins from the crude extract of *Hedera helix* berries, and two saponins from the bark of *Cornus florida* could be two excellent examples (Hostettmann et al., 1979). DCCC was successfully applied for the purification of phenolic compounds, lignans (9α-hydroxysesamin, 9β-hydroxysesamin and pinoresinol) and flavonoids (kaempfertol and quercetin) from *Cuscuta racemosa*, a well-known herbal medicine that is used as an anti-inflammatory and a diuretic, for stomach and hepatic disorders, and for treating fresh wounds. In this separation, a solvent system comprising *n*-hexane: ethyl acetate: methanol: water (1:2:1:1) was applied (Sousa et al., 2012). Several other examples of the use of DCCC in the analysis of herbal medicine could be found only until the middle part of 2012 (Rodriguez et al., 2009; Szakiel et al., 2011; Sousa et al., 2012).

The use of DCCC in recent years has almost been replaced by its modern alternative, high-speed counter-current chromatography (HSCCC) for the analysis of herbal medicine (Chen et al., 2020; Gong et al., 2020; Wang et al., 2020). However, research labs, who still have an active DCCC set up, can successfully utilize this low-cost and simple technique for the isolation of components in preparative scale from herbs and their commercial medicinal products; DCCC is old, but not totally obsolete.

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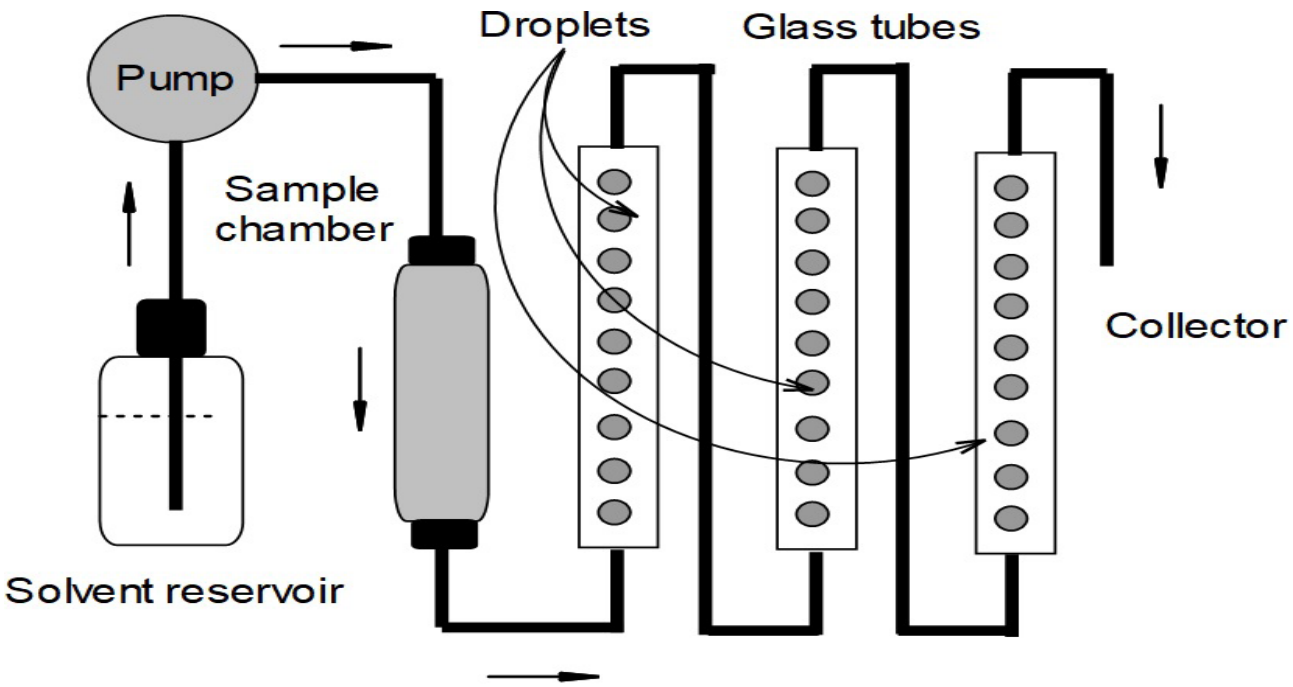

Fig. 1. A schematic diagram of droplet counter current chromatographic (DCCC) system.

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