UPLC-MS: A Powerful Tool in Analytical Research

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Editorial

The emergence of ultra-performance liquid chromatography (UPLC) coupled to mass spectrometry (MS) as an alternative to traditional high-performance liquid chromatography techniques is a powerful technique that combines the physical separation capabilities of liquid chromatography with the mass analysis capabilities of mass spectroscopy with significant gains in resolution and sensitivity and marked reductions in the overall time of analysis [1]. UPLC is an advanced technique which consists of narrow bore columns with very fine packing materials (approximate particle size: 1.7μm) and the mobile phases are introduced at ultra-high pressures [2]. The typical UPLC instrument is designed in such a way that the integrated system from pump (withstand a pressure up to 15000 psi) to auto sampler, heater, detector, software are fully compatible with the small particle technology [3]. Due to this advancement, ultra-sensitive responses are obtained and ultimately detection sensitivity by MS is enhanced [4]. UPLC- MS technique has tremendous applications in various analytical procedures which include: toxicity analysis, analysis of food stuffs, beverages, identification of drug metabolites in biological samples, for simultaneous extraction and screening of diuretics, beta-blockers, steroids in human fluids, Functional Genomic Studies and multi-residue analysis of pharmaceuticals in waste water etc.

Cannabinoids are one of the critical forensic investigations worldwide. Therefore an accurate and precise method was reported for detection and quantification of cannabinoids in blood samples utilizing the UPLC-MS technique. Solid phase extraction technique (SPE) was used for extraction of cannabinoids from blood samples. The tetrahydrocannabinol (THC) and its major metabolites were quantified by ultra-high pressure liquid chromatography-tandem mass spectrometry. This method was advantageous over the existing GC-MS method by minimized specimen handling, ease of extraction as well as reduced run time [5].

Folates are important nutritional ingredients which have role in various health benefits such as reduced risk of cardiovascular diseases [6], dementia [7] and cancer [8]. The UPLC-MS technique was successfully utilized for determinations of trace concentrations of folates in rice and ultrasensitive results were obtained such as LOD value of 0.06-0.45μg/100g and LOQ value of 0.12-0.91μg/100g. Six types of folates were determined by this technique with high sensitivity and low matrix interferences [9].

Another excellent application of UPLC-MS technique is in the field of metabolic profiling of human and animal tissues. A two-step process was reported for tissue samples which were based on extraction into "aqueous" and "non-aqueous" phases. High efficiency separation was achieved by UPLC and metabolite identification was carried out through MS [10].

Tibolone is employed as a substitute in place of lack of estrogen production in post-menopausal women due to its estrogenic effects on vagina, bones and thermoregulatory centres of brain. A novel, fast, robust and precise method was developed for the separation and quantification of 3α-hydroxy tibolone bioavailability of its formulations in humans by utilizing UPLC-MS technology. The analyte extraction was carried out through liquid-liquid extraction from plasma [11]. This method was a landmark in explaining various pharmacokinetic as well as bioequivalence parameters for tibolone as well as for other drugs.

Deficiency of B-vitamins in food leads various disorders especially in breast feeding mothers. Therefore a suitable concentration of these vitamins must be present in human milk so as to protect the infant against various diseases [12,13]. A novel, significant, accurate and precise method was reported for rapid, simultaneous analysis of thiamine, riboflavin, Flavin adenine dinucleotide, nicotinamide and pyridoxal in human milk by UPLC –MS technique. The LOQ values obtained were in the range of 0.05-5ppb with excellent retention time of 2 minutes. Due to presence of endogenous vitamins in milk, a matrix-like calibration curve was used for quantification [14].

Opiate drugs are well known for their therapeutic potentials as well as they are also recognized as substances of abuse. To carry out analysis of opiates, heroin and their metabolites in urine a novel, accurate and robust method was developed by utilizing UPLC-MS technology. The results obtained were highly sensitive which include LOD value in the range 0.001-0.02μg/ml and LOQ values of 0.003-0.06μg/ml. These methods have been continuously used by National Institute of Public Health (NIPH) since 2007 in routine analysis of opiates [15].

The identification of biomarkers in case of diseases and toxicity is nowadays an advantageous approach in the new drug development. By keeping in view this concept, UPLC-MS approach was utilized to generate molecular fragment information for structural elucidation of biomarkers in biological fluids. This approach has produced both precursor and product ion peaks in a single analytical run. Unlike the traditional techniques, the first quadrupole is not used in this for mass filtration and the data gives exact mass values for precursor and product [16].

Pesticides are routinely used in agriculture field to improve the productivity, still their presence in environment and food stuffs is considered hazardous. A novel UPLC-MS method was developed for multi-residue pesticide analysis in food stuffs. Analysis of 17 polar pesticides samples was carried out in crude apple extract. The result obtained was more sensitive than the traditional HPLC method [17].

Nowadays due to increased industrialization, water resources are continuously contaminated by various pharmaceutical effluents and waste products. A novel and rapid method was developed for analysis of ecologically relevant pharmaceuticals in waste water and surface water using solid phase extraction and UPLC-MS. The results obtained were highly sensitive such as recovery rates from 80-125% and LOD values of 1.0-51.0ng/L. This method was significant for monitoring of effluents and surface water samples and from the data presence of many API's was found [18].

Phenolic acids are secondary metabolites obtained from plant resources and are derived from cinnamic and benzoic acids. A novel method has been developed for qualitative and quantitative analysis of 17 phenolic acids in different beverages by utilizing UPLC-MS technique. The analytes were determined by multiple reactions monitoring to obtain highly sensitive results. This method was successively used further for analysis of white wine samples, grapefruit juice and green tea infusion. This method was used for monitoring of 12 phenolic acids in the concentration range of 40.8-9046 μg/L [19].

So in nut shell, the UPLC-MS technique have been widely adopted in various analytical procedures which involve minute concentration determinations or sensitive materials due to its fast detection time and small particle size technology.

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