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Short Communication

Coupling of Different Chromatography Techniques

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DESCRIPTION

The advancement of mass spectrometry methods has opened up new avenues for forensic toxicology analyses, where the identification and quantification of illicit drugs is one of the most pressing concerns in forensic science. The prevalence of drug addiction and abuse in the global population is extremely high, making it one of the primary causes of high criminal activity. Excessive use of psychotropic substances, natural drugs, hallucinogens, and, most recently, "new psychoactive substances," which are designed from the skeletons of previously known natural drugs, is the main focus of the development of new analytical methodologies, with mass spectrometry playing a key role. To identify and quantify metabolites from unknown drugs in a toxicological analysis, screening can be performed by combining different chromatography techniques, such as liquid and gas chromatography, with mass spectrometry. In cases where an increase in the signal-to-noise ratio (S/N) is required and the structure of the compound is known tandem mass spectrometry (MS/MS) in ion products or selected reaction monitoring can provide additional selectivity (SRM). This latter method is the most commonly used because it improves specificity, selectivity, and detectability; however, the analyses become too time-consuming when prior chromatographic separation and sample preparation are required [1].

Furthermore, ionization mass spectrometry techniques such as Direct Analysis in Real Time (DART), Desorption Electrospray Ionization (DESI), Low-temperature Plasma (LTP), Desorption Atmospheric-pressure Photoionization (DAPPI), Paper Spray (PS), Touch Spray Mass Spectrometry (TS-MS), and, more recently, Laser Diode Thermal Desorption (LDTD), and Atmospheric Solids Analysis Probe (ASAP) have gained popularity in toxicological analysis because they can Nonetheless, compounds with identical fragmentation patterns cannot be identified depending on the matrix sample; this is why more research in mass spectrometry is needed to provide relevant information that can help solve a crime. In this regard, this review presents the main current applications of mass spectrometry for the control of illicit drugs and the discovery of synthetic drugs in biological and synthetic matrices; additionally, methodological limitations as well as innovative methodologies to improve forensic toxicology analysis are discussed, based on an examination of the current literature over the last eight years [2].

The combination of chromatography techniques with mass spectrometry has been widely used in drug abuse analysis, particularly when sample screening is required, with separation techniques such as Gas Chromatography-mass Spectrometry (GC-MS), Liquid Chromatography-mass Spectrometry (LC-MS), LC-MS/MS, and, more recently, two-dimensional Gas Chromatography-mass Spectrometry (GC-GC-MS) being the most commonly used. After chromatographic separation, the steps for analyzing non-objective analytes are typically the same.

The mass spectrometer first performs a scan to identify or recognize some compounds of interest; then, a Selected Ion Monitoring (SIM) is performed to increase the sensitivity and selectivity of the analysis, in which only fragments of a specific group of molecules are monitored, resulting in an increased S/N. As a result, this technique is the most widely used in quantitative compound analysis. This section focuses on the most recent and innovative analyses performed using mass spectrometry coupled to chromatographic techniques, including all new toxicological methodologies developed [3].

GC-MS

The type of analyte that can be analyzed using this chromatographic technique has limited the advancements in techniques using MS coupled to gas chromatography. Despite the fact that high molecular weight compounds can be derivatized and analyzed by GC, the sample treatment is not appealing for forensic toxicological analysis of drugs of abuse, where speed of analysis is critical. As a result, the majority of GC-MS advances focus on the resolution and separation capacity during the analysis. On the other hand, toxicological analysis methods in various matrices are well established and widely used in drug analysis to confirm forensic toxicology from blood, urine, saliva,

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and hair samples, among others, during specific screening analysis, demonstrating high selectivity, detectability, and robustness [4].

LC

The use of LC as a versatile separation technique has improved the detection and quantification of analytes in a variety of matrices, including amphetamines, benzodiazepines, hallucinogens, cannabinoids, opiates, cocaine, designer drugs, pharmaceutical products, and illicit drugs. To determine an individual ion transition ratio for each analyte, ultrahigh-performance liquid chromatography was combined with tandem mass spectrometry in SRM mode.

CONCLUSION

The most important technique in toxicological forensic analysis is mass spectrometry. Although time-consuming, MS coupled with chromatography is the preferred technique for identifying new drugs or metabolites through screening analysis, providing excellent results in terms of limit of detection, precision, accuracy, and sensitivity. Direct MS techniques are more commonly used in target analysis or routine qualitative analysis. However, sample complexity, combined with the problems caused by ionization chemical suppression, complicates the identification of compounds with similar fragmentation patterns.

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