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Application News

Liquid Chromatograph Mass Spectrometer LCMS™-8050

Rapid Detection of Illicit Drugs and Psychoactive Plant Component by Green Technology DPiMS™-8060

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User Benefits

- Rapid screening of illicit drugs and controlled substances with direct injection technology coupled to highly sensitive mass spectrometry
- Environmentally sustainable technology to reduce usage of organic solvents significantly
- Minimal sample preparation of complex matrices including oil, beverage and sachet powders

■ Introduction

In addition to illicit substances, the abuse of ketum or kratom *(Mitragyna speciosa)*, especially, has received significant attention. Kratom (*Mitragyna speciosa)* has been originally utilized by local community as traditional medicine to combat fatigue and as energy supplement. However, its primary active alkaloid, mitragynine, has opium properties and stimulant-like effect. There have been numerous cases of patients with heroin/opiate withdrawal symptoms from consumption of kratom drink.

Kratom (Fig. 1A) is still regulated under Poison act in most ASEAN countries and thus categorized as controlled substance. Currently, conversations to group kratom into illicit substance have been reported in USA and ASEAN countries. Illicit drugs and controlled substances are often found in various forms and mixed into complex matrices to cloak the presence. This makes it inevitable for authorities to consider more advanced, versatile and rapid detection solutions.

Mass spectrometry is the gold standard in forensic drug analysis and amongst the most discriminatory technique. However, extensive sample preparation is required for complicated matrices. In this study, we reported development of accurate screening for illicit drugs and controlled substances using ambient ionization mass spectrometry by Shimadzu Direct Probe Ionization Mass Spectrometer, DPiMS-8060 (Fig. 1B). DPiMS utilizes direct injection system and thus reduces the use of organic solvents significantly. This ultrafast method (1 min) was proven to effectively monitor the presence of multiple drugs and controlled substances in complex matrices using fast and easy sample pre-treatment.

Table 1 Analytical conditions for detection of illicit drugs and controlled substances on LCMS-8050 tandem with DPiMS-8060

Acquisition mode	Scheduled MRM with 5 transitions for each target analyte
Ionization mode	Positive mode
Injection volume	10µL
Measurement time	1 min
Dwell time	1 msec
Pause time	1 msec
Interface voltage	2.45 kV
DL temp.	250˚C
Heat block tem.	30˚C
CID gas	270 kPa

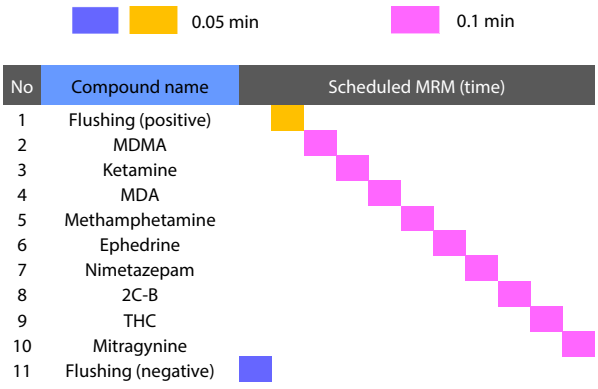

Fig. 2 Schematic of scheduled MRM method

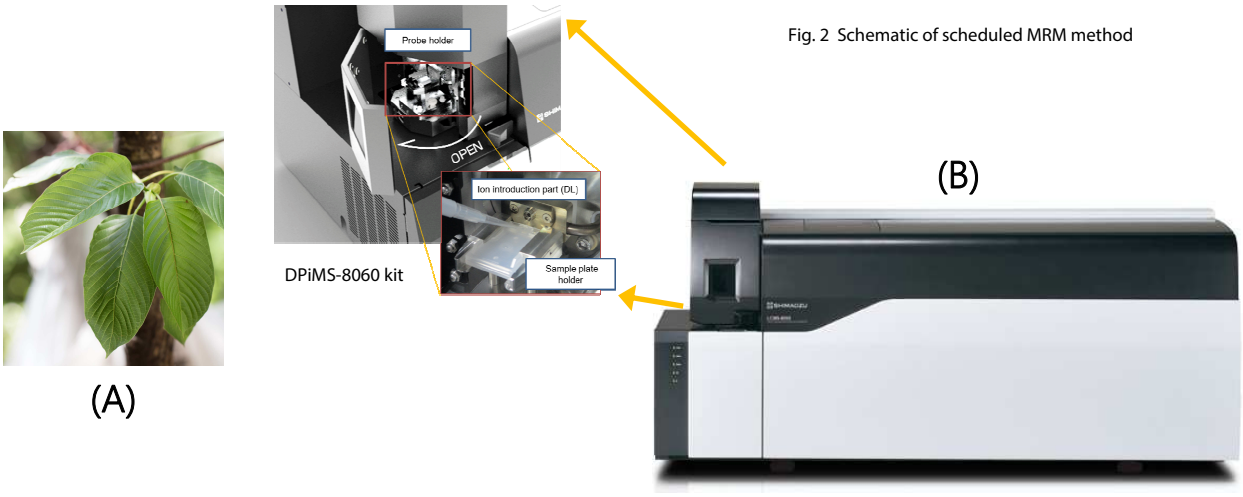

Fig. 1 (A) Kratom plant (*Mitragyna speciosa*) and (B) DPiMS™-8060 kit tandem with a triple quadrupole mass spectrometer

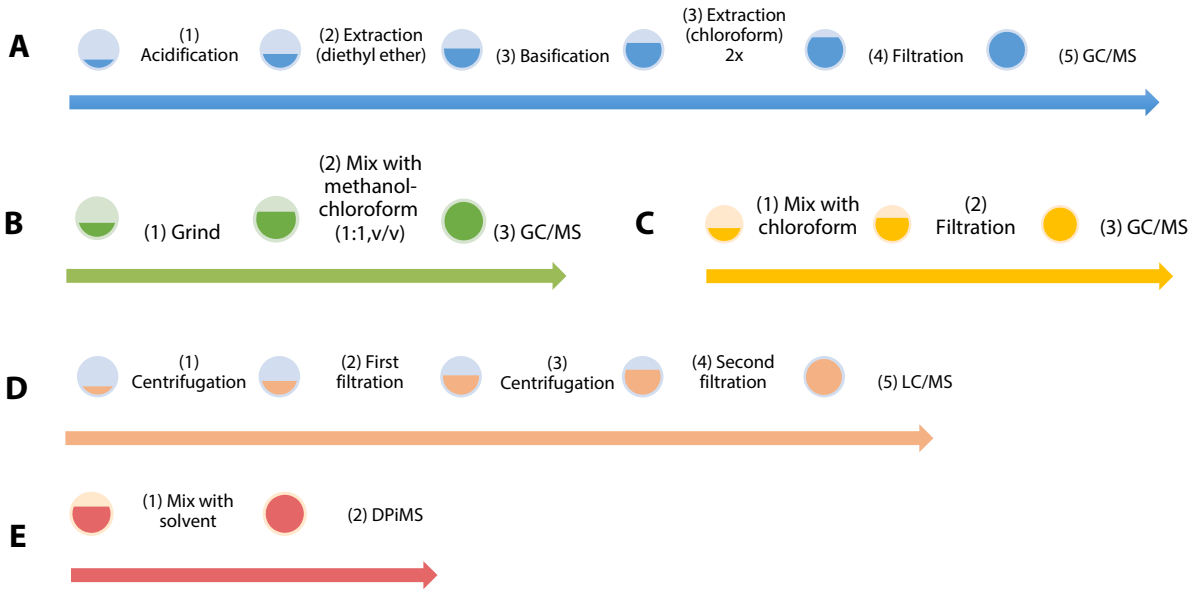

Fig. 3 Conventional sample pre-treatment for (A) beverage, (B) sachet, (C) oil samples by GC/MS and (D) for detection of rape drug in beverage by LCMS. (E) Sample pre-treatment for DPiMS analysis is fast and easy as follows: mix with solvent, put into sample plate and slide in into plate holder.

■ Measurement Conditions and Samples

A total of 14 real samples including, 1) six sachets, 2) seven beverages, 3) one oil were analyzed by using PESI kit (P/N: 225-32900-58) installed on LCMS-8050. Analytical conditions are described on Table 1. Conventional method by using GC/MS and straightforward method with DPiMS were compared and displayed in Fig.3. Extensive sample preparation is naturally applied for beverage samples to remove sugar content (Figure 3A). By utilizing DPiMS, samples were simply mixed with methanol. Samples were vortexed and filtered with 0.22 µm PTFE filter (when necessary).

Analysis method was set using scheduled MRM with 0.1 min window for each analyte. Total analysis time per sample for nine target analytes is 1 min inclusive of 0.1 min for flushing, as shown in Fig.2.

■ Results and Discussion

A fast-screening method was established for synthetic drugs and plant-based substances using LCMS-8050 tandem with DPiMS-8060 as follows: methamphetamine, ephedrine, nimetazepam, mitragynine, ketamine, MDA, MDMA, 2C-B, and THC.

MRM chromatogram of mixed drugs and substances on DPiMS is shown in Fig.4 and used to estimate the limit of detection (LOD). Sensitivity varies to each drug. Identification was conducted using absolute reference ion ratio with 20% allowance relative to quantitative ion (the most intense ion). The LOD was determined based on the lowest concentration at which five MRM transitions were observed. It was ranged from 10 to 45 ppb for each drug/substance.

Five MRM transitions were used for detection of each drug/substance based on Shimadzu LC/MS/MS Forensic Toxicology Database (P/N: 225-31175-92) or auto MRM optimization program. The use of MRM transition and scheduled MRM program enhances selectivity and sensitivity of analysis tremendously. This is in line with Shimadzu's UFMS (Ultra-Fast Mass Spectrometry) ability that provide measurement up to 555 MRM/sec without compromising its sensitivity.

Detection of two drugs and one controlled substance (MDMA in sachet powder, mitragynine in beverages, and THC in oil) was feasible in all real samples and matched to that of GC/MS system (Fig. 5A-5D, Table 2). In comparison to conventional method, DPiMS cuts down the overall analysis time (sample pre-treatment and running time) significantly. Conventional GC/MS method requires extensive sample pre-treatment and much longer running time (30 min).

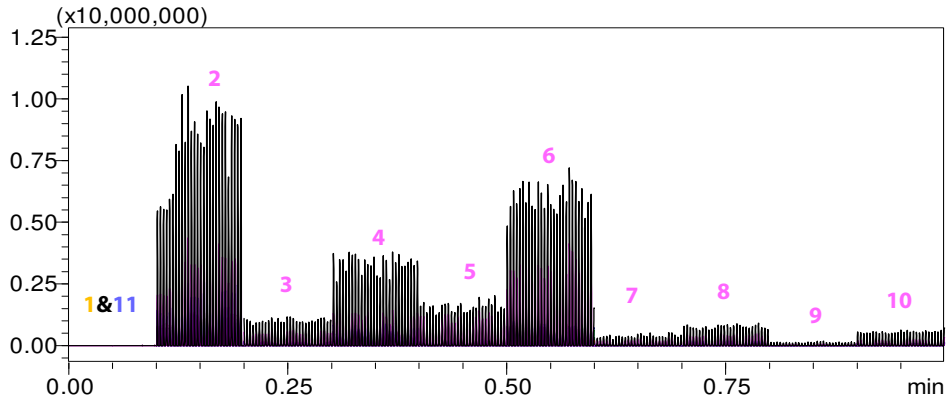

Fig. 4 MRM chromatogram of mix standards (concentration vary from 10 to 100ppb) by scheduled MRM on DPiMS. Numbers represent each analysis window: 1) flushing (positive scan), 2) MDMA, 3) Ketamine, 4) MDA, 5) Methamphetamine, 6) Ephedrine, 7) Nimetazepam, 8) 2C-B, 9) THC, 10) Mitragynine, and 11) flushing (negative scan).

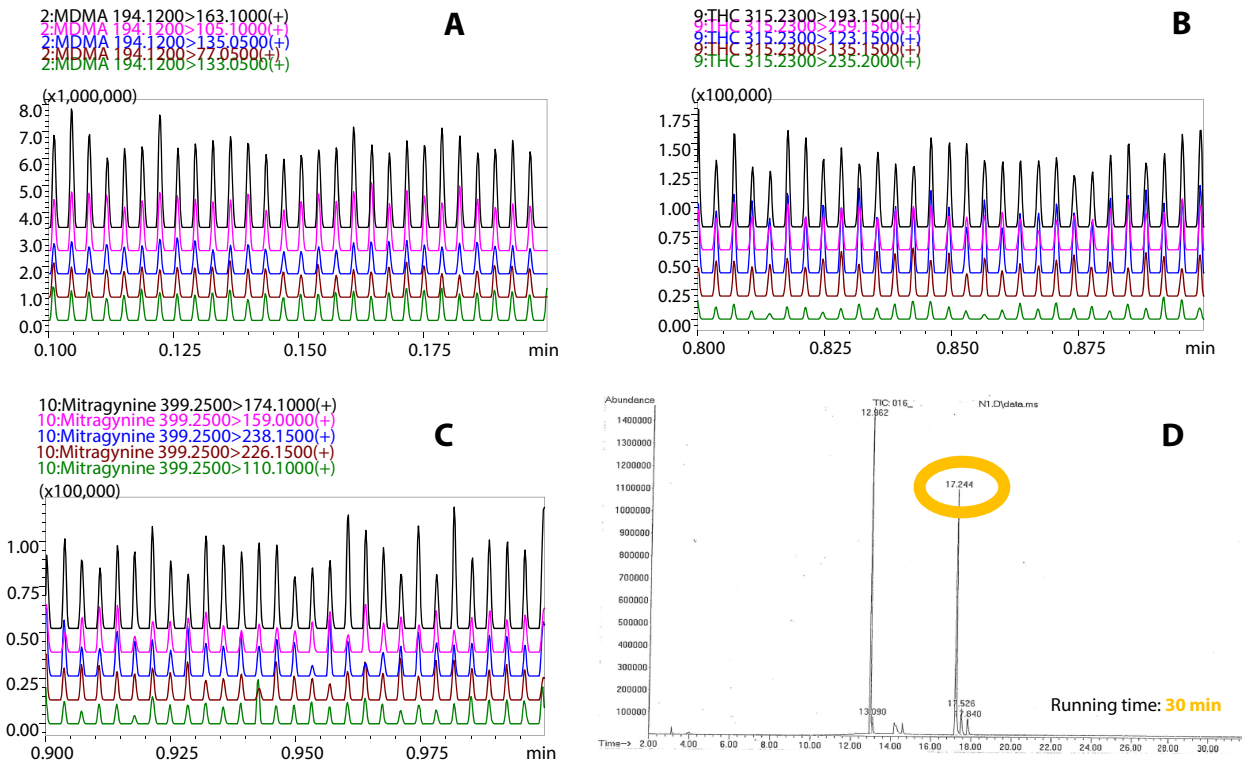

Fig. 5 MRM chromatogram (base shift) of MDMA in sachet powder (A), THC in oil (B), mitragynine in beverage (C) by DPiMS. GC/MS chromatogram shows mitragynine peak in same beverage sample (D). Mitragynine peak was eluted at 17.24 min in conventional GC/MS method. Identification was carried out by comparing to GC/MS mass spectral database.

Table 2 Screening results of real case samples. Identification was performed based on five MRM transitions for DPiMS and comparison to in-house mass spectral database for GC/MS.

Sample	DPiMS detection	GC/MS detection	Sample	DPiMS detection	GC/MS detection
Sachet powder 1	MDMA	MDMA	Beverage 1	Mitragynine	Mitragynine
Sachet powder 2	MDMA	MDMA	Beverage 2	Mitragynine	Mitragynine
Sachet powder 3	MDMA	MDMA	Beverage 3	Mitragynine	Mitragynine
Sachet powder 4	MDMA	MDMA	Beverage 4	Mitragynine	Mitragynine
Sachet powder 5	MDMA	MDMA	Beverage 5	Mitragynine	Mitragynine
Sachet powder 6	MDMA	MDMA	Beverage 6	Mitragynine	Mitragynine
Oil	THC	THC	Beverage 7	Mitragynine	Mitragynine

■ Conclusion

An ultra fast method for qualitative screening of illicit drugs and plant-based controlled substances was developed by using Shimadzu direct injection technology, DPiMS-8060 coupled to LCMS-8050. Detection of MDMA, THC, and mitragynine was achieved in complicated matrices using minimal sample preparation and thus reduce the use of organic solvent significantly. It cuts down analysis time tremendously compared to conventional GC/MS method. DPiMS demonstrates practicality for analyzing multigroup illicit drugs and presents as an alternative green technology for rapid screening forensic analysis.

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