Application Note AN-RS-040

Détection de traces de DMT dans la matière végétale

Protéger la sécurité des consommateurs avec MIRA

N,N-Dimethyltryptamine (DMT) is a naturally occurring [1] potent hallucinogenic compound used in traditional religious ceremonies of indigenous Central and South American cultures [2]. Modern recreational use of DMT is growing and although it is legally protected in some countries, new legislation attempts to reduce its abuse and associated adverse health effects. However, laws that address plant material containing DMT differ in neighboring countries, making enforcement of such legislation difficult. In the United States, for instance, DMT is a Schedule 1 drug, but the cultivation of trees and other plants known to contain high levels of the easily extracted compound (as much as 3.8 mg/g or 0.38% dried plant weight [3], with a typical dose of 0.48 mg/kg body weight [4]) is permitted.

Illicit synthesis and large-scale distribution of DMT-enriched plant material is rising and must be regulated. As of March in fiscal year 2022, the U.S. Customs and Border Protection Officers (CBPOs) in Memphis, Tennessee had already seized over 635 pounds (288 kg) of DMT [5]. The ideal test for detection is robust, field-based, and can quickly and easily identify DMT in plant materials. MIRA XTR DS from Metrohm Raman provides rapid and sensitive detection of DMT in a limited resource setting using spiked plant bark as the test material.

INTRODUCTION

This Application Note simulates a test for DMT in plant material (e.g., roots, bark). Simple extraction, followed immediately by SERS (Surface-enhanced Raman spectroscopy) analysis of the extract using colloidal gold nanoparticles (Au NPs) and/or Au P-SERS strips as SERS substrates yields positive detection of DMT.

REFERENCE SPECTRUM AND LIBRARY CREATION

A SERS reference spectrum for DMT (Cayman Chemicals) was prepared using a solution of 1 mg/mL DMT in methanol mixed with Au NPs. The SERS spectrum (Figure 1) contains several highly resolved peaks which permit unambiguous identification of DMT. This spectrum can be used to create a DMT library entry that can be matched against test samples.

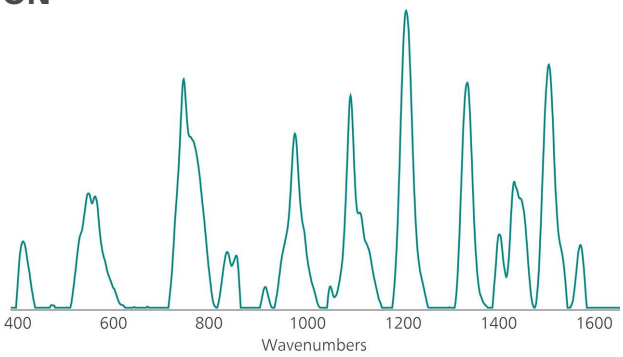
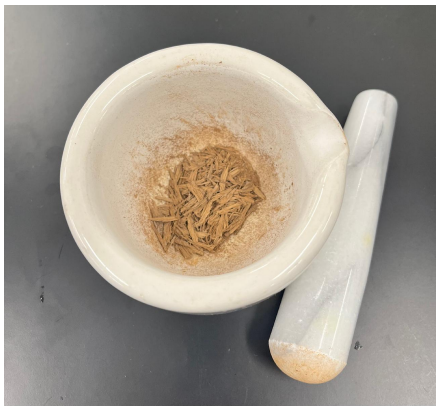


Figure 1. Reference Au NP SERS spectrum of DMT.

MATERIALS AND METHODS

To simulate testing for the presence of DMT in suspect test samples, bark was harvested from a local plant, dried in an oven, and then ground to a rough powder using a mortar and pestle.

The resulting powder was measured out in 50 mg portions and treated with DMT to yield test samples containing 0.1%, 0.05%, 0.01%, and 0.005% mass ratios of DMT to the ground bark. After drying, each sample was placed in a glass vial with 500 µL of dichloromethane (DCM). The vials were capped, shaken for one minute, then rested for five minutes to facilitate extraction of DMT and allow the settling of the plant material from the solution.



COLLOID TEST

For assays using Au NPs, care was taken to pipette 100 µL of clear extract from the top of each test sample vial to a fresh vial. DCM was removed from the sample through evaporation before 800 µL of Au NPs was introduced, and afterward the vial was capped and gently shaken. After two minutes, the vial was placed into the vial holder attachment on MIRA XTR DS for spectral acquisition (Figure 2).

P-SERS TEST

For analysis using P-SERS strips, 10 µL of the DCM extract was pipetted onto the test strip, followed by 10 µL of 1 mmol/L HCl. The strip was then fully dried and placed into the SERS attachment on MIRA XTR DS for measurement.

MIRA XTR DS settings for both assays	
Laser Power	5
Integration time (s)	4.0
Averages	5
Raster	ON

RESULTS

As shown in Figure 2, dichloromethane extracts of bark samples containing 0.1% and 0.05% DMT provide a strong SERS response using Au NPs. While the response is considerably reduced at the lower concentrations tested, it is sufficiently strong for some of the peaks to provide a LOD of approximately 0.005% for the experimental conditions employed in the test simulation.

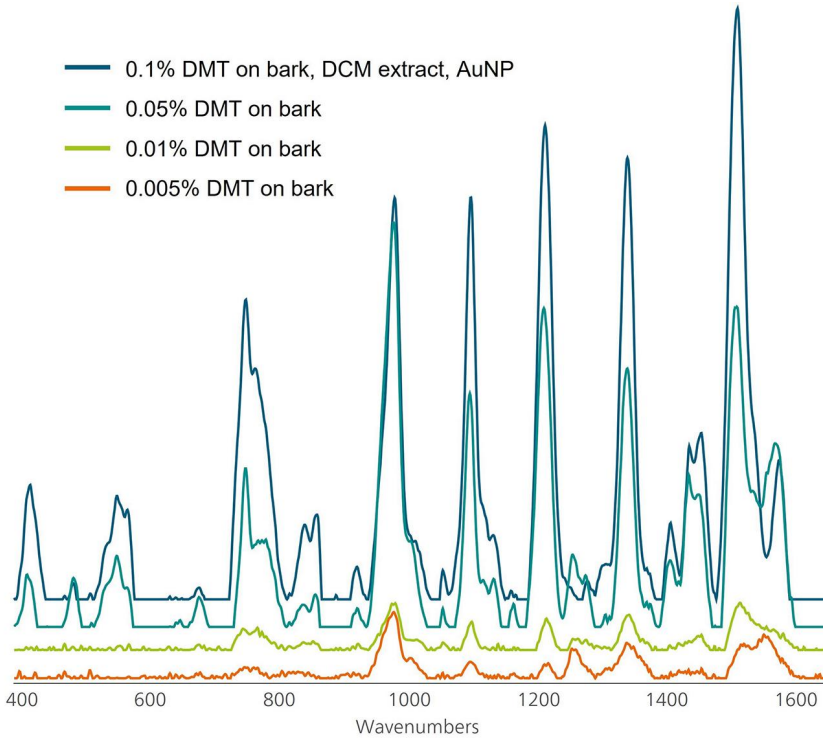


Figure 2. Signature Au NP SERS peaks from DMT can be detected very sensitively at even at 0.005 wt% (shown in orange).

With P-SERS strips, detection sensitivity is reduced but still sufficient for test samples containing higher concentrations of DMT (Figure 3). There are two arguments for the use of P-SERS strips:

1. P-SERS, included in the ID Kit, is designed specifically for use in field conditions.
2. Assay sensitivity is not as critical for DMT detection as for some other trace substances, as extractable DMT is typically present in plant materials at concentrations greater than 0.1%.

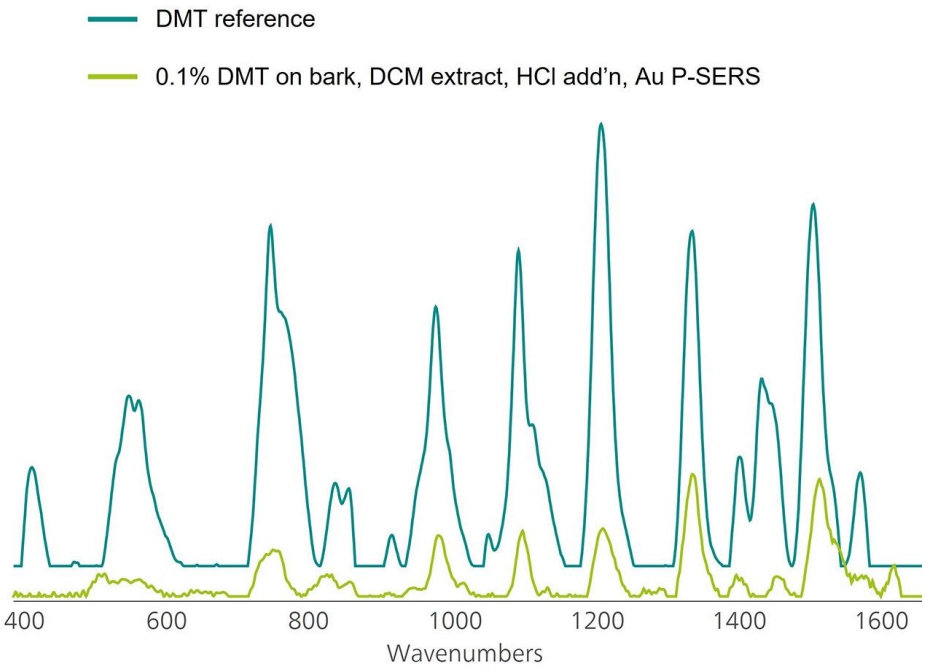


Figure 3. Signature Au P-SERS peaks from DMT can be detected sensitively even at 0.1 wt% (shown in green).

CONCLUSION

DMT is among the most common drugs seized by Custom and Border Patrol (CBP) agents—it is often encountered as shipments of root bark containing high concentrations of the hallucinogen (from 0.2% to 3.8% by weight). MIRA XTR DS, used with ID Kit, is a user-friendly, on-site solution for rapid and sensitive DMT detection that can facilitate detection and seizure of illegal imports.

REFERENCES

1. Philadelphia CBP Seizes Two Shipments of Dangerous Controlled Substances Destined to NY and Chicago | U.S. Customs and Border Protection. https://www.cbp.gov/newsroom/local-media-release/philadelphia-cbp-seizes-two-shipments-dangerous-controlled-substances (accessed 2022-10-17).
2. 60 Pounds of Dimethyltryptamine Seized by CBP Officers | U.S. Customs and Border Protection. https://www.cbp.gov/newsroom/local-media-release/60-pounds-dimethyltryptamine-seized-cbp-officers (accessed 2022-10-17).
3. Chambers, M. I.; Appley, M. G.; Longo, C. M.; et al. Detection and Quantification of Psychoactive N,N-Dimethyltryptamine in Ayahuasca Brews by Ambient Ionization High-Resolution Mass Spectrometry. *ACS Omega* **2020**, *5* (44), 28547–28554. DOI:10.1021/acsomega.0c03196
4. N,n Dimethyltryptamine - an overview | ScienceDirect Topics. https://www.sciencedirect.com/topics/nursing-and-health-professions/n-n-dimethyltryptamine (accessed 2022-10-14).
5. CBP Memphis Seizes over 634 lbs of DMT so far this Fiscal Year | U.S. Customs and Border Protection. https://www.cbp.gov/newsroom/local-media-release/cbp-memphis-seizes-over-634-lbs-dmt-so-far-fiscal-year (accessed 2022-10-14).

CONTACT

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CONFIGURATION

MIRA XTR Basic

MIRA XTR est une alternative pour les systèmes haute puissance 1 064 nm. Piloté par un traitement informatique avancé, MIRA XTR utilise une lumière laser de 785 nm plus sensible ainsi que des algorithmes XTR pour eXTRaire les données Raman de la fluorescence de l'échantillon. MIRA XTR dispose également d'un balayage de trame orbital (ORS, Orbital Raster Scanning) pour fournir une meilleure couverture de l'échantillon, augmentant ainsi l'exactitude des résultats.

Le package de base est un module d'entrée de gamme qui contient les composants de base nécessaires au fonctionnement du MIRA XTR. Le package de base comprend le standard de calibrage, l'embout universel intelligent et la bibliothèque de substances illicites. Fonctionnement en classe 3B.

Kit d'identification – substrats d'or P-SERS (Au P-SERS)

Le kit d'identification Au P-SERS comprend les composants nécessaires à un utilisateur Mira/Misa pour une analyse SERS avec des substrats d'or P-SERS. Le kit se compose d'une spatule à usage unique, d'une pipette compte-gouttes, d'un petit flacon d'échantillon et de 2 bandelettes réactives P-SERS d'or.