Illicit drug sniffer
Characterization of the smell of drugs

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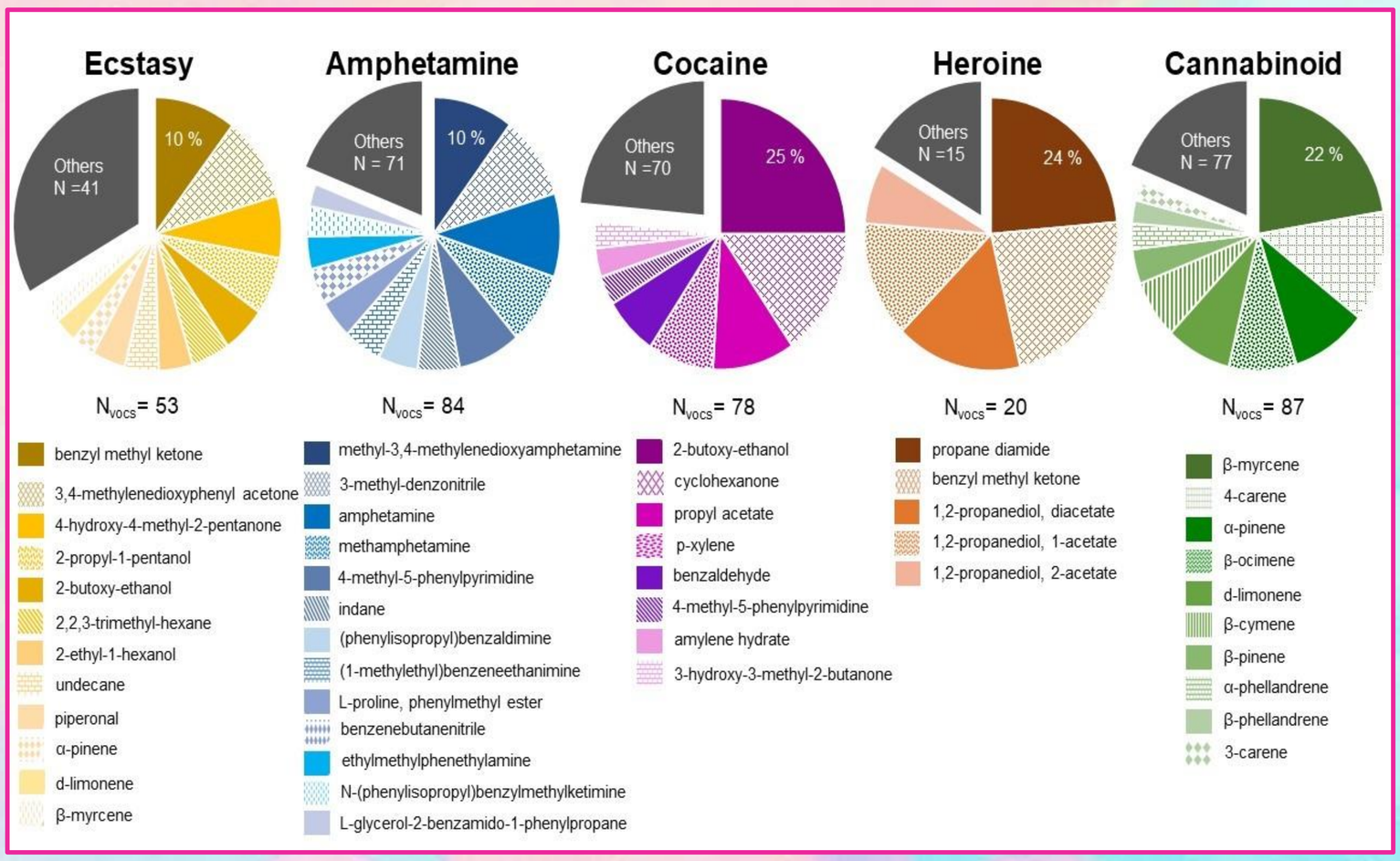
Illicit drugs are chemically diverse substances each with distinct chemical compositions. These variations influence their **volatile organic compound (VOC) profiles**, which are recognized as valuable tools in forensic science and public health, giving information about drug production methods, origin, and even adulterants.

This project aims to **characterize VOCs** from a panel of illicit drugs offering predictive VOC signatures, drug differentiation, and forensic traceability.

Illicite drugs (n=5)	Active compounds	Year of Seizure
Cannabinoids (Marijuana 1)	16% THC	2019
Cannabinoids (Marijuana 2)	15% THC	2019
Cannabinoids (Hashish 1)	23% THC	2019
Cannabinoids (Hashish 2)	1,51% THC	2019
Opium	-	2019
Cocaine 1	76% Cocaine	2019
Cocaine 2	80% Cocaine	2018
Cocaine 3	92% Cocaine	2019
Heroine 1	48% Heroin	2018
Heroine 2	55% Heroin	2018
Heroine 3	55%Heroin	2018
Amphetamine 1	23% Amphetamine sulphate	2018
Amphetamine 2	96.5% Amphetamine sulphate	2019
Ecstasy 1	95% MDMA	2018
Ecstasy 2	88% MDMA	2019
Ecstasy 3	42% MDMA	2018
Ecstasy 4	29% MDMA	2018
Ecstasy 5	46% MDMA	2019
Ketamine	95%	2019

Drug seizures, including concentration (%) and year of seizure



Pie charts displaying the relative proportions of the VOCs contributing to each drug profile

Volatile Profiles Across Drug Types

218 VOCs were identified across 95 illicit drug samples.

- Cocaine, heroin, and cannabinoids exhibited profiles dominated by 3–4 VOCs.
- Ecstasy and amphetamine showed lower VOCs dominance.
- No VOCs were detected in opium and ketamine.

Recommendation:

For low-emitting substances, more sensitive techniques (*e.g.*, HiSorb probes, vacuum-assisted SPME) are advised.

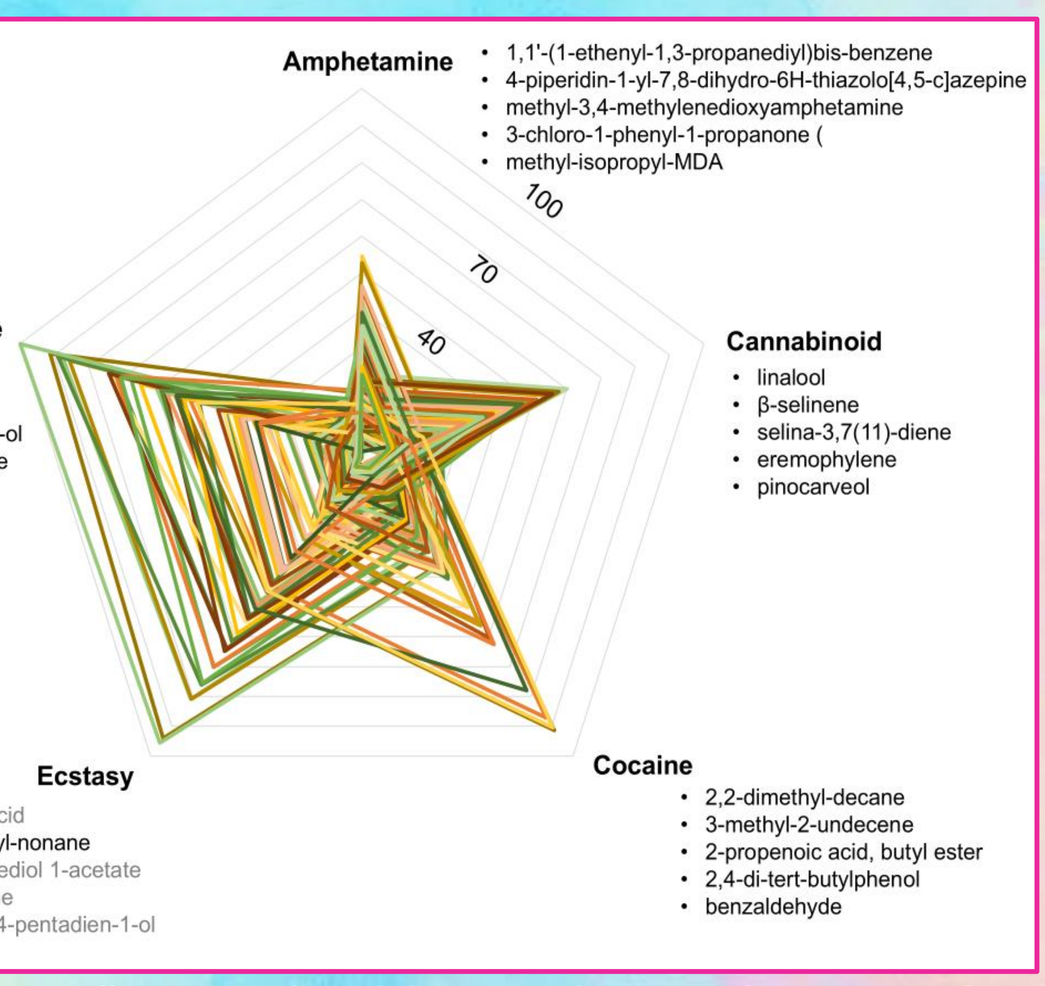
Statistical Differentiation of VOC Profiles

Multivariate analysis confirmed significant differences in drug VOC profiles.

PLS-DA modeling achieved 91.8% classification accuracy.

Findings

- Model successfully identifies distinct VOC signatures.
- High specificity across categories, except ecstasy.
- Major and trace VOCs contributed to classification could be chemical markers.



Spider chart displaying all compounds and their contribution in the PLSDA analysis

This study provides **comparative VOC profiles** for a wide range of illicit drugs, offering new insights into their odor signatures.

- The identification of by-products and cutting agents offers valuable leads for forensic investigations, aiding in the determination of drug origin, manufacturing methods, and distribution routes.
- Identification of chemical markers can support detection dog training.

VOC profiling represents a promising tool for both operational detection and forensic intelligence in the fight against illicit drug trafficking.