



Composition Analysis of "Legal Highs" by GC-EI-MS for Medico-Legal Purposes

Sebastian Rojek, Martyna Maciów, Małgorzata Kłys

Department of Forensic Medicine Jagiellonian University Medical College, 16 Grzegorzewska St., 31-531 Kraków, Poland

Introduction

"Legal highs" are synthetic and plant-derived chemical substances that together form a giant group of modified (designer) drugs, employed chiefly as psychostimulants at parties, in discos and clubs. Usually designer drugs are the structural modification of known drugs of abuse. This modification is made to circumvent a legal prevention of psychotropic substance abuse so as to make them widely available in so-called "smart shops". In response to the increasing new narcotic market in Poland in 2010 and in view of the amendment to the Act on the Prevention of Narcotic Substances Abuse, inspections of "smart shops" were carried out. The 943 samples of "legal highs" obtained during these inspections were examined for identification of composition. Most likely, subsequent amendments to the Act have restricted the use of "legal highs", but they will not resolve the problem, since there is no possibility for the Act on Drug Addiction Counteraction to keep pace with or precede illegal synthesis of subsequent analogs of psychoactive substances. For this reason, clinical and forensic toxicologists have to be prepared for new challenges. Through methodological work, databases of analytical parameters must be developed and experience has to be gained in clinical and medico-legal practice. The objective of the study was to work out a method of identification of designer drugs by GC/MS, as well as a database of mass spectra based on the analysis of reference standards, followed by employing the said database in xenobiotic determinations in "collector's products".

Materials and method

Powders and tablets (50 mg) were prepared by extraction with 2.5 ml methanol for a night. Herbal mixtures (100 mg) were also extracted with methanol (2 ml) for a night.

The analysis of standards and 943 examined samples was performed by gas chromatography electron impact mass spectrometry (GC-EI-MS; 7890A GC and 7000 MS; Agilent Technologies, Santa Clara, CA, USA).

Gas chromatography-mass spectrometry (GC-MS) was used in electron impact (EI) mode at 70 eV of electron energy. The analysis was performed using a capillary column (HP-5ms-UI, 30 m x 0.25 mm x 0.25 µm) and helium as a carrier gas in splitless mode. An initial column temperature of 60°C was held for 1 min, and it was increased at a rate of 40°C/min to 325°C held for 12 minutes. The total run time was 19.63 min. Helium at constant pressure of 14.9 psi was used as a carrier gas. The data were obtained in the full scan mode with a scan range of m/z 50-600.

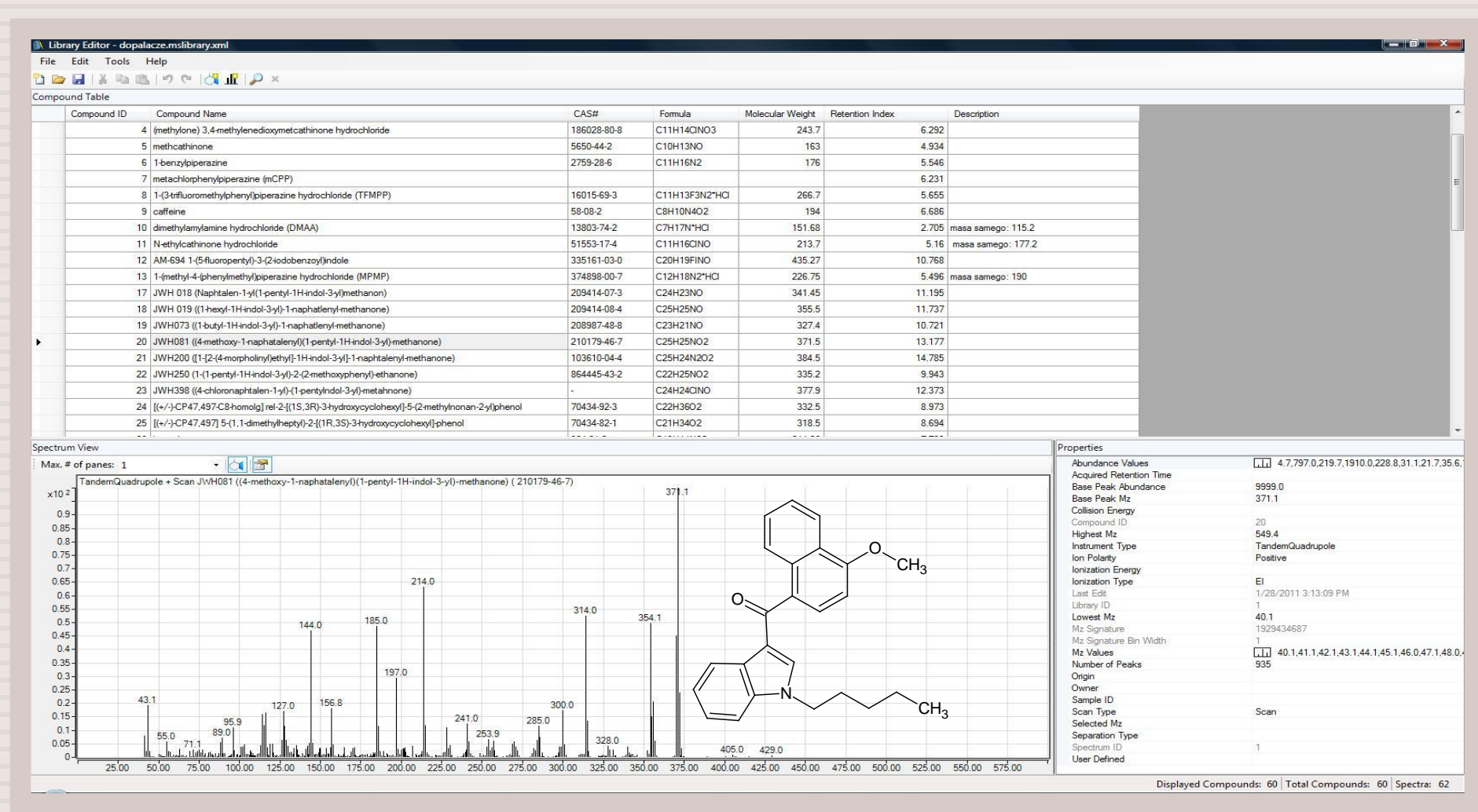


Fig. 1. Illustration of the window from Library Editor.

Results

Unfortunately, NIST library which is widely used contains very few compounds that are components of the products of "legal highs". Therefore, we focused on creating our own library of mass spectra. For this purpose, we used a program offered by Agilent Technologies named "Library Editor" (Fig. 1), which worked alongside the program "Mass Hunter Workstation" and thus it was possible to search in chromatograms through created library automatically after the initial chromatogram deconvolution.

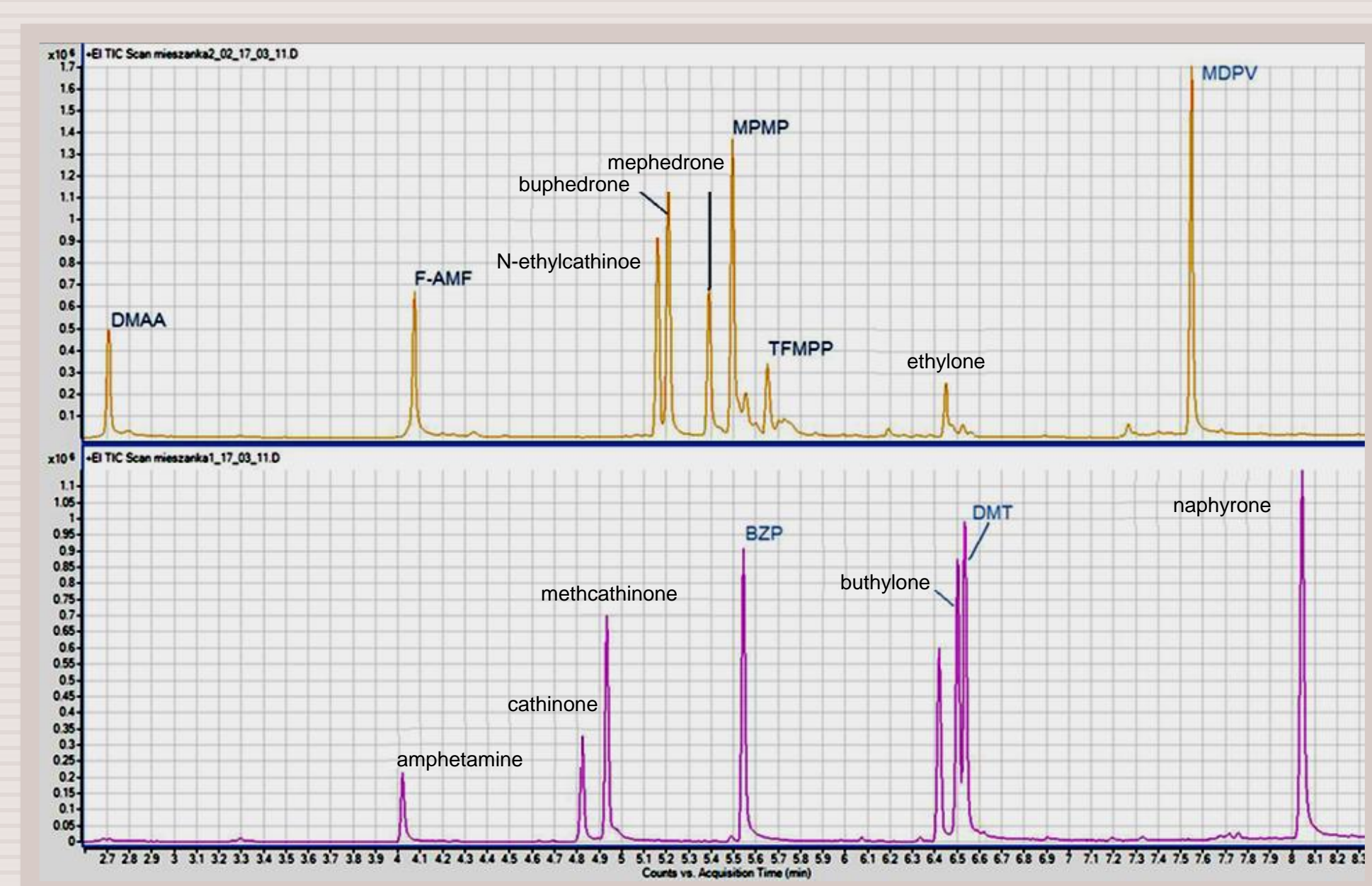


Fig. 2. Chromatograms for the mixtures of reference standards.

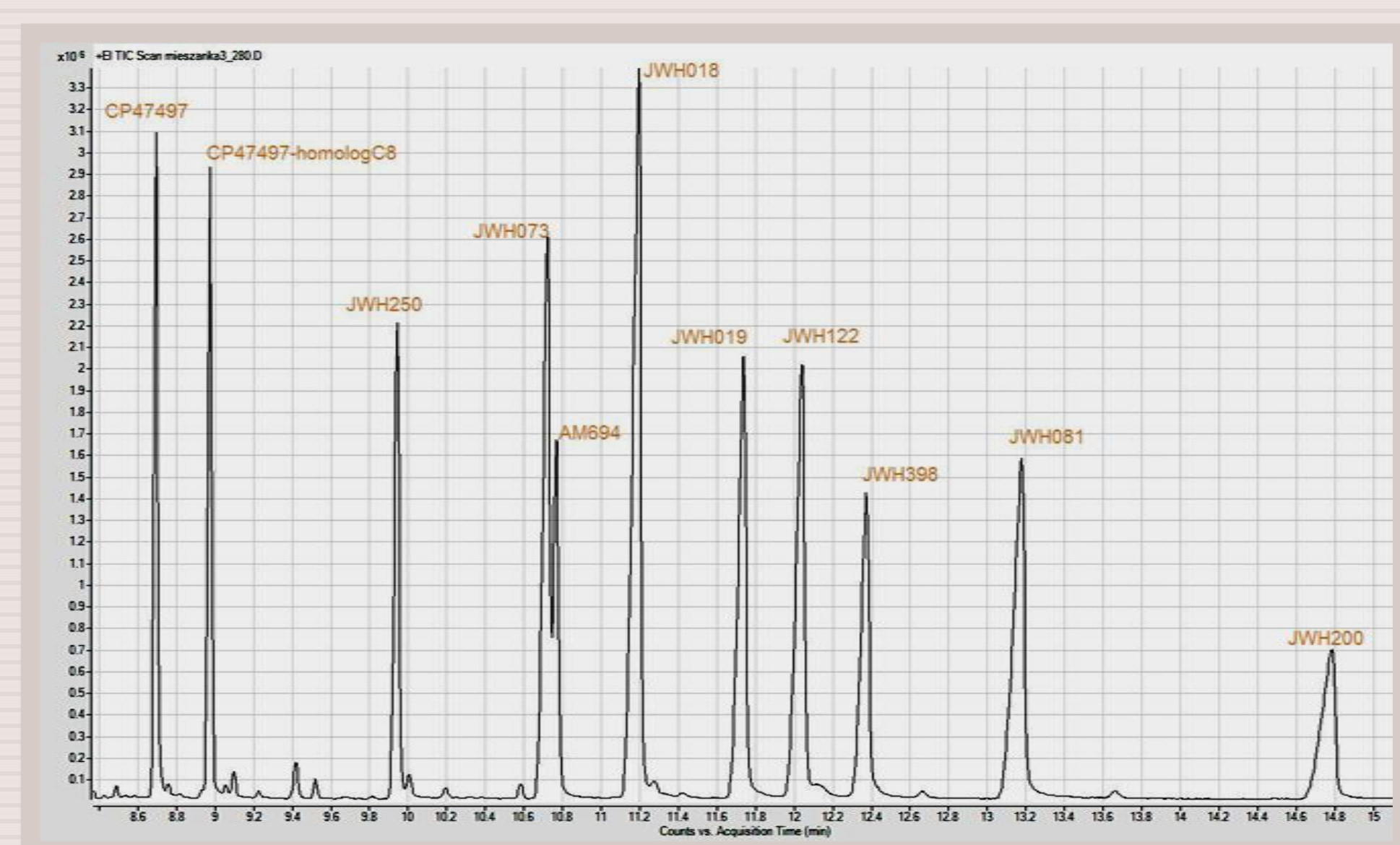


Fig. 3. Chromatogram for the mixtures of cannabinoids reference standards.

Prior to the study we gathered the necessary certified reference standards, which are controlled by Polish legislation and part of those expected in the material that were chosen based on reports on "legal highs" components. The library created in this way contains 53 mass spectra of designer drugs, including 15 synthetic cannabinoids, 8 cathinones, 7 phenethylamines, 5 piperazines, 2 pyrrolidines and 16 unclassified compounds. Our library has proved to be irreplaceable in problematic situations, and greatly accelerated the process of analyzing such a large number of chromatograms.

Of all the preparations in the form of tablets and powders we were able to distinguish 64 groups of preparations of the same name. It was checked whether the preparations of the same name had the same active ingredients and we found that only half of them had the same composition.

Using a rich population we decided to find out which active ingredients are added most frequently to tablets and powders. As it can be seen in chart in Fig 4a, the most popular is caffeine (found in 202 samples), then butylone and MDPV – cathinones representatives (the most commonly added group – Fig. 4b) and TFMP belonging to a group of piperazines.

For all the samples of "herbal highs" 17 groups of preparations of the same name could be distinguished. As in the case of tablets and powders only in a few more than half of the groups active ingredients were the same.

Posted graph (Fig. 4c) indicates the frequency distribution of monitored compounds. Compounds most frequently added to the mixtures were synthetic cannabinoids: JWH081, JWH 122 and RCS-4. There was no single instance of the CP series of compounds or HU-210, nor any of the natural psychoactive compounds (as kavaine, mitraphylline etc.). It is also note worthy that in a few found unusual additives - lidocaine and MDPV.

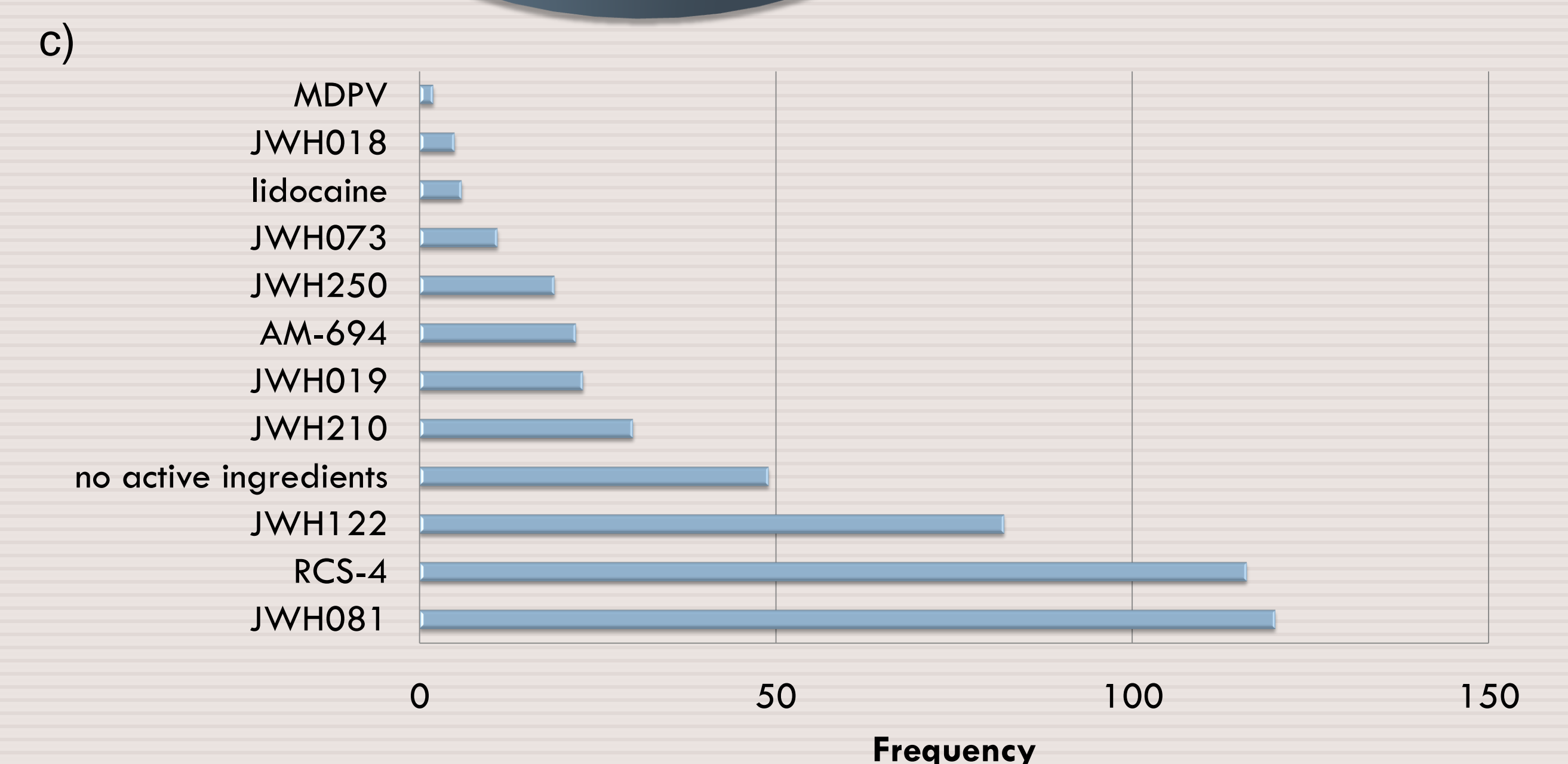
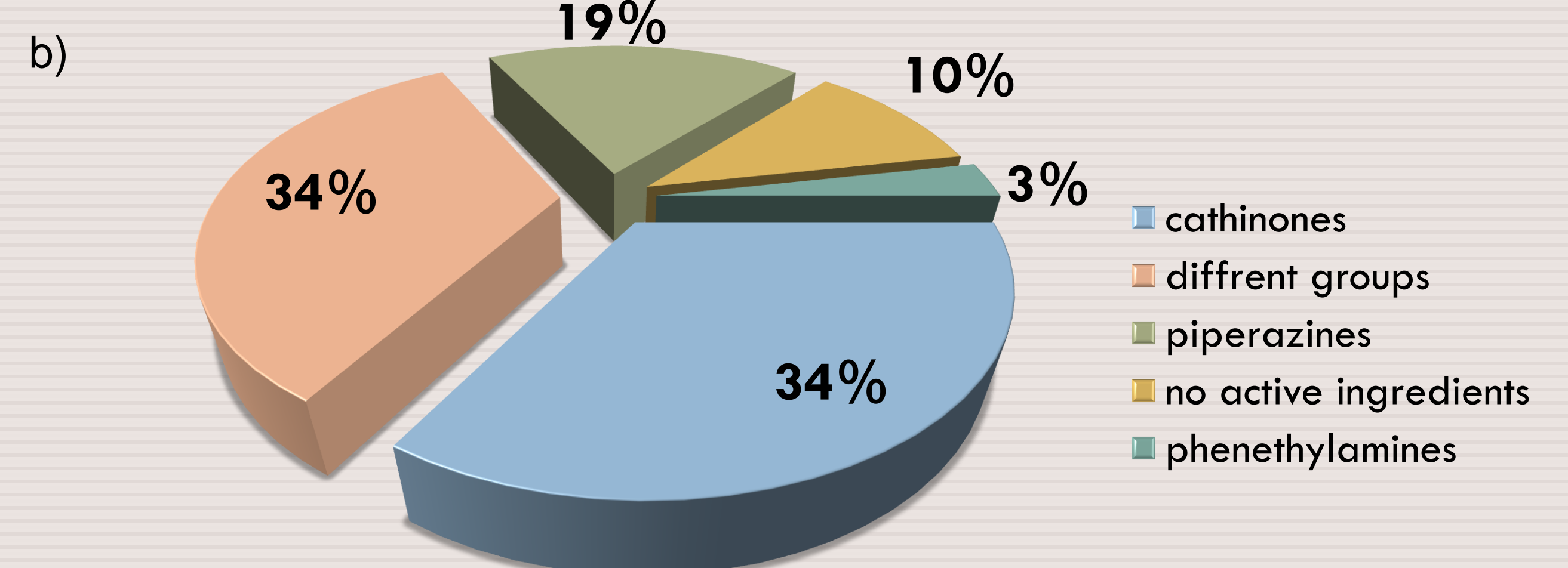
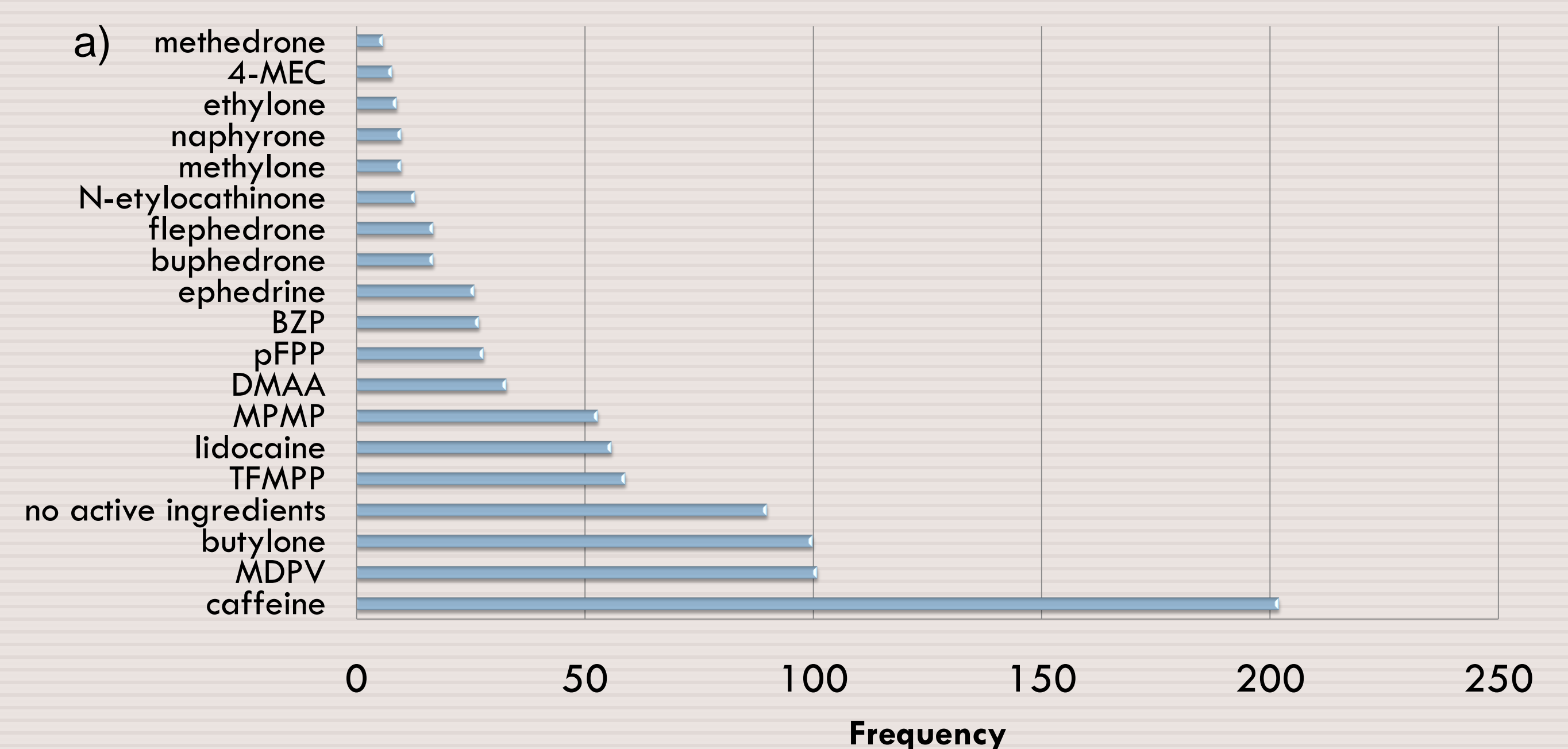


Fig. 4. The results of identification analysis a), b) – powder and tablets analysis; c)- herbal mixtures analysis.

Conclusion

- The method worked out could be successfully applied to the test material. It is important that it is still open, it is possible because of its extension for other designer drugs.
- The need to create your own library of mass spectra should be emphasized, in order to avoid mistakes in interpretation due to large number of compounds that have similar structure and often fragmented in almost identical way.
- The most common compounds were identified, illustrating the direction of "legal highs" market developments in Poland. Tablets and powders contained caffeine, butylone, MDPV, (mostly there were compounds belonging to the group cathinones) and TFMP, and plants JWH081, RCS-4 and JWH122.

For further information

Please contact martyna.maciow@uj.edu.pl. More information on this and related projects can be obtained at <http://www.kms.cm-uj.krakow.pl/>.