ПОЗИТИВНИЙ ДОСВІД В ЕКСПЕРТНІЙ ДІЯЛЬНОСТІ
POSITIVE EXPERIENCE IN FORENSIC ACTIVITY

УДК 343.575/613.83 DOI: 10.37025/1992-4437/2021-36-2-93

O. Tarasenko, *PhD (Technical Sciences),*
Forensic Expert of the Drugs, Psychotropic Substances,
Their Analogues and Precursors Research Sector,
Materials, Substances and Products Research Department,
Luhansk Scientific Research Forensic Center, MIA of Ukraine,
Rubizhne, Luhansk Region, Ukraine
ORCID: https://orcid.org/0000-0001-9861-2256
email: tarasencom.ua@ukr.net
tel.: +38(099)404-63-02

INVESTIGATION OF THE COMPOSITION OF LIQUID MIXTURES FOR SMOKING. DETERMINATION OF SYNTHETIC CANNABINOIDS AND α-PVP

The purpose of the article is to highlight the possibility of quantitative identification of narcotic drugs, psychotropic substances and their analogues in the context of studying the composition of liquid mixtures for smoking (vapes), to propose a method. ***Methodology***. A set of general scientific and special methods was used to achieve this goal. In particular, using theoretical methods (analysis, generalization, comparison, modeling), systematized theoretical materials on the problems to be solved; the state of practical elaboration of the problem is empirically determined; organizational and experimental means (diagnostic, ascertaining, formative, corrective experiment) in combination with qualitative analysis and mathematical processing of the obtained results confirmed the effectiveness of the proposed method. The reliability of the results is ensured by the use of modern instrumental physicochemical, mathematical, statistical methods of analysis, as well as software processing of experimental data. ***Scientific novelty***. The composition of liquid mixtures for smoking was determined using physicochemical methods of research, for the first time the possibility of quantitative identification of synthetic cannabinoids and α-PVP in the composition of vapes was proved. ***Conclusions***. The composition of liquid mixtures for smoking (vapes) was determined and the possibility of quantitative identification of narcotic drugs, psychotropic substances and their analogues using various instrumental methods based on modern scientific research, in particular the content of synthetic cannabinoids and α-PVP in liquid mixtures for smoking by thin-layer, gas chromatography and using mass spectrometry. The effectiveness of current methods of researching synthetic cannabinoids was tested on specific examples and a contribution was made to the future development of methods for studying the composition of drug-containing liquid mixtures for smoking and those containing psychotropic substances, the demand for which is currently growing on the world market and in Ukraine. A method for isolating synthetic cannabinoids and α-PVP from a solution of smoking mixtures has been developed. The general approaches to the choice of the scheme of research of synthetic narcotic drugs and psychotropic substances depending on the questions, form (liquid), type and quantity of the objects submitted for research are offered.

Keywords: synthetic cannabinoids; α-PVP; liquid mixtures for smoking; vape; glycerin; propylene glycol; chromato-mass spectroscopy; gas-liquid chromatography.

Introduction

Ukraine is spreading of different types of tobacco products is becoming increasingly important as the use of a wide range of products in the most varied forms for obtaining pleasure is gaining particular popularity today (Hall, 2015, s. 1013; Levchenko, Kurdil, & Lutsenko, 2016, s. 95; Balakirieva, Pavlova, Nhuien, Levtsun, Pyvovarova, Sakovych, & Fliarkovska, 2019, s. 6; Chernolohova, 2019, s. 407). Then, a special attention paid to products whose distribution is currently not actually controlled and which therefore become available (Mavrynska, 2020, s. 224).

This refers to mixtures for smoking in rare forms, which may or may not contain more nicotine, or even (and these cases are far from uncommon lately) synthetic and natural cannabinoids – analogues of tetrahydrocannabinol (trans-Δ-9-tetrahydrocannabinol) – psychotropic substance with limited circulation on the territory of Ukraine, also referred as dronabinol (Raso, 2018; Skrypnikov, Herasymenko, Rud, & Kydon, 2020, s. 8).

On the rise of Ukraine since the mid-2000s has been started the use of synthetic cannabinoids. Notably through the spread of spice-like smoking bags (plant chemicals infused with highly reactive chemicals, (plant-based substance infiltrated with highly active chemical reagents), which are distributed by online shops and various delivery services under the guise of odours. They have become available for retail due to insufficient legislation, which is carried out by private enterprises, which has had a significant impact on the social characteristics of the consumer population in a short time (Tkachenko, & Tkachenko, 2018, s. 123).

This process is determined by the general trends of globalization. It's ensures the existence of a single information space, as well as measures of state control of the circulation of narcotic drugs, depending on the inclusion of the substance in the appropriate register, according to the criteria of the chemical composition of the substance in fact (Pon, & Fenyvesi, 2018, s. 24; AL-Eitan, Asa'ad, Battah, & Aljamal, 2020, s. 4172).

Rare smoking compounds are used, mainly in the form of spices, icons, vapes – special devices similar to electronic cigarettes (Angerer, Franz, Moosmann, Bisel, & Auwärter, 2019, s. 186). The analysis of these products showed that flavourings, nicotine, glucerine and propylene glycol are their main components in different proportions. The plasticine is mainly composed of propylene glycol and glycerine. There are even special mixtures for smokers with an intolerance to the first or the second ingredient. They do not contain any propylene glycol or glycerine or their minimum quantity. It's could be added some flavourings and medicinal nicotine to the formulation to give the product a pleasant, bright flavour.

Tight and water-soluble, with a malodorous taste, propylene glycol is odourless. Therefore, it is often used as a formulation for liquids, as a food additive etc. The average and rare mixture consists of 10–30 % propylene glycol. This ingredient, however, may cause an allergic reaction, in spite of its lack of adverse effects.

Oily glycerine is widely used in food production. This is the main component of the mixture, the proportion of which often fluctuates between 60–90 %. It is not harmful for the organism. Dissolved in water. Dryness and discomfort in the throat may occur due to single ingestion of large quantities of glycerine. Allergic reactions are extremely rare.

The non-hazardous nicotine is not the main or non-essential ingredient and, as the manufacturers claim, its only used in vaping mixtures in a purified medicinal form, i. e. without resins or other domestics. It should be noted the concentration of nicotine may vary and that nicotine-free, rare vaping mixtures are also used (Eckberg, Arroyo-Mora, Stoll, & DeCaprio, 2019, s. 170).

Flavourings, the concentration of which often does not exceed 20 % of the total volume of the mixture, add flavour and aroma to the vapor in the electronic vaporizer. Responsible manufacturers of vaping-busyness used widely permitted food flavour additives in their vaping mixes.

So, at first glance, these main components are not particularly dangerous or harmful. However, more and more often the flavourings in smoking bags, apart from propylene glycol and glycerine, contain prohibited substances and reagents. For instance, cannabis extract containing among other, not forbidden, α-PVP (1-phenyl-2-pyrolidin-1-yl-pentane-1-one-one) or synthetic analogues of the main active component of drugs derived from cannabis plants – tetrahydrocannabinol.

However, the main risk to the use of such products is that synthetic cannabinoids not produced, according to standards or formulas. Their composition usually changes at the discretion of the manufacturer. For example, the addition of α-PVP is very advantageous for the retailer, as a kilogram of this substance in China costs only one or two thousand U.S. dollars, but there are enough quantities for thousands of doses.

Currently, it's impossible to reliably identify synthetic cannabinoids, α-PVP or their analogues due to the lack of comparative templates and ion mass spectra data in existing libraries, in particular in RFC (Karadzhian, & Kasparian, 2015, s. 338; Raso, 2018, s. 4).

The purpose and objectives of the study

This article aims to investigate the possibility of quantitative identification of narcotic drugs, psychotropic substances and their analogues in the context of the study of the composition of rare tobacco bags (vape), to propose a certain methodology.

To achieve this goal, it is necessary to solve the following tasks:

determines the feasibility of identifying psychotropic substances in rare smoking bags using different instrumental methods, Based on modern scientific research, in particular, the content of synthetic cannabinoids and α-PVP using fine ball, gas chromatography and mass spectrometry;

to determine the quantities and composition of rare vape mixtures without synthetic cannabinoids and the quantities of synthetic cannabinoids called JWH-018, JWH-073, AM-2201(565B), ADB-CHMINACA(597B), AB-FUBINACA (608B) and α-PVP, individually added to the specified smoking bags;

to propose a methodology for the separation of a mixture of synthetic cannabinoids and α-PVP in the formulation of rare smoking sums.

Presentation of the main material

Experimentally investigated liquid smoking mixtures of unknown type of vape as well as mixtures containing synthetic cannabinoids and α-PVP (1-phenyl-2-pyrolidine-1-yl-pentane-1-one-one).

Methods of Investigation

In Vitro analyses. Firstly in order to identify presence of cannabinoids and α-PVP in the sample a chemical analysis was carried out. For this purpose a 0.5 vol. % solution of Tri-Blue B reagent was applied on a filter pad and applied on a crust of the film containing separately synthetic cannabinoids and a PVP solution. As a result, the samples showed a purplish-black colour, confirming the presence of cannabinoids, and a blacid barring, indicating the probable presence of α-PVP (*Department of Justice*, 2019).

It was carried out by fine-ball chromatography to determine the presence of synthetic cannabinoids and PVP in a rare smoking mixture, following the recommendations of foreign counterparts (Cannaert et al., 2020). 5 ml of the obtained solutions were applied on a series of «Sorbfil» PTC-AF-A-UF chromatographic plates (sorbent – silica gel STX-1A; grain size 5–17 µm; ball thickness 110 µm; integral – silicazole; UV-indicator – UV-254; pad type – Al). The samples for the comparison were methanol solutions of synthetic cannabinoids (JWH-018, JWH-073, AM-2201(565B), ADB-CHMINACA(597B), AB-FUBINACA(608B), methanol PVP.

Initial studies have shown that for the identified set of objects three different solvent systems are most efficient and have been used for chromatography: Hexane – chloroform – acetone (4:1:1); Hexane – acetone (4:1); Methanol – 25 % ammoniaque solution (100:1.5); Cyclohexane – Toluene – Diethylamine (75:70:10). At the same time the length of the solution was 100 mm.

At the end of the chromatographic process all plates were dried at 70 °C and examined under natural light and in ultraviolet light of a quartz lamp (at a length of λ = 254 nm).

In the course of the inspection the zones detected were isolated, the chromatographic plates were sprayed with triturated blue B reagent solution (0.5 vol. % reagent solution in 10 vol. % sodium carbonate solution), 0.2-vitre solution of ningidrine in acetone, Marki reagent, 2-vitre solution of cobalt rhodanide and Mandelin reagent.

It should be noted, that the barring of the chromatographic plates did not change after treatment of the chromatographic plates with ningidrine solution in acetone. At the same time after screening with triturated blue B solution, reagent Mandelin and cobalt rhodanide (for the test for α-PVP content) a characteristic change of coloration occurred.

The chromatographic analysis on the chromatographic plates (Table 1–4) resulted in a series of zones.

Table 1

The results of chromatographic research
(system: hexane – chloroform – acetone (4:1:1)

Objects	The value of R_f comparative sample	The value of R_f object extract
JWH-018	0,87	0,70
JWH-073	0,76	0,76
ADB-CHMINACA(597B)	0,73	0,73
AB-FUBINACA(608B)	0,70	0,70
AM-2201(565B)	0,79	0,79

Table 2

The results of chromatographic research
(system: hexane – acetone (4:1)

Objects	The value of R_f comparative sample	The value of R_f object extract
JWH-018	0,52	0,52
JWH-073	0,41	0,41
ADB-CHMINACA(597B)	0,35	0,35
AB-FUBINACA(608B)	0,33	0,33
AM-2201(565B)	0,38	0,38

Table 3

The results of chromatographic research
(system: methanol – 25 percent ammonia solution (100:1,5)

Component	The value of R_f		Zone color (treatment with ninhydrin solution and Marki's reagent)
	comparative sample	object extract	
α-PVP	0,70	0,70	Orange

Table 5

The results of chromatographic research
(system: cyclohexane – toluene – diethylamine (75:70:10)

Component	The value of R_f		Zone color (processing 2 % solution of cobalt rhodanide)
	comparative sample	object extract	
α-PVP	0,81	0,81	Blue

The main factors affecting the identification of the components in the mixture is the maximum discrepancy of color and location of the beaches (blocked areas) on the chromatographic plates with analogous indicators in the samples of the comparison, made with standard reagents, as well as the dip lines in the ultraviolet spectrum.

As a result of chromatographic research was established the gap ratio Rf (chromatographic coefficient of volatility, defined as the ratio of the distance from the start line to the centre of the area of the object to the value of the distance from the start line to the front line of the solution), chromatographic areas of the solutions of the comparator (methanol solutions of synthetic cannabinoids and α-PVP). The extracts indeed contain synthetic cannabinoids JWH-018, JWH-073, AM-2201(565B), ADB-CHMINACA(597B), AB-FUBINACA (608B), whose trafficking is prohibited – synthetic analogues of trans-9-tetrahydrocannabinol – a particularly dangerous psychotropic substance, the main active ingredient of cannabis plant drugs, and α-PVP (1-phenyl-2-pyrolidine-1-yl-pentane-1-one), a particularly harmful psychotropic substance whose trafficking is prohibited (*NIDA*, 2018).

The presence of the indicated cannabinoids in the mixture (referring to a high range of 0.70 to 0.79) makes their identification difficult through close Rf values (see Tables 1 and 2). The hexane-chloroform-acetone system (4:1:1) is therefore ineffective for these cannabinoids.

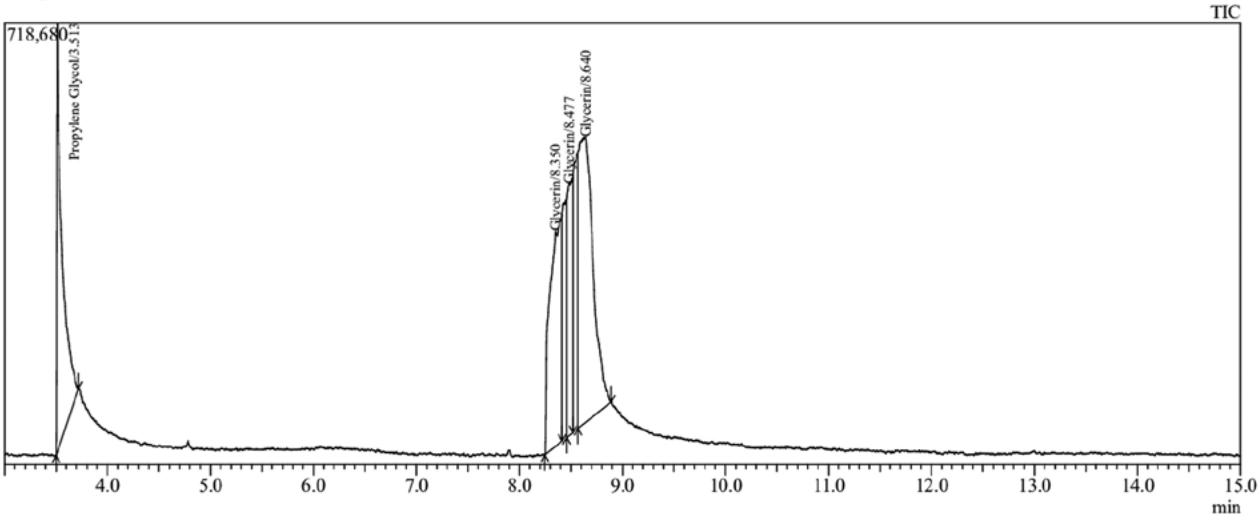
Chromato-mass spectrometric analysis. To determine the presence of narcotic drugs, psychotropic substances, precursors in the object further qualitative investigation was carried out by gas chromatography with mass-selective detection (Kolesnikova, Khatsko, Demin, Shevyrin, & Kalueff, 2019, s. 169; Shkurdoda, Pasichnyk, & Korol, 2019, s. 7).

For this purpose 10.0 ml of methanol was added to each part of the extract and mixed (Kochetkova, Duruncha, Perezhogina, & Ostapchenko, 2017, s. 54). The obtained solutions chromatographed, using a Shimadzu GCMS-QP2020 NX EI mass-selective detector under the conditions:

column	capillary Rxi-5ms, l = 30 m, D = 0.25 mm
detector	mass-selective
carrier gas	helium, flow 1.27 ml/min
evaporator temperature	250 °C
column temperature:	
initial	40 °C (0.3 min)
final	280 °C
heating rate	15 °C/min
temperature:	
interface	280 °C
ion source	220 °C
ionization	electronic shock
sample	1 μl, automatic injection
duration of analysis	30 min
scan mode	full ionic current
scan range	30–600 m/z

As a result of the study, ions characteristic of the above list of synthetic cannabinoids (Fig. 1–3) were detected, data on which are available in the database of the Lugansk RFC of the Ministry of Internal Affairs, which confirms their presence in the contents of the surveyed objects.

Analyzed : 23.03.2021 10:39:47
Sample Type : Unknown
Sample Name : 347e

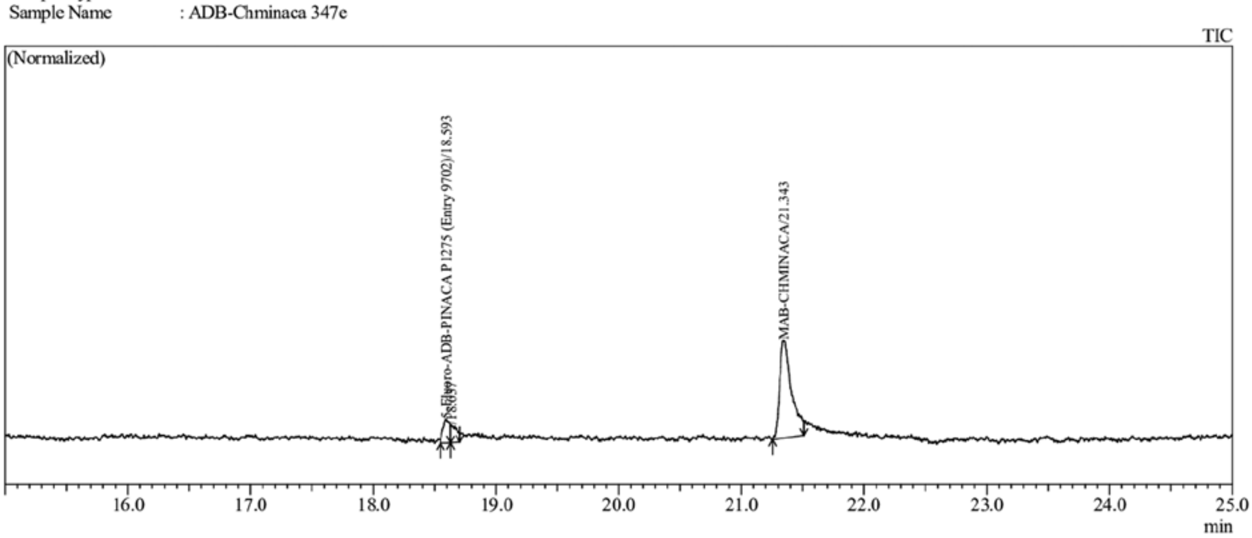


Peak Report TIC

Peak#	R.Time	Area	Height	Similarity	CAS#	Name
1	2.069	4438138	3571834	99	67-66-3	Trichloromethane
2	3.513	2613951	697475	98	57-55-6	Propylene Glycol
3	8.350	2832391	349751	92	56-81-5	Glycerin
4	8.477	1468207	410047	88	56-81-5	Glycerin
5	8.640	4446044	463867	98	56-81-5	Glycerin

Fig. 1. GC-MS – spectrum of glycerol / propylene glycol

Analyzed : 19.03.2021 18:39:10
Sample Type : Unknown
Sample Name : ADB-Chminaca 347e

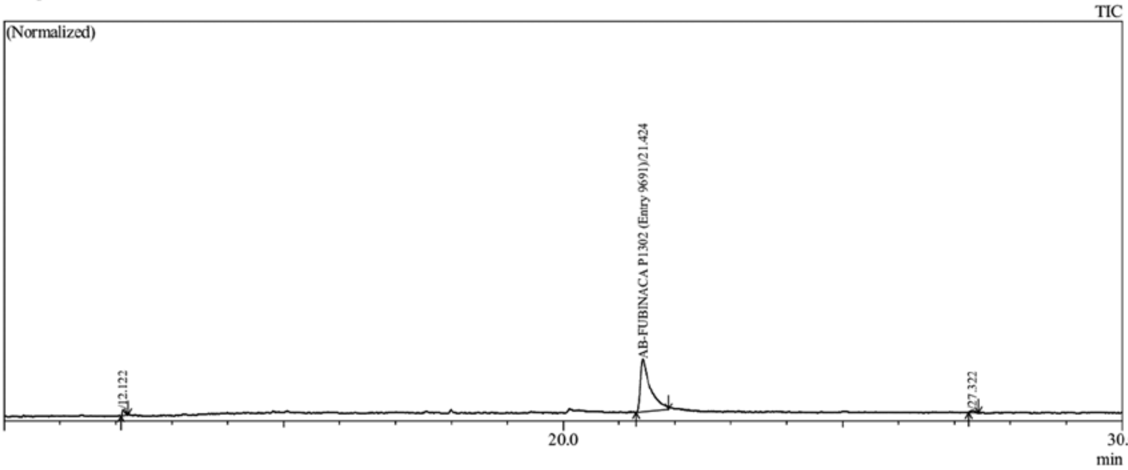


Peak Report TIC

Peak#	R.Time	Area	Height	Similarity	CAS#	Name
1	18.593	98656	26640	83	0-0-0	5-Fluoro-ADB-PINACA P1275 (Entry 9702)
2	18.637	69684	19945	0	0-0-0	
3	21.343	743065	109740	96	1863065-92-2	MAB-CHMINACA
4	31.838	5417565	436501	91	0-0-0	AKB48 4-fluorobenzyl analog
5	33.517	50236	4969	0	0-0-0	

Fig. 2. GC-MS – ADB-CHMINACA (MAB-Chminaca) spectrum

Analyzed : 19.03.2021 20:41:58
Sample Type : Unknown
Sample Name : AB-Fubinaca 347e



Peak Report TIC

Peak#	R.Time	Area	Height	Similarity	CAS#	Name
1	6.956	198705	68081	90	0-0-0	Adamantane, 1-isocyanato-
2	12.122	131368	36986	0	0-0-0	
3	21.424	4179677	340235	96	1185282-1-2	AB-FUBINACA P1302 (Entry 9691)
4	27.322	81155	13756	0	0-0-0	
5	31.944	30185903	2490478	90	0-0-0	AKB48 4-fluorobenzyl analog

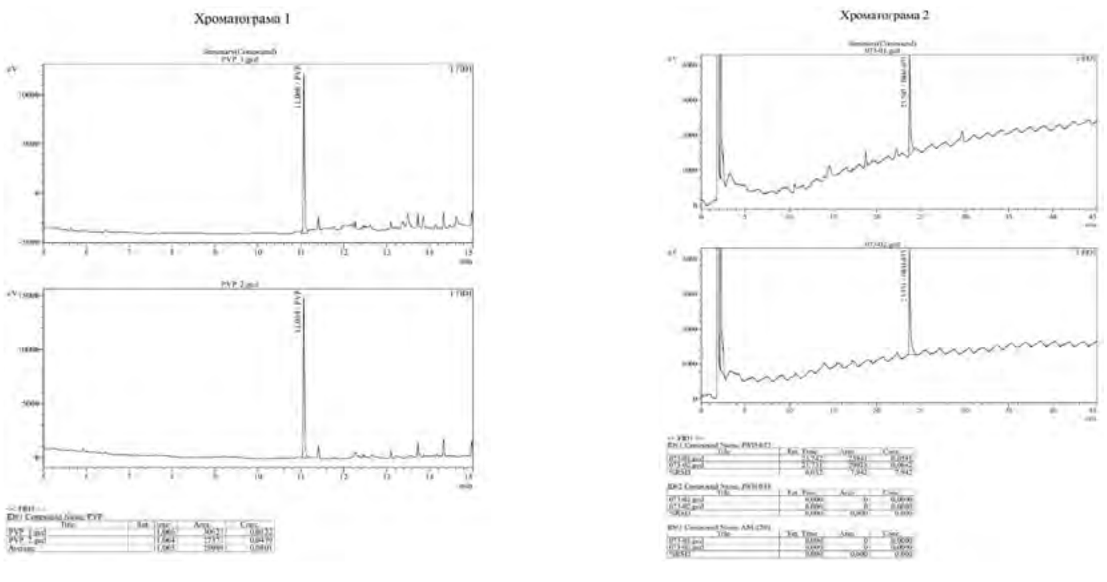
Fig. 3. GC-MS – AB-Fubinaca spectrum

The study performed by gas chromatography to quantify synthetic cannabinoids and α-PVP in the substances.

A 0.1 ml sample and a 0.1 ml parallel sample diluted with 1.0 ml of NaOH solution, suspended in methanol, stirred, and the organically separated spheres dissolved after disintegration. The extracts combined and analyzed on Shimadzu GC-2010 Plus chromatograph under the conditions of:

column	capillary Rxi-5ms, l = 30 m, D = 0.25 mm
detector	FID (flame ionization detector)
carrier gas	helium, flow 1.13 ml/min
evaporator temperature	250 °C
detector temperature	300 °C
column temperature:	
initial	100 °C (2 min)
final	280 °C
heating rate	15 °C/min
air flow	400 ml/min
hydrogen consumption	40 ml/min
sample	1 μl, automatic injection

At the final of the studying synthetic cannabinoids and α-PVP found in the composition of the reagents (Fig. 4).



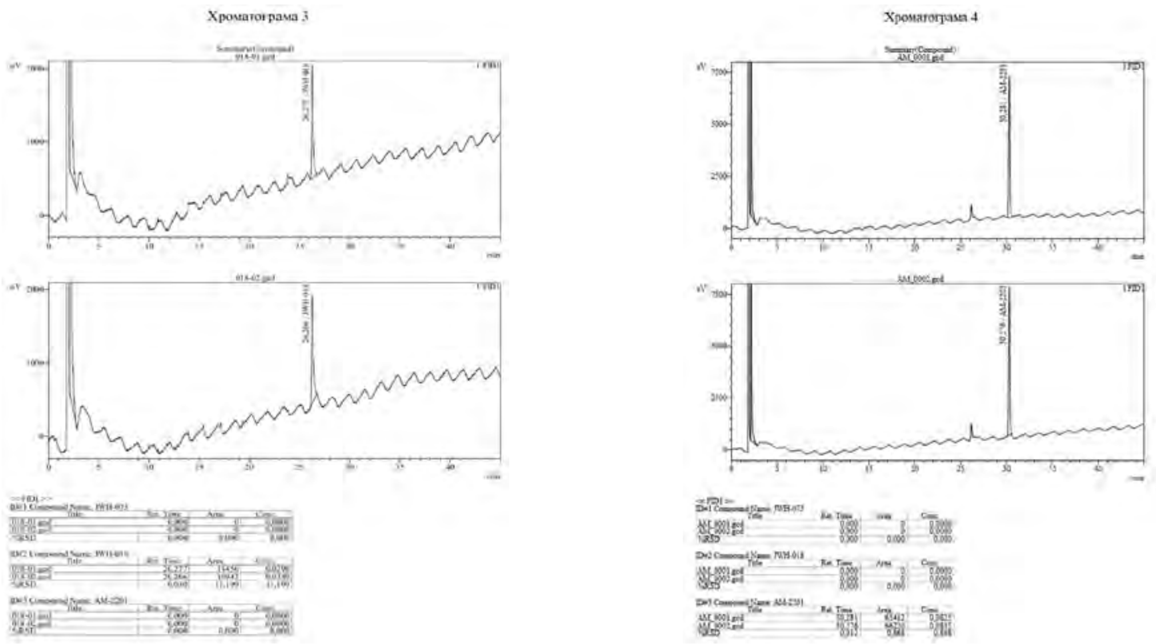


Fig. 4. The results of the study by gas chromatography

To determine the quantities of synthetic cannabinoids and α-PVP, the aliquots of the previously obtained extracts analyzed two times on a chromatograph using the «LabSolution» program by absolute calibration (Table 5).

Table 5

The results of gas chromatographic research

Objects name	Retention time, min	Peak area	Concentration, mg/ml (average)
α-PVP	11,065	28999	0,05000
JWH-073	23,736	27484	0,06265
JWH-018	26,271	15699	0,03150
AM-2201	30,278	65816	0,08300

Note. Due to the lack of enough samples of canabinoids ADB-CHMINACA (597B), AB-FUBINACA (608B) at the Lugansk RFC MIA the gas chromatographic analysis was not realized to determine their content.

The mass of synthetic cannabinoids and α-PVP calculated according to the formula (Table 6):

$$X = \frac{C \cdot V}{1000},$$

C is the concentration of cannabinoids / α-PVP by calibration, mg/ml;
V – volume of extractant, ml.

Table 6

The results of mass calculations of synthetic cannabinoids and PVP

Object name	Extractant volume, ml	Mass of substance, g
α-PVP	9,5	0,000475
JWH-073	10,0	0,000626
JWH-018	10,0	0,000315
AM-2201	9,0	0,000747

Scientific novelty

The composition of rare smoking mixtures was determined using physical and chemical methods of examination and for the first time the possibility of quantitative identification of synthetic cannabinoids and α-PVP in the composition of vape products was established.

Conclusions

1. The composition of rare smoking bags (vape) was determined and the possibility of quantitative identification of drugs, psychotropic substances and their analogues using different instrumental methods was stated, based on modern scientific research, in particular the content of synthetic cannabinoids and α-PVP in rare smoking tobacco mixtures by fine ball, gas chromatography and using mass spectrometry.

2. The efficacy of current methods of investigating synthetic cannabinoids and the contribution to the future development of methods for investigating the composition of narcotic rare substances for smoking and those containing psychoactive substances were tested by specific examples, that contain psychotropic substances, the popularity of which is growing on the world market and in Ukraine.

3. Methods of synthetic cannabinoids and α-PVP isolation from the solution of smoking bags were developed. A general approach to the choice of a scheme of investigation of synthetic drugs and psychotropic substances depending on the posed questions, the form (drug), type and number of objects to be tested was suggested.

The possibility of identifying low synthetic cannabinoids and α-PVP in the composition of rare smoking bags increases the prospect of rapid diagnostics, and effective help for people who use rare tobacco compounds due to overdose or toxic exposure to them.

References

Angerer, V., Franz, F., Moosmann, B., Bisel, P., & Auwärter, V. (2019). 5F-Cumyl-PINACA in ‹e-liquids' for electronic cigarettes: comprehensive characterization of a new type of synthetic cannabinoid in a trendy product including investigations on the in vitro and in vivo phase I metabolism of 5F-Cumyl-PINACA and its non-fluorinated analog Cumyl-PINACA. *Forensic toxicology*, 37 (1), 186–196.
DOI: https://doi.org/10.1007/s11419-018-0451-8.

Al-Eitan, L. N., Asa'ad, A. S., Battah, A. H., & Aljamal, H. A. (2020). Application of Gas Chromatography-Mass Spectrometry for the Identification and Quantitation of Three Common Synthetic Cannabinoids in Seized Materials from the Jordanian Market. *ACS omega*, 5 (8), 4172–4180.
DOI: https://doi.org/10.1021/acsomega.9b03881.

Balakirieva, O. M., Pavlova, D. M., Nhuien, N-M. K., Levtsun, O. H., Pyvovarova, N. P., Sakovych, O. T., & Fliarkovska, O. V. (2019). *Kurinnia, vzhyvannia alkoholiu ta narkotychnykh rechovyn sered pidlitkiv, yaki navchaiutsia: poshyrennia y tendentsii v Ukraini*: za rezultatamy doslidzhennia 2019 roku v ramkakh mizhnarodnoho proektu «Yevropeiske opytuvannia uchniv shchodo vzhyvannia alkoholiu ta inshykh narkotychnykh rechovyn – ESPAD». Kyiv: Obnova kompani. 214 s. [in Ukrainian].

Cannaert, A., Sparkes, E., Pike, E., Luo, J. L., Fang, A., Kevin, R. C., Ellison, R., Gerona, R., Banister, S. D., & Stove, C. P. (2020). Synthesis and *in Vitro* Cannabinoid Receptor 1 Activity of Recently Detected Synthetic Cannabinoids 4F-MDMB-BICA, 5F-MPP-PICA, MMB-4en-PICA, CUMYL-CBMICA, ADB-BINACA, APP-BINACA, 4F-MDMB-BINACA, MDMB-4en-PINACA, A-CHMINACA, 5F-AB-P7AICA, 5F-MDMB-P7AICA, and 5F-AP7AICA. *ACS chemical neuroscience*, 11 (24), 4434–4446.
DOI: https://doi.org/10.1021/acschemneuro.0c00644.

Chernolohova, S. M. (2019). Problemni pytannia lehalizatsii kanabisu [Problems of cannabis legalization]. *Yurydychnyi naukovyi elektronnyi zhurnal*, 6, 406–408 [in Ukrainian].
DOI: https://doi.org/10.32782/2524-0374/2019-6/98.

Department of Justice. Drug Enforcement Administration. 21 CFR Part 1308 [Docket No. DEA–491]. (2019). Schedules of Controlled Substances: Temporary Placement of 5F-EDMBPINACA, 5F-MDMB-PICA, FUB-AKB48, 5F-CUMYL-PINACA, and FUB-144 into Schedule I. Federal Register. *Rules and Regulations,* 84 (73), 15505–15511.

Eckberg, M. N., Arroyo-Mora, L. E., Stoll, D. R., & DeCaprio, A. P. (2019). Separation and Identification of Isomeric and Structurally Related Synthetic Cannabinoids Using 2D Liquid Chromatography and High Resolution Mass Spectrometry. *Journal of Analytical Toxicology,* 43, 170–178.
DOI: https://doi.org/10.1093/jat/bky081.

Hall, W. (2015). Challenges in minimizing the adverse effects of cannabis use after legalization. *Soc Psychiatry Psychiatr Epidemiol,* 50, 1013–1015.
DOI: https://link.springer.com/article/10.1007/s00127-015-1067-5.

Karadzhian, K., & Kasparian, G. (2015). Vnedrenie i sovershenstvovanie metodiki ekspertnogo issledovaniia rastitelnykh kuritelnykh smesei i soderzhashchikhsia v nikh naibolee rasprostranennykh sinteticheskikh kannabinoidov [Introduction and development of methodology forforensic research of herbal smoke mixtures andwidespread synthetic cannabinoids containing inthem]. *Kriminalistika i sudebnaia ekspertiza*, 60, 337–349. Polucheno iz file:///C:/Users/HAHANO~1/AppData/Local/Temp/krise_2015_60_37.pdf [in Russian].

Kochetkova, S. K., Duruncha, N. A., Perezhogina, T. A., & Ostapchenko, I. M. (2017). Issledovanie zhidkostei dlia elektronnykh sistem dostavki nikotina. *Mezhdunarodnyi nauchno-issledovatelskii zhurnal*, 4 (58), ch. 4, 54–57 [in Russian]. DOI: 10.23670/IRJ.2017.58.103.

Kolesnikova, T. O., Khatsko, S. L., Demin, K. A., Shevyrin, V. A., & Kalueff, A. V. (2019). DARK Classics in Chemical Neuroscience: α-Pyrrolidinovalerophenone («Flakka»). *ACS chemical neuroscience*, 10 (1), 168–174. DOI: https://doi.org/10.1021/acschemneuro.8b00525.

Levchenko, O. E., Kurdil, N. V., & Lutsenko, O. H. (2016). Fenomen spais: sumishi dlia palinnia abo nova khimichna zbroia [The phenomenon of spice: smoking blends or a new chemical weapons]. *Medytsyna nevidkladnykh staniv,* 2 (73), 94–99. Uziato z http://nbuv.gov.ua/UJRN/Medns_2016_2_12. [in Ukrainian].

Mavrynska, N. M. (2020). *Syntetychni kanabinoidy. Kryminalnyi protses ta kryminalistyka: suchasnyi stan ta perspektyvy:* tezy dop. vseukr. nauk.-prakt. konf. (Kharkiv, 26 lystop. 2020 r.). Kharkiv. S. 224–226 [in Ukrainian].

NIDA. 2018, February 5. Synthetic Cannabinoids (K2/Spice) DrugFacts. Retrieved from https://www.drugabuse.gov/publications/drugfacts/synthetic-cannabinoids-k2spice on 2021, September 27.

Pon, D., & Fenyvesi, I. J. (2018). Validated Method for the Detection and Quantitation of Synthetic Cannabinoids in Whole Blood and Urine, and its Application to Postmortem Cases in Johannesburg, South Africa. *S. Afr. J. Chem*, 71, 24–29. DOI: https://doi.org/10.17159/0379-4350/2018/v71a3.

Raso, S. (2018). The Determination and Evaluation of Pyrolytic Products: A Focus on Synthetic Cannabinoids. *Graduate Theses, Dissertations, and Problem Reports*. 6481. DOI: https://doi.org/10.33915/etd.6481.

Shkurdoda, S. V., Pasichnyk, V. V., & Korol, K. P. (2019). *Yakisne ta kilkisne vyznachennia kanabinoidiv u chastynakh roslyn konopel metodom khromato-mas-spektroskopii:* metod. rek. Kyiv: DNDEKTs MVS. 54 s. [in Ukrainian].

Skrypnikov, A. M., Herasymenko, L. O., Rud, V. O., & Kydon, P. V. (2020). *Kanabis ta kanabinoidy*: navch. posib. Poltava: ASMI. 120 s. [in Ukrainian].

Tkachenko, I. H., & Tkachenko, V. V. (2018). Molekuliarnyi dokinh dlia modeliuvannia kompleksiv potentsiinykh psykhoaktyvnykh spoluk iz kanabinoidnymy retseptoramy SV1. *Kryminalistychnyi visnyk,* 2 (30), 122–131 [in Ukrainian]. DOI: https://doi.org/10.37025/1992-4437/2018-30-2-122.

List of used sources

Al-Eitan, L. N., Asa'ad, A. S., Battah, A. H., & Aljamal, H. A. (2020). Application of Gas Chromatography-Mass Spectrometry for the Identification and Quantitation of Three Common Synthetic Cannabinoids in Seized Materials from the Jordanian Market. *ACS omega*, 5 (8), 4172–4180. DOI: https://doi.org/10.1021/acsomega.9b03881.

Angerer, V., Franz, F., Moosmann, B., Bisel, P., & Auwärter, V. (2019). 5F-Cumyl-PINACA in 'e-liquids' for electronic cigarettes: comprehensive characterization of a new type of synthetic cannabinoid in a trendy product including investigations on the in vitro and in vivo phase I metabolism of 5F-Cumyl-PINACA and its non-fluorinated analog Cumyl-PINACA. *Forensic toxicology*, 37 (1), 186–196. DOI: https://doi.org/10.1007/s11419-018-0451-8.

Балакірєва, О. М., Павлова, Д. М., Нгуєн, Н-М. К., Левцун, О. Г., Пивоварова, Н. П., Сакович, О. Т., & Флярковська, О. В. (2019). *Куріння, вживання алкоголю та наркотичних речовин серед підлітків, які навчаються: поширення й тенденції в Україні:* за результатами дослідження 2019 року в рамках міжнародного проекту «Європейське опитування учнів щодо вживання алкоголю та інших наркотичних речовин – ESPAD». Київ: Обнова компані. 214 с.

Cannaert, A., Sparkes, E., Pike, E., Luo, J. L., Fang, A., Kevin, R. C. … Stove, C. P. (2020). Synthesis and *in Vitro* Cannabinoid Receptor 1 Activity of Recently Detected Synthetic Cannabinoids 4F-MDMB-BICA, 5F-MPP-PICA, MMB-4en-PICA, CUMYL-CBMICA, ADB-BINACA, APP-BINACA, 4F-MDMB-BINACA, MDMB-4en-PINACA, A-CHMINACA, 5F-AB-P7AICA, 5F-MDMB-P7AICA, and 5F-AP7AICA. *ACS chemical neuroscience*, 11 (24), 4434–4446. DOI: https://doi.org/10.1021/acschemneuro.0c00644.

Чернологова, С. М. (2019). Проблемні питання легалізації канабісу [Problems of cannabis legalization]. *Юридичний науковий електронний журнал*, 6, 406–408. DOI: https://doi.org/10.32782/2524-0374/2019-6/98.

Department of Justice. Drug Enforcement Administration. 21 CFR Part 1308 [Docket No. DEA–491]. (2019). Schedules of Controlled Substances: Temporary Placement of 5F-EDMBPINACA, 5F-MDMB-PICA, FUB-AKB48, 5F-CUMYL-PINACA, and FUB-144 into Schedule I. Federal Register. *Rules and Regulations,* 84 (73), 15505–15511.

Eckberg, M. N., Arroyo-Mora, L. E., Stoll, D. R., & DeCaprio, A. P. (2019). Separation and Identification of Isomeric and Structurally Related Synthetic Cannabinoids Using 2D Liquid Chromatography and High Resolution Mass Spectrometry. *Journal of Analytical Toxicology,* 43, 170–178. DOI: https://doi.org/10.1093/jat/bky081.

Pon, D., & Fenyvesi, I. J. (2018). Validated Method for the Detection and Quantitation of Synthetic Cannabinoids in Whole Blood and Urine, and its Application to Postmortem Cases in Johannesburg, South Africa. *S. Afr. J. Chem*, 71, 24–29. DOI: https://doi.org/10.17159/0379-4350/2018/v71a3.

Hall, W. (2015). Challenges in minimizing the adverse effects of cannabis use after legalization. *Soc Psychiatry Psychiatr*

Epidemiol, 50, 1013–1015.
DOI: https://link.springer.com/article/10.1007/s00127-015-1067-5.

Караджян, К., & Каспарян, Г. (2015). Внедрение и совершенствование методики экспертного исследования растительных курительных смесей и содержащихся в них наиболее распространённых синтетических каннабиноидов [Introduction and development of methodology forforensic research of herbal smoke mixtures andwidespread synthetic cannabinoids containing inthem]. *Криминалистика и судебная экспертиза,* 60, 337–349. Получено из file:///C:/Users/HAHANO~1/AppData/Local/Temp/krise_2015_60_37.pdf.

Кочеткова, С. К., Дурунча, Н. А., Пережогина, Т. А., & Остапченко, И. М. (2017). Исследование жидкостей для электронных систем доставки никотина. *Международный научно-исследовательский журнал,* 4 (58), ч. 4, 54–57. DOI: 10.23670/IRJ.2017.58.103.

Kolesnikova, T. O., Khatsko, S. L., Demin, K. A., Shevyrin, V. A., & Kalueff, A. V. (2019). DARK Classics in Chemical Neuroscience: α-Pyrrolidinovalerophenone («Flakka»). *ACS chemical neuroscience*, 10 (1), 168–174.
DOI: https://doi.org/10.1021/acschemneuro.8b00525.

Левченко, О. Е., Курділь, Н. В., & Луценко, О. Г. (2016). Феномен спайс: суміші для паління або нова хімічна зброя [The phenomenon of spice: smoking blends or a new chemical weapons]. *Медицина невідкладних станів*, 2 (73), 94–99. Узято з http://nbuv.gov.ua/UJRN/Medns_2016_2_12.

Мавринська, Н. М. (2020). Синтетичні канабіноїди. *Кримінальний процес та криміналістика: сучасний стан та перспективи:* тези доп. всеукр. наук.-практ. конф. (Харків, 26 листоп. 2020 р.). Харків. С. 224–226.

NIDA. 2018, February 5. Synthetic Cannabinoids (K2/Spice) DrugFacts. Retrieved from https://www.drugabuse.gov/publications/drugfacts/synthetic-cannabinoids-k2spice on 2021, September 27.

Raso, S. (2018). The Determination and Evaluation of Pyrolytic Products: A Focus on Synthetic Cannabinoids. *Graduate Theses, Dissertations, and Problem Reports*. 6481.
DOI: https://doi.org/10.33915/etd.6481.

Шкурдода, С. В., Пасічник, В. В., & Король, К. П. (2019). *Якісне та кількісне визначення канабіноїдів у частинах рослин конопель методом хромато-мас-спектроскопії:* метод. рек. Київ: ДНДЕКЦ МВС. 54 с.

Скрипніков, А. М., Герасименко, Л. О., Рудь, В. О., & Кидонь, П. В. (2020). *Канабіс та канабіноїди:* навч. посіб. Полтава: АСМІ. 120 с.

Ткаченко, І. Г., & Ткаченко, В. В. (2018). Молекулярний докінг для моделювання комплексів потенційних психоактивних сполук із канабіноїдними рецепторами CB1. *Криміналістичний вісник*, 2 (30), 122–131.
DOI: https://doi.org/10.37025/1992-4437/2018-30-2-122.

The article was received by the editors 20.07.2021

О. І. Тарасенко, *кандидат технічних наук,*
судовий експерт сектору дослідження наркотичних засобів,
психотропних речовин, їх аналогів та прекурсорів
відділу досліджень матеріалів, речовин та виробів,
Луганський науково-дослідний експертно-
криміналістичний центр МВС України,
м. Рубіжне Луганської обл.
ORCID: https://orcid.org/0000-0001-9861-2256
email: tarasencom.ua@ukr.net
тел.: +38(099)404-63-02

ДОСЛІДЖЕННЯ СКЛАДУ РІДКИХ СУМІШЕЙ ДЛЯ КУРІННЯ. ВИЗНАЧЕННЯ СИНТЕТИЧНИХ КАНАБІНОЇДІВ ТА α-PVP

Мета статті – висвітлити можливість кількісної ідентифікації наркотичних засобів, психотропних речовин та їх аналогів у контексті дослідження складу рідких сумішей для куріння (вейпів), запропонувати певну методику. ***Методологія***. Для реалізації поставленої мети використано комплекс загальнонаукових, спеціальних методів. Зокрема, застосовуючи теоретичні методи (аналіз, узагальнення, порівняння, моделювання), систематизовано теоретичні матеріали з проблем, що вирішуються; емпірично визначено стан практичної опрацьованості проблеми; організаційно-експериментальними засобами (діагностичний, констатувальний, формувальний, коригувальний експеримент) у поєднанні з якісним аналізом і математичним обробленням отриманих результатів підтверджено ефективність запропонованої методики. Достовірність результатів забезпечено використанням сучасних інструментальних фізико-хімічних, математичних, статистичних методів аналізу, а також програмним обробленням експериментальних даних. ***Наукова новизна***.

Визначено склад рідких сумішей для куріння з використанням фізико-хімічних методів дослідження, вперше засвідчено можливість кількісної ідентифікації синтетичних канабіноїдів і α-PVP у складі вейпів. ***Висновки***. Визначено склад рідких сумішей для куріння (вейпів) і засвідчено можливість кількісної ідентифікації в їх складі наркотичних засобів, психотропних речовин та їх аналогів із використанням різних інструментальних методів, які базуються на сучасних наукових дослідженнях, зокрема вмісту синтетичних канабіноїдів і α-PVP у рідких сумішах для куріння методом тонкошарової, газової хроматографії та із застосуванням мас-спектрометрії. На конкретних прикладах перевірено ефективність чинних методик дослідження синтетичних канабіноїдів і зроблено внесок у майбутнє формування методики з дослідження складу нарковмісних рідких сумішей для куріння і тих, що містять психотропні речовини, попит на які на світовому ринку та в Україні наразі зростає. Розроблено методику виділення синтетичних канабіноїдів і α-PVP з розчину сумішей для куріння. Запропоновано загальні підходи щодо вибору схеми дослідження синтетичних наркотичних засобів і психотропних речовин залежно від поставлених запитань, форми (рідина), виду та кількості наданих на дослідження об’єктів.

Ключові слова: синтетичні канабіноїди; α-PVP; рідкі суміші для куріння; вейпи; гліцерин; пропіленгліколь; хромато-мас-спектроскопія; газорідинна хроматографія.

А. И. Тарасенко, *кандидат технических наук,*
судебный эксперт сектора исследования наркотических средств,
психотропных веществ, их аналогов и прекурсоров
отдела исследований материалов, веществ и изделий,
Луганский научно-исследовательский экспертно-
криминалистический центр МВД Украины,
г. Рубежное Луганской обл.
ORCID: https://orcid.org/0000-0001-9861-2256
email: tarasencom.ua@ukr.net
тел.: +38(099)404-63-02

ИССЛЕДОВАНИЕ СОСТАВА ЖИДКИХ СМЕСЕЙ ДЛЯ КУРЕНИЯ. ОПРЕДЕЛЕНИЕ СИНТЕТИЧЕСКИХ КАННАБИНОИДОВ И α-PVP

Цель статьи – осветить возможность количественной идентификации наркотических средств, психотропных веществ и их аналогов в контексте исследования состава смесей для курения (вейпов), предложить соответствующую методику. ***Методология***. Для реализации поставленной цели использован комплекс общенаучных, специальных методов. В частности, применяя теоретические методы (анализ, обобщение, сравнение, моделирование), систематизированы теоретические материалы по решаемым проблемам; эмпирически определено состояние практической проработанности проблемы; организационно-экспериментальными средствами (диагностический, констатирующий, формирующий, корректирующий эксперимент) в сочетании с качественным анализом и математической обработкой полученных результатов подтверждена эффективность предложенной методики. Достоверность результатов обеспечена использованием современных инструментальных физико-химических, математических, статистических методов анализа, а также программной обработкой экспериментальных данных. ***Научная новизна***. Определен состав смесей для курения с использованием физико-химических методов исследования, впервые раскрыты возможности количественной идентификации синтетических каннабиноидов и α-PVP в составе вейпов. ***Выводы***. Определен состав смесей для курения (вейпов) и рассмотрена возможность количественной идентификации в их составе наркотических средств, психотропных веществ и их аналогов с использованием различных инструментальных методов, основанных на современных научных исследованиях, в частности содержания синтетических каннабиноидов и α-PVP в жидких смесях для курения методом тонкослойной, газовой хроматографии и с применением масс-спектрометрии. На конкретных примерах проверена эффективность действующих методик исследования синтетических каннабиноидов и внесен вклад в будущее формирования методики по исследованию состава наркосодержащих смесей для курения и содержащих психотропные вещества, спрос на которые на мировом рынке и в Украине пока растет. Разработана методика выделения синтетических каннабиноидов и α-PVP из раствора смесей для курения. Предложены общие подходы к выбору схемы исследования синтетических наркотических средств и психотропных веществ в зависимости от поставленных вопросов, формы (жидкость), вида и количества предоставленных на исследование объектов.

Ключевые слова: синтетические каннабиноиды; α-PVP; жидкие смеси для курения; вейпы; глицерин; пропиленгликоль; хромато-масс-спектроскопия; газожидкостная хроматография.