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Forensic examination of illicit cannabis plantations

Summary

The aim of this article is to present selected aspects related to the sampling for the purposes of forensic examinations of plants from cannabis plantations suspected to be not of industrial hemp, and the methodology of plant material testing allowing to determine the total delta-9-tetrahydrocannabinol (9THC) and tetrahydrocannabinolic acid (9THCA) content. The result of the research allows to qualify the cultivation in terms of its legality using the percentage criterion of 0.2% defined in the Act on Counteracting Drug Addiction.

Key words: illicit cannabis plantations, cannabis plants, sampling, delta-9-tetrahydrocannabinol, tetrahydrocannabinolic acid

Introduction

Cannabis sativa L. var. sativa is widely used in many European countries in different industries, such as textile, construction, food and cosmetics production. In 2017, the total area of their plantations in the EU amounted to 42.5 thousand hectares. Also in Poland, the interest in their cultivation is growing and results in a rapid increase in the acreage. According to the website of the Ministry of Agriculture and Rural Development[1], in 2020, the area of industrial hemp plantations in Poland covered 3.6 thousand hectares.

However, in addition to those produced for legal applications there are varieties of cannabis (Cannabis sativa L. var. indica) that are used, among others, in the illicit drug market as narcotic drugs. The problem of drug addiction and related crimes is dealt with by many institutions, including the Police one of whose tasks is to detect crimes and offenses and prosecute their perpetrators, including the detection and counteracting non-fibrous cannabis plantations prohibited by law[2]. In order to determine the type of crop cultivated in a given area it is necessary to take plant samples, test them in a laboratory and refer the obtained result to the applicable regulations. It should be emphasised that the tasks of the Police include detecting crimes and offences by identifying perpetrators and collecting evidence necessary to confirm (or exclude) the fact they committed a crime in question. Due to the above, it is not Police task to inspect legal plantations but to verify notifications / reports of alleged illegal growing of Cannabis sativa L. var. indica under the cover of an industrial hemp plantation.

Legal aspects

The legitimacy of cannabis cultivation in Poland is regulated the Act on Counteracting Drug Addiction (UoPN)[3] of July 29, 2005, as amended. According to Art. 45 section 3: "The cultivation of fibrous hemp shall be permitted exclusively for the needs of the textile, chemical, cellulose and paper, grocery, cosmetic, pharmaceutical, construction materials and seed production industries", and according to paragraph 4 "cultivation of hemp other than listed in paragraph 3 shall be prohibited." According to Art. 46 section 2: "The cultivation of fibrous hemp may be performed in a predetermined area, in a designated location, upon the cultivation license, with use of first or second class seed material with the meaning of the provisions on seed production." The use of appropriate seed material is confirmed by the purchase invoice and the packaging label (Art. 46 (3)). According to Art. 63 section 1 a person who grows cannabis, with the exception of fibrous hemp, shall be subject to imprisonment for up to three years. If an offence consists in a cultivation that may provide a significant

[1] https://www.gov.pl/web/rolnictwo/uprawa-konopi-siewnych-i-medycznych-tematem-posiedzenia-podkomisji-stalej-ds-biogospodarki-i-innowacyjnosci-w-rolnictwie (accessed on 4.02.2021).

[2] The Police Act of 6 April 1990 (as amended, Journal of Laws 2020, item 360).

[3] Act of 29 July 2005 on Counteracting Drug Addiction (as amended, Journal of Laws 2005, item 2050).

amount of resin or hemp plant material other than fibrous, the perpetrator is subject to imprisonment from 6 months to 8 years (section 3). In addition to that, the Act specifies which plants can be considered industrial hemp – pursuant to Art. 4 point 5 'fibrous hemp' means any plant of the species Cannabis sativa L. in which the sum of the content of delta-9--tetrahydrocannabinol and tetrahydrocannabinolic acid (delta-9-THC-2-carboxylic acid) in flowering or fruiting plant tops, from which the resin has not been removed, does not exceed 0.20% on a dry matter of the plant. It should be noted that this definition does not classify cannabis plants by botanical variety, but only on the basis of the quantitative content of the two substances, and there is no tolerance whatsoever for this value. Thus, all cannabis plants in which the sum of delta-9--tetrahydrocannabinol (hereinafter referred to as: 9THC) and tetrahydrocannabinolic acid (abbreviated: 9THCA) is greater than 0.20% must be considered non-fibrous hemp, without any deviations or limit values, because the act only mentions one numerical value.

It is worth mentioning here that until 2006, in accordance with the then effective drug addiction counteracting law, the division of hemp plants into fibrous and non-fibrous was made on the basis of 9THC content only. Plants with a 9THC content below 0.20% were considered industrial hemp. However, in 2006, marijuana obtained from, so-called, "genetically modified cannabis", emerged for the first time on the illegal drug market in Poland. Its chemical composition was a characteristic feature: the content of the substance determining the biological activity of cannabis, i.e. 9THC, was below 0.20%, while the main cannabinoid present in the plant was 9THCA. In some samples of dried plants, the acid content was even several dozen times larger than the 9THC content (an example of dried plant material is shown in Figure 1). In the light of the regulations that were in force at that time, such dry material might have been classified as **fibrous hemp green parts**, but due to its effect on the human body, it should rather have been labelled as "highly narcotic". It was related to the process of thermal decomposition of 9THCA acid to 9THC; during smoking, 9THC present in "pure" form, and, additionally, 9THC resulting from high-temperature decarboxylation of 9THCA acid took effect on user's body. In response to this situation, an amendment to the Act on Counteracting Drug Addiction was introduced in December 2006. According to the new definition the division of hemp into fibrous and non-fibrous types has since been made on the basis of the total content of delta-9-tetrahydrocannabinol and tetrahydrocannabinolic acid.

Fig. 1. Dried genetically modified cannabis confiscated in 2006.

General situation on the European market

Based on the latest data from the European Monitoring Centre for Drugs and Drug Addiction (2019), it can be concluded that cannabis is one of the most popular and widely used drugs in Europe. On the one hand, there is an international debate about the healing properties of cannabis, on the other hand, however, it is now mentioned as the most common reason for patients to seek specialist addiction treatment, especially for the first time. Moreover, in recent years, due to advances in cultivation, extraction and production techniques new hybrid cannabis varieties with a much stronger effect than those known in Europe have been created. Another example of rapid changes is the launching in the market dried low-potency cannabis and oil obtained from it (in health food stores or specialist shops). These products are purchased not only by people interested in a possible health application, but also by the users of Cannabis indica. The marijuana sold in Europe comes mainly from European production, most often from plants grown in closed spaces, in the so-called indoor plantations. In 2017, EU Member States reported 782,000 seizures of cannabis products, including 440,000 seizures of marijuana and 22,700 seizures of plants. The confiscates of cannabis plants can be regarded an indicator of the production of this drug in a given country. Under the EU Common Agricultural Policy, the cultivation of various types of cannabis intended for industrial use is subsidised but the content of the psychoactive substance in them, i.e. 9THC or the total content of 9THC and 9THCA may not exceed a certain level. These limits in individual countries range from 0 to 0.3%. This value is intended for distinguishing between the varieties of fibrous hemp and the so-called narcotic cannabis and not for determining the level of safety for human consumption.

Dismantling illicit cannabis plantations

With regard to the cultivation of cannabis, the tasks of the Police include all activities inconsistent with the aforementioned Act on Counteracting Drug Addiction, including the disclosure and dismantling of illegal plantations. At this point, it should be emphasised that

the Police does not exercise supervision or control over the cultivation of hemp, however, in the event of suspicion of the legitimacy of the cultivation, especially in terms of the variety of crops, which is directly related to the content of active substances, a laboratory analysis is the only form of reliable test. On the basis of the appearance of the plants alone, it cannot be ascertained that authorised plants are cultivated in a given area. There are also no tests or devices available that would allow direct testing of fresh plants at the place of cultivation. For this reason, there are situations when the Police, having a reasonable suspicion of committing a crime, must take samples and order examinations leading to verification of the legitimacy of the plantation whose owner has been granted a permission to grow hemp. Unfortunately, sometimes typically "narcotic" plants with a very high active substance content can be found among fibrous cannabis. They belong to a completely different variety than those that would be expected in the cultivation of industrial hemp. Table 1 presents data on non-fibrous hemp crops closed down by the Police in 2016–2020, broken down by year. These values have remained relatively constant in recent years.

Table 1. Number of non-fibrous cannabis plantations closed down by in years 2016–2020.

Year	2016	2017	2018	2019	2020
Number of closed down plantations	1295	1208	1224	1237	1235

In case of revealing a cannabis planation that is suspected of being maintained in violation of the provisions of the Act on Counteracting Drug Addiction in the first place, the existing situation is consolidated by inspecting the place where the cultivation is disclosed, during which plant samples are secured for laboratory tests in order to confirm or exclude the commission of a crime. Then laboratory tests are carried out because, as previously mentioned, no devices or methods are currently available to directly determine the sum of 9THC and 9THCA in growing cannabis plants. For the purposes of testing hemp plant material in police forensic laboratories, in order to standardize the tests and compare the results regardless of the place where they are performed, the Central Forensic Laboratory of the Police (CFLP) has developed a methodology that incorporates, inter alia, the method of collecting and testing samples from crops. The methodology used by the Police primarily takes into account the provisions of the Act on Counteracting Drug Addiction, therefore the sum of 9THC and 9THCA is determined in terms of dry weight and given as a percentage.

The activities connected with sampling can be divided into those performed at the scene and the ones done in the laboratory.

A) The activities performed at the scene of inspection related to revealing a plantation and taking a sample

A scene of crime officer or, in special cases, an expert in chemical analysis, usually performs the selection and sampling in the location when the cultivation of suspected cannabis has been observed. Initially, plants are visually assessed in terms of their appearance and stage of development. The consistence of the appearance and development stages of all plants are checked. The next step involves determining the stage of development – whether it is the initial growth, the stage before blooming, actual blooming or fruiting. Then, detailed photographic documentation of the crop is made, and in the next step all plants are divided into the so-called plots. Each plot includes plants growing in a given area (in the case of "outdoor" plantation) or hall (in the case of "indoor" cultivation). Plants in the plot should be of similar height, have a similar appearance and be in the same growth phase (development stage). According to the above rules, flowering plants are not combined with plants in the pre-blooming phase, even if they are present in one plot. They are then treated as separate plots. In the case of very large crops, especially outdoor ones, the so-called "outdoor" (over 1000 plants), even if all the plants look similar, the whole field should be divided into sectors containing a maximum of 1000 – then each sector forms one plot.

Further activities are conducted according to the following rules:

1. from each plot, one representative sample of plants is collected consisting of at least 5 pieces (maximum 25), depending on the number of plants in a given plot (the more plants there are the larger sample must be taken); plants should be cut above the ground, and picked up from a minimum of five different places; especially in the case of "outdoor" plantations, these should not plants growing on the edges,
2. plants collected from one plot are combined together and placed in a paper packaging.

An illustrative algorithm for the approximate number of plants taken for testing depending on the number of recovered plants and their growth phase is presented in Table 2. It was developed in accordance with international standards for sampling for forensic examinations recommended by UNODC (the United Nations International Drug Control Programme) – the United Nations agenda for the control of narcotic substances and their precursors, as well as ENFSI (European Network of Forensic Science Institutes). The recommendations on drug testing compiled by a team of specialists in the field of forensic science, which were published in *Issues of Forensic Science* journal issues no. 242/03 and no. 243/04, were also taken into account.

Table 2. Numbers of plants collected for examination (treated as a single sample) depending on their quantities and growth stages.

No.	Number of plants	Growth stage	Number of plants in a sample [items]	Comments
1	not more than 100	before blooming, below 10 cm high	15	Higher number of plants needed due to their small size and low weight upon drying
2	not more than 100	before blooming, over 10 cm high	5	-
3	not more than 100	blooming/fruiting	5	-
4	from 100 to 1000	before blooming, below 10 cm high	from 15 to 25	-
5	from 100 to 1000	before blooming, over 10 cm high	from 5 to 25	-
6	from 100 to 1000	blooming/fruiting	from 5 to 25	-
7	over 1000	before blooming, below 10 cm high	from 15 to 25 × number of plots	Divide cultivation into plots
8	over 1000	before blooming, over 10 cm high	from 15 to 25 × number of plots	Divide cultivation into plots
9	over 1000	blooming/fruiting	from 15 to 25 × number of plots	Divide cultivation into plots

Figures 2–7 present examples of illicit cannabis plantations with information on growth stage and size of recommended samples for examination.

Samples of plants from plantations suspected of being illegal are taken in a slightly different way than those from areas where fibrous hemp is grown and for which support system claims have been submitted (legal industrial plantations). In the latter case, the sampling rules and examination methodology are specified in separate regulations[4]. This is due to the different nature of the activities and the purpose of the research. It should be emphasized that there are situations when the declaration of the cultivator is not consistent with the facts, and therefore any questionable crop is approached in the same way, in accordance with the methodology of examining illegal crops.

B) Activities conducted after recovery of evidential material

1. plants submitted for examination are dried in room temperature for a few days until obtaining air-dried mass.

C) Activities conducted in a laboratory

1. the recovered plants are weighed and subjected to detailed macroscopic examination,
2. in the case of plants in the pre-blooming stage, if their height does not exceed 10 cm entire over-ground parts of the plants shall be taken for testing.
3. in the case of plants in the pre-blooming stage, if their height exceeds 10 cm the top part of the plant (the top shoot) is taken for testing in the amount of about 10% of the height of the entire over-ground part of the plant.
4. in the case of plants in the blooming or fruiting stage – the upper part of the plant (top) with inflorescences or fruits is taken for testing.
5. each collected sample of dried material is subjected to preliminary fragmentation and then one representative sample is taken from the resulting material.
6. the representative samples are dried at 35°C until solid material is obtained, and then each of them is homogenised.

Quantitative examinations

The quantitative examinations are carried out using gas chromatography with a flame ionization detector using an internal standard method. The quantitative analysis is based on the determination of the sum of delta-9-tetrahydrocannabinol (9THC) and delta--9-tetrahydrocannabinolic acid (9THCA) in the dried material expressed as a percentage by weight, with 9THCA being converted into 9THC in the decarboxylation process in the dispenser chamber. Two separate weighted portions are taken from each dried sample. Next, a methanol solution with an internal

[4] Commission Implementing Regulation (EU) No. 809/2014 of 17 July 2014.

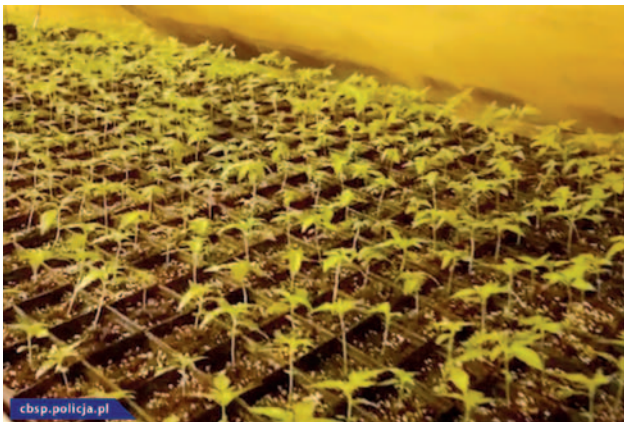

Fig. 2. Approximately 250 plants before blooming stage of height below 10 cm; it is advisable to collect for examination one sample counting from 15 to 25 plants.

Fig. 3. Plantation consisting of 62 plants before blooming stage of height over 10 cm; it is advisable to collect one sample counting 5 plants.

Fig. 4. Approximately 500 plants before blooming stage of over 10 cm height; it is advisable to take for examination one sample counting from 5 to 25 plants.

Fig. 5. Below 100 plants in blooming stage; one sample counting 5 plants should be taken for examination.

Fig. 6. Plantation comprising from 100 to 1000 plants in the blooming phase; it is advisable to take for examination one sample counting from 5 to 25 plants.

Fig. 7. Plantation counting 1840 plants before blooming stage above 10 cm height; the entire plantation ought to be divided into plots and two samples counting from 5 to 25 items each should be collected.

standard – tribenzylamine – is added to the samples. The choice of solvent is not random. Tests carried out at CFLP have demonstrated that the solubility of both 9THC and 9THCA in methanol is very good, which means that this specific solvent eliminated the error of unequal solubility of the above compounds and allows obtaining reliable results regarding the content of both substances in the analyte. Until 2006, hexane had been used as a solvent for the extraction of dried samples in quantitative research with the GC-FID method, but the poor solubility of 9THCA in it prevented its further use after the amendment in the Act on Counteracting Drug Addiction. It was impossible to fully determine the total concentration of both substances, which after the change of the UoPN in 2006 became crucial for the correct legal classification of plants. Next, the samples are mixed in the rotator mixer for 60 minutes. After centrifuging the solution, the clear extract is transferred to an appropriately labelled glass vessel intended for use with an automatic sample feeder and analysed automatically on a gas chromatograph. Each obtained chromatogram is checked for correctness of the course of the process and the obtained value for the analyte and the internal standard. The final result is the arithmetic average of the values obtained for the two parts. Each obtained average result is corrected for the uncertainty value for the method, which is of particular importance at the 0.20% threshold value. Finally, this value is taken into account in the final interpretation and concluding.

An expert carries out the interpretation of the outcome taking into considerations the result of quantitative examinations, method uncertainty, as well as the stage of plants growth, and eventually, formulates the final conclusions according to the scheme below.

It ought to be observed that it is not always possible to categorically classify cannabis plants in the context of the Act on Counteracting Drug Addiction. Particularly in a case of very young plants, with a low content of 9THC and 9THCA, an unambiguous indication would be burdened with error, because it is not known what the content of both substances would be in an already mature plant.

Quality and method correctness control

In order to ensure the credibility of the obtained results, quality control of the process is performed, which includes many factors. The standards used for quantitative tests are of determined purity confirmed by appropriate certificates. Each time during quantitative tests, a control sample with a known content of the substance in question (standard) is analyzed in order to check both the correctness of the preparation of the sample and the method, as well as the analytical

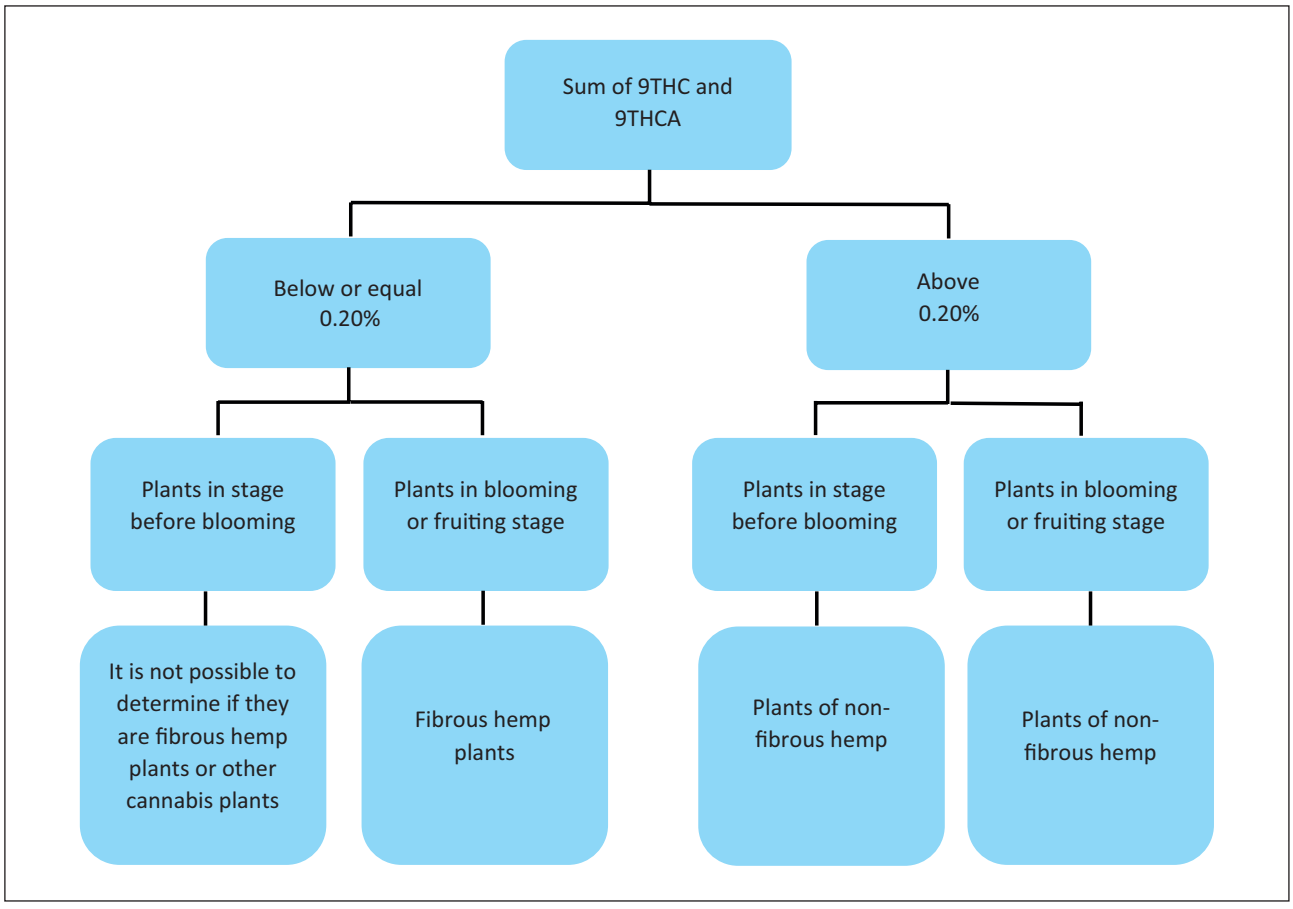

Fig. 8. Scheme of quantitative examination results interpretation in case of plants recovered from an illicit plantation.

equipment. The equipment is periodically checked and maintained by an authorized external service.

In order to confirm the competences of the Police analytical units and to maintain high standards of work, CFLP and forensic laboratories of the Voivodeship Police Headquarters systematically participate in international proficiency tests/interlaboratory comparisons of psychoactive substances that consist of qualitative and quantitative tests, including those for the content of 9THC and 9THCA in dried cannabis plants.

Comparison with the European Union method used in inspections of fibrous hemp plantations

The content of individual cannabinoids (Mańkowska et al., 2015), including 9THC, in a given variety of cannabis is influenced by many different factors. Besides genetic features, the most significant ones include abundance of the soil in in nutrients, geographical latitude, height above sea level and weather conditions during vegetation.

As part of the Common Agricultural Policy of the European Union, legal provisions have been developed concerning, inter alia, direct payments to farmers under support schemes[5] as well as rules for verification of such crops, including hemp sampling and testing. According to the EU method for the quantification of delta-9 tetrahydrocannabinol[6] in varieties of Cannabis sativa L., the sampling and testing is performed, as follows:

1. One sample is taken from among the crop of one variety of hemp grown in the field:
   a. **procedure A:** thirty centimetre parts of plant comprising at least one female inflorescence each collected from a total number of fifty plants,
   b. **procedure B:** one-third of a plant from the top from each of a total number of two hundred plants (exclusively from female plants),
2. plants recovered as one sample are placed together in a textile or paper sack,
3. the samples are dried at temperature below 70°C until obtaining solid material,
4. the samples undergo extraction with hexane with squalene as an internal standard,
5. the analyses are carried out using gas chromatography with flame ionization detection (in the case of procedure A – one determination per test sample, in the case of procedure B – the final result corresponds to the average value of two determinations made on one sample).

As already mentioned, this methodology is slightly different from that used for forensic examinations. The difference is mainly due to the much larger areas of hemp cultivation and the quantification of only one component, i.e. 9THC.

Summary

Currently, Polish legislation does not provide for any permissible deviations in the context of qualifying plants as fibrous or non-fibrous hemp. The Act on Counteracting Drug Addiction unequivocally defines the division based on the total content of 9THC and 9THCA, which is 0.20%. With regard to all plantations suspected of being carried out in breach of the provisions of the Act on Counteracting Drug Addiction, the Police apply a standardised course of proceedings in order to obtain reliable results, because the kind of charges depends on them.

The content of the report[7] on the activities of the Agency for Restructuring and Modernization of Agriculture for 2017 shows that in 17 of the 70 inspected plots of hemp plantations, the content of 9THC was exceeded above the acceptable level in the European Union. In 2018, out of 80 inspected plots, transgressions were determined in 9 cases. There are no detailed data for 2019. The report only stated that, for the 72 plots of hemp plantations audited, in the case of two varieties: Finola and Glyana the content of 9THC exceeded the permissible value for hemp, i.e. 0.2% calculated as the average of the results for all control samples of the given variety. Note that these studies only involved determining 9THCcontent not the sum of 9THC and 9THCA.

Therefore, in order to counteract situations where farmers, who, in accordance with their licence, cultivate fibrous hemp, may be held criminally responsible for the transgressions found in the total content of 9THC and 9THCA, the most effective solution seems to be a very careful selection of hemp varieties permitted for cultivation, possibly making changes to the applicable regulations.

Source of Figures and Tables

Figs. 1, 4, 6: CFLP
Figs. 2, 3, 5, 7: Central Investigative Bureau of the Police (CBŚP)
Fig. 8: CFLP
Table 1: Data of the Criminal Bureau of the Police Headquarters
Table 2: Authors

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