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The use of pesticides in Belgian illicit indoor cannabis plantations

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ABSTRACT

Cannabis (*Cannabis* spp.) use and cultivation continue to increase in many (European) countries. The illicit indoor cannabis plantations that supply Belgian and European cannabis markets create problems and concerns about health and safety of intervention staff, dismantling companies, the direct environment of cannabis plantations and, eventually, of cannabis users. Main risks may come from pesticide residues on plants, cultivation infrastructure and materials; left-over plant growth-promoting substances; mycotoxins from fungal pathogens on harvested plants; and/or high levels of cannabinoids in cannabis plant parts for consumption. In the present research, we report on pesticides found in illicit indoor cannabis plantations in Belgium. EN15662 QuEChERS extraction method and LC–MS/MS analysis were used to identify pesticides in indoor cannabis plantations and thus to evaluate the hazards associated with the use, cultivation and removal of cannabis plants in plantations as well as with dismantling activities in the cultivation rooms. We found pesticides in 64.3% of 72 cannabis plant samples and in 65.2% of 46 carbon filter cloth samples. Overall, 19 pesticides belonging to different chemical classes were identified. We found *o*-phenylphenol, bifenazate, cypermethrin, imidacloprid, propamocarb, propiconazole and tebuconazole, which is consistent with the commonly reported pesticides from literature. In only a few cases, pesticides found in bottles with a commercial label, were also identified in plant or stagnant water samples collected from the growth rooms where the bottles had been collected. We further revealed that, even though most pesticides have a low volatility, they could be detected from the carbon filters hanging at the ceiling of cultivation rooms. As a result, it is likely that pesticides also prevail in the plantation atmosphere during and after cultivation. The risk of inhaling the latter pesticides increases when plants sprayed with pesticides are intensively manipulated during dismantling activities. We conclude that pesticides represent an underestimated and under-documented health risk for intervention staff. The standard procedure for dismantling illicit indoor cannabis cultivation sites should be improved by including guidelines for appropriate personal protection equipment and dismantling protocols that take into account all possible hazards.

1. Introduction

Although total size of illicit Belgian indoor cannabis plantations is unknown, official seizure data indicate that cannabis production in Belgium is on the rise. In 2007, police confiscated 466 indoor cannabis plantations in Belgium. By 2010 this number had risen to 979 and by 2015 to 1241 plantations. In 2015, 979 (79%) of the confiscated plantations had more than 5 plants and 529 (43%) had more than 50 plants (unpublished data from the Belgian Federal police). Plantations with more than 5 plants are most likely planted for commercial reasons. Spider mites (Fam. Tetranychidae), thrips (Order Thysanoptera), white flies (Fam. Aleyrodidae), aphids (Superfam. Aphidoidea), and fungi such as *Fusarium oxysporum* and rust (Order Pucciniales, several genera and species) can cause a lot of damage to indoor cannabis plants [1–3]. Pesticide applications can prevent or kill most pests and diseases and will increase the likelihood of a successful harvest for the commercial indoor cannabis grower. However, a literature research on the chemical contamination of cannabis did not reveal widespread pesticide use in illicit indoor cannabis plantations [4]. In the USA,

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pesticides (the acaricide dicofol; insecticides chlordane, malathion, chlorpyrifos, fenvalerate, cypermethrin, tetramethrin and permethrin; and the fungicide chlorothalonil) were found in only 5 (12%) out of 40 indoor cannabis plantations studied [5]. Schneider et al. found 7 different pesticides on a total of 50 seized cannabis plants [6]. They comprise the fungicides promocarb, tebuconazole, propiconazole and tolylfluanid, the neonicotinoid insecticides imidacloprid, bifenthrin and hexythiazox. In the late 1970s and early 1980s, paraquat residues were found on confiscated cannabis samples [7–13]. Recently paraquat, together with other herbicides such as glyphosate and aminomethylphosphonic acid were detected on illicit cannabis samples from unknown origin in Brazil [14]. In the US, Sullivan et al. reported pesticide residues in three cannabis smoking devices (water pipe with filter, water pipe without filter and glass pipe) [15]. Residue recovery was as high as 69.5% of samples depending on the analytical device used, suggesting that the danger of pesticide residues harming cannabis users is substantial and may pose a significant toxicological threat.

Pesticide prevalence in cannabis plantations and the risks these products pose to cannabis growers and intervention staff have hardly been investigated. In indoor cannabis plantations, the latter persons can be exposed to pesticides by dermal contact with plants while moving through the plantation and during plant removal, as well as by inhalation of pesticide vapours from the cultivation room atmosphere. Identification of pesticides used in indoor cannabis cultivation as well as data on the frequency and location of their prevalence, is crucial to adequately assess their risks to intervention staff. Martyny et al. and Van Dyke found that most insecticides encountered in indoor cannabis plantations are pyrethroids, which have a low toxicity when inhaled or in case of dermal contact [16,17].

Pesticide health hazards are determined by product type and dose, exposure duration and absorption route. Speed of dermal absorption depends on the exposed body part with the slowest absorption rates reported from the lower arm, whereas fastest absorption occurs in the genital area. Oral exposure can lead to severe illness, organ damage and even death. Inhalation is the most dangerous absorption route because pesticides are quickly absorbed by blood vessels through the pulmonary alveoli [18].

There is currently no reliable information on the extent of pesticide use in illicit Belgian indoor cannabis plantations. As a result, cannabis growers, users and intervention staff might be exposed to a great but currently unknown risk. In order to shed more light on the prevalence of pesticides in Belgian indoor cannabis plantations, we investigated the presence of (commercially available) pesticide products as well as of pesticide traces in water tanks, on cannabis plants and on carbon filters sampled from indoor cannabis plantations in Belgium.

2. Materials and methods

2.1. Plantation surveys and sampling

Local as well as federal police departments were informed about our study with the express demand to facilitate our research activities in seized plantations. When a plantation had been confiscated by local and federal police staff during the study period (17 July until 3 December 2014), its seizure was immediately signalled to the Central Desk 'Drugs' of the Belgian Federal Police, who then informed researchers when visits were qualified by police as safe and feasible. Descriptive primary data was thus collected from 43 illicit indoor cannabis plantations, spread over 35 Belgian municipalities belonging to 8 out of the 10 Belgian Provinces. Most (35) surveyed plantations were situated in the northern, Flemish part of the country. In 4 plantations, no plants were found. From 38 out of the 43 plantations toxicological product samples were taken. Twenty-six sampling runs were done by academic researchers from Ghent University and the Catholic University of Leuven. The other 17 surveys were performed by police officers in cases where for judicial reasons, plantations had to be dismantled quickly, so that researchers could not visit the plantations in time. During sampling, investigators wore a white Tyvek® Expert overall, a 7000 Easylock halfmask with a Moldex® P3 R 9030 dust filter and a ABEK1 Easylock® 9400 chemical filter, Hazmax™ SSSRA HRO CI FO E safety boots and Virtex ™ 79-700 safety gloves as personal protective equipment (PPE).

To assure accurate and uniform data collection, both researchers and police officers used the same characterization data and sample collection protocol. Primary data concerned (i) a detailed description of the cultivation room's infrastructure; (ii) names of pesticides, growth stimulants and other products, as stated on packages; (iii) description (colour, volume, pH) of samples taken; and (iv) a sketch of the cultivation room compartments. When different cultivation rooms on a same location applied different cultivation techniques (such as substrate, lighting system or plant density), they were considered as different plantations. For each plantation, a photo log was made with pictures of cultivation rooms, equipment and product labels. Data were processed in MS-Excel 2010 and SPSS 22.0.

For all **liquid substances** found in closed containers, a 3 mL sample was collected in a 5 mL Sarstedt CryoPure® tube. In cases where puddle water was observed, a 35 mL sample was collected in a 70 mL Sarstedt PP beaker. Liquid samples were immediately transported to and stored at 4 °C at the Catholic University of Leuven, until toxicological analysis.

Per plantation, 3 complete **plants**, cut just above the growth substrate, were collected in a paper bag. When plants were found to be in different development stages, 3 plants from each development stage were collected. Plants were immediately transported to, and stored at −20 °C at the Catholic University of Leuven, prior to toxicological analysis.

Cannabis growth room atmospheres are continuously refreshed by turbines that evacuate air through **carbon filters.** These neutralize the intense cannabis smell [19,20] and can consequently be considered as an archive of all volatile substances that were ever present in the rooms. The latter substances are adsorbed on the active carbon inside the filter, and on the fibres of the filter cloth that is wrapped around the filters. Pesticide residues that can be identified on carbon filter cloth are consequently most likely the same pesticides that have been used to control pests or diseases on cannabis plants cultivated in the same plantations. Filter cloth fibre samples were collected in airtight glass tubes and brought to the Catholic University of Leuven for toxicological analysis.

2.2. Extraction and analysis

2.2.1. Standards

Pestanal® pesticide standards (42) and internal standard triphenylphosphate (TPP) were purchased from Sigma-Aldrich, Belgium. A stock solution of 10 mg/mL was prepared. Working solutions of 100 and 500 μg/mL were prepared in methanol, ethanol, acetonitrile or dichloromethane, depending on the solubility of the standard. TPP was dissolved in a 10 mg/mL stock solution in ethanol and 10 μL of working solution (10.62 μg/mL) was used.

2.2.2. Extractions

For every cultivation room of every plantation, the development stage and weight (±1 g) of the plant samples were determined (Table 2). 200–300 mg of carbon filter cloth was taken