

# Identification and quantification of THC and the synthetic cannabinoid MDMB-4en-PINACA in edible products seized by UK police in 2024

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## Abstract

**Aims:** To characterise edible products seized in the United Kingdom (UK) illicit market by (1) analysing packaging designs, (2) quantifying tetrahydrocannabinol (THC) content and identifying other psychoactive substances, including synthetic cannabinoids (SCs), and (3) evaluating a field-portable device for rapid drug identification directly from food products with an illicit substance added (edibles).

**Design:** Laboratory-based chemical analysis of seized drug products and evaluation of a point-of-care diagnostic device.

**Setting:** University analytical laboratories in Bath and Manchester, UK.

**Participants/Materials:** A total of 31 edible products (representing 24 unique items), seized by Merseyside Police and Avon & Somerset Constabulary in the UK during 2024.

**Measurements:** Visual inspection of packaging. Quantification of THC and the SC MDMB-4en-PINACA using validated liquid chromatography-tandem mass spectrometry (LC-MS/MS) with isotopic dilution following homogenisation, liquid-phase extraction, and sample preparation. Evaluation of a portable fluorescence and photochemical degradation-based device for detecting THC and SCs directly on edible surfaces.

**Findings:** Of 24 unique edible products, 19 (79%) used packaging mimicking popular confectionery brands. THC was detected in 28/31 (90.3%) products (70/79 individual edibles). Median THC content per edible was 13.28 mg (range 0–91.18 mg). Of edibles labelled with a THC dose, 95% (65/68) contained significantly less (>45%) than stated. Substantial inter-product variability (e.g., 6.07–29.22 mg THC in edibles labelled as 75 mg) and intra-product variability (dose difference >5 mg THC between items in the same pack for 8/25 packs, max difference 51.91 mg) were found. One product contained MDMB-4en-PINACA (mean 11.42 mg/edible) instead of THC. The portable device demonstrated 94% accuracy (100% on solid sweets/chocolates) in identifying THC/SC content compared to LC-MS/MS.

**Conclusions:** Illicit edibles products seized in the UK use misleading packaging attractive to children, exhibit highly variable and inaccurate THC dosing, and can potentially contain dangerous synthetic cannabinoids like MDMB-4en-PINACA instead of THC, posing significant public health risks. Portable detection technology shows promise for rapid, point-of-care identification to support harm reduction efforts.

## Introduction

Cannabis is traditionally consumed by smoking dried plant material in the form of a hand-rolled joint [1]. Alternate means of consumption have become increasingly popular in recent years, most notably vaping and edibles [2,3]. Edible products are generally sold in the form of sweet confectionary items such as brownies, gummies and chocolates and are manufactured through the addition of oil-based cannabis extracts containing high concentrations of THC, the primary cannabinoid responsible for the psychoactive effects of cannabis [4]. Several challenges are associated with the use of edibles in both legal and illicit markets, particularly amongst young people.

Although dried cannabis flower is the most widely used cannabis product in legal and illegal markets, repeat-cross sectional surveys have found it to be increasingly displaced by ‘processed products’ such as vapes and edibles [5]. Many consumers are transitioning from smoking plant material to ingesting edibles as their primary means of consuming cannabis; almost 25% of Canadian and over 28% of American consumers reported favouring edibles over herbal cannabis in a recent study [6]. Edibles are especially favoured in social settings due to the discrete nature in which they can be consumed where no distinctive smell is produced. Edible consumers also avoid inhalation of cannabis smoke - shown to contain several toxins and carcinogens- contributing to the perception that edibles are safer cannabis delivery vehicles [7]. Moreover, consumption of edibles may produce a different sensation to that smoking of herbal cannabis in addition to a less intense onset [8]. When inhaled, THC passes directly into the blood stream via the lungs, where psychotropic effects begin within seconds as CB1 receptors are activated in the brain. However, following oral ingestion, gastrointestinal absorption delays the onset of psychotropic effects by 30-90 minutes, where maximum effects are reached after 2-3 hours and can persist for as long as 12 hours [6]. Notably, the delayed onset of cannabis edibles can lead to inadvertent overconsumption as intoxicating effects cannot be easily titrated as for inhalation of cannabis. Overconsumption of THC is associated with a variety of acute adverse health effects including neurological, respiratory and cardiovascular symptoms, sometimes requiring medical attention [9]. These adverse effects can be prevented by avoiding excessive dosing of THC. A low dose (5mg THC3) has been proposed as a “standard THC unit”, and this has been endorsed by the US National Institutes of Health for use in research [10,11]. In jurisdictions that have legalized recreational cannabis use (e.g., Canada and many US states), regulatory standards for edibles (e.g., maximum serving size of 5 or 10mg per edible) are used to increase product safety and consistency to prevent over-consumption of THC [12,13]. However, in countries where THC is a controlled drug (e.g., UK), edibles are sold illicitly without regulation, accurate dosing information or consistency within or between products. This context strongly warrants testing of the illegal edibles market, to inform consumers about product contents to enable them to reduce their risks of harm.

Cannabis edibles are often sold in packaging that mimics products from well-known confectionary brands. Many edibles look almost identical to shop bought sweets and lack salient and/or accurate warnings of THC content, leading to unintended consumption, particularly among children and young people. Numerous cases of paediatric poisonings have been reported the USA and Canada in connection with edible products [14,15,16]. Moreover, there is potential for other, more dangerous, designer drugs to be mis-sold as THC. For example, in the UK in March 2022, consumption of cannabis ‘gummies’ containing the synthetic cannabinoid (SC) MDMB-4en-PINACA resulted in two hospital admissions, resulting in one fatality [17].

Thus, there are several risks associated with consumption of edible products in illicit markets: uncertain potency, drug content and a strong appeal to youth through packaging designs. Despite these challenges, THC edibles continue to be a popular means of consuming cannabis in the UK, with several large-scale seizures carried out by police forces around the country [18,19]. Here we report, to our knowledge, the first study to quantify THC content in edible products seized by UK police forces, and the first to quantify content of other drugs in these products such as SCs. We also demonstrate the accuracy of a field-portable device in identifying THC and SCs directly from the surface of edibles, by testing against samples analysed in this study.

## Methods

### Food samples

We examined a total of 31 edible products (packets containing multiple individual sweets or stand-alone items), of which 24 were unique with 7 duplicates to assess inter-batch variation. Samples were provided by UK police forces in two separate batches. Batch 1.0 was provided by Merseyside police, where we examined 23 products. Batch 2.0 was provided by Avon and Somerset police and comprised eight unique products. To assess the variation in THC content between individual sweets (candy or chocolates) from the same packet, where possible, three individual edibles (servings) were analysed. In the case of honey and ketchup samples, where each product was a single item rather than a packet containing multiple individual sweets, three individual products were analysed to assess product-to-product variation.

### Chemicals and reagents

THC, THC-d3, MDMB-4-en-PINACA and MDMB-4-en-PINACA-d4 were purchased from Caman Chemical as 1mg/mL standards in either acetonitrile (THC) or methanol (MDMB-4en-PINACA). HPLC grade methanol, acetonitrile and water were purchased from Merck. QuEChERS ready-to-use cleanup tubes (S2-15-GFV-EN-KIT) were purchased from Thermo Scientific. All reference standards were stored in the dark at -20°C as per manufacturers recommendations.

### Quantification of drug content in edibles products

LC-MS/MS analysis was used for quantification of all samples reported in this study, where this method was validated using  $^1\text{H}$  qNMR. For a detailed description of analytical methods see supplementary materials.

### Field-portable detection of drug material in edibles

We previously reported on the development of a field-portable device capable of detecting SCs and THC from sealed e-cigarettes and in e-cigarette liquid [21]. That device functions by self-actuating an e-cigarette to deposit e-liquid vapour onto a porous filter, with drug identification performed using fluorescence detection coupled with photochemical degradation. As photochemical-based detection of THC on a solid matrix (porous filter) was previously validated, we reasoned that expanding this technology to report on cannabis edible-style confectionary items would provide a useful means of rapidly assessing drug content of suspicious samples. We therefore incorporated an 'edibles mode' on the device which allows testing of solid samples. We achieve this by designing a custom 3D-printed edibles sample holder with an integrated sapphire window that sits directly above the optical detection array, where the geometry of the detection apparatus is preserved from our previous design. Upon initiation of a scan, the device takes a maximum of 30 s to perform a measurement; an initial reading that can report on the presence of SCs followed by three 10s interspaced readings that inform on the presence of THC through photochemical degradation. The device is shown in figure S4 and a video of the device in operation (detecting presence of THC in an edible from article 1.21) is available in Supplementary video 1.

## Results

### Edibles packaging

External presentation of edible products is shown in Figures 1 and 2. We found 19 of 24 (79%) unique articles had external designs that directly mimicked well-known products from popular confectionary brands. Branding being imitated on packaging of articles in batch one is described in Table 1, where 15 of 16 unique articles reference existing products. All products from batch one were labelled with THC dosing information in addition to a small '18+' stamp and were branded with 'magical munchies'.

From batch two, four of eight articles (50%) presented in packaging that directly mimicked existing products or brands. These items were also labelled with THC dosing and a warning sticker indicating presence of THC. The branding being imitated on packaging of articles in batch two is presented in Table 2. Articles 2.6, 2.7 and 2.8 presented in clear packaging without brand labelling, THC dosing or warning of drug content. Article 2.1 presented in packaging that had clearly been designed for the sale of cannabis flower (depicting cannabis buds and a label with net weight of 3.5g).

### Quantitative analysis

Quantitative LC-MS/MS analysis of edibles from batch one and two are summarized in Tables 3-4. THC was positively identified in 28 of 31 products (90.3 %) and in 70 of 79 individual edibles analysed. Median THC content per edible across batches was  $13.28 \pm 15.36$  mg (range = 0 – 91.18) and median THC concentration was  $2.00 \pm 1.58$  mg/g (range = 0 - 8.23). From batch one (57 edibles), median THC content per edible was  $14.15 \pm 11.66$  (range = 0 – 91.18), and median concentration was  $2.32 \pm 1.12$  mg/g (range = 0 – 3.91). From batch two (22 edibles), median THC content per edible was  $6.03 \pm 22.67$  (range = 0 – 84.39), and median concentration  $1.39 \pm 2.43$  mg/g (range = 0 – 8.22).

Articles 1.3 and 2.3 were labelled with respective THC doses of 25 and 60 mg per edible; however, no drug content was detected in these samples. Article 2.1 was found to contain the synthetic cannabinoid MDMB-4en-PINACA. Quantitative analysis revealed a mean dose of  $11.42 \pm 1.51$  mg MDMB-4en-PINACA in three sweets from this product (range = 9.70 – 12.70), with a mean concentration of 0.64 mg/g (range = 0.60 – 0.72).

### Portable device analysis

Portable device testing results are shown in Table 5. From 31 samples the device reported with an accuracy of 94%, calculated from 19 true positives (TP), 10 true negatives (TN), 0 false positives (FP) and two false negatives (FN). THC was positively identified in 19 of 21 THC containing samples tested. The presence of SCs in an edible from article 3.1 was also positively identified. The device performed with 100% accuracy on solid sweet/chocolate samples, where the two false negatives reported were THC-infused honey and ketchup products.

## Discussion

Cannabis-infused edibles are illegal in the UK and are believed to be generally purchased through online platforms such as WhatsApp, Instagram and Telegram [22]. In the absence of any regulatory standards in the UK, these products contain unknown quantities of THC and, potentially, other more harmful drugs. Here, we report the first study to identify and quantify THC and MDMB-4en-PINACA in edibles seized by UK police forces.

Visual analysis of external edible packaging revealed that 19 of 24 (79%) unique products investigated in this study were imitations of popular confectionery items sold by established brands. 'Lookalike' cannabis edible products have been highlighted as a public health concern in both legal and illicit markets, where suppliers use fonts, colours and brand names from existing commercial products to market their items. Concerns surrounding these tactics include the subtlety of cannabis warnings and their attractiveness to children and adolescents, who may either mistake them for non-intoxicating products or might be interested in using them as novelty items as they resemble familiar chocolates/candy [23]. The marketing of edible products to young people has been highlighted by police forces in UK, where active harm prevention strategies such as briefing of schools and distribution of information leaflets have recently been implemented [22,24]. These measures should continue to be used to combat decreased perceived notions of risk tied to these products.

All articles from batch one appeared to be from the same supplier, 'Magical Munchies'. Many of these items were labelled with the State of California 'universal symbol for cannabis', implying these products had been approved for sale there and subsequently illegally imported into the UK [25]. However, to our knowledge, there exists no company operating under this name in California, hence these are likely to be products produced to imitate regulatory standards for sale in US stores [26]. Consumers therefore may be under the illusion that these products have been subject to US quality control measures ensuring safe consumption, whereas in fact they are likely to contain an unknown quality of THC/other substances. This is reflected in the dosing inconsistencies revealed by quantitative LC-MS/MS analysis described below.

THC dosing per edible was labelled for 27 of 31 products (68 of 79 individual edibles analysed). LC-MS/MS analysis revealed that 95% of labelled edibles (65 of 68) contained less (>45%) THC than claimed on packaging, where the minimum deficit of these samples was 24.06 mg (Table 4, 2.2A). Notably, from batch one, all 23 products (57 individual edibles) contained less than one third of the labelled THC dose. Indeed, the median THC content in edibles labelled with dosing of 75mg THC was  $14.93 \pm 4.49$  mg (39 of 57 analysed). Significant discrepancies between package labelling and actual dosing are problematic as consumers may be under the impression that they are comfortable with consuming far higher quantities of THC than is truly being ingested. Should users attempt to replicate this dosing with another product, future overconsumption leading to associated adverse effects is therefore likely. Significant inter-product variation across items claiming to contain identical THC doses (75 mg) was also revealed, where a range of 6.07 - 29.22 mg THC was identified in these products. This variation poses harm to consumers expecting a consistent experience.

Significant intra-product variation was also identified in packets containing multiple individual edibles. From 25 articles of this type, 8 were shown to contain two or more edibles that differed in dose by > 5mg THC, recently designated as a 'standard THC unit' [27]. Quantitative analysis of edibles from article 2.5 revealed a dosing discrepancy of 51.91 mg THC between samples A-B, the largest reported in this study. Notably, article 2.5A was shown to contain  $84.39 \pm 2.97$  mg THC, 41% more than the stated dose of 60 mg. This represents an 'acute dose' with significant risk of adverse effects for naïve consumers who lack tolerance to the effects of THC; Health Canada recommend that consumers "start low and go slow" by not exceeding 2.5mg THC [28]. We note the risk associated with a dose variation of this magnitude for supposedly identical servings; unaware users attempting to consume a repeat dose are likely to be caught off guard, leading to increased likelihood of accidental overconsumption and associated adverse health effects.

We identified the synthetic cannabinoid MDMB-4en-PINACA in three edibles analysed from article 2.1, which presented in packaging depicting a State of California cannabis warning, suggesting this product was sold as a THC-infused edible. THC is a partial agonist at the CB<sub>1</sub> cannabinoid receptor whereas MDMB-

4en-PINACA is a highly potent full agonist, and consumption is associated with significantly increased risk of severe negative outcomes [29, 30]. SCs are frequently mis-sold as THC-containing vapes/vape-liquid in the UK, as highlighted by sample results from drug checking service WEDINOS and a recent study [31, 32]. Involuntary consumption of MDMB-4en-PINACA puts users at heightened risk of overdose, where clinical presentations include seizures, vomiting, headaches and cardiotoxicity [33, 34]. Unfortunately, in 2022, occurrence of MDMB-4en-PINACA in a product mis-sold as a THC-infused edible led to the overdose death of a 23-year-old woman in the UK [17]. We found a mean dose of  $11.27 \pm 1.51$  mg MDMB-4en-PINACA across three edibles from article 2.1. To our knowledge, no previous studies have quantified SC content in edibles, and the oral potency of MDMB-4en-PINACA is unknown, meaning we cannot comment on the risk to life associated with consumption of these products.

Given the potential for SCs to appear in THC-infused edibles in illicit markets such as the UK - and the high risk associated with their accidental consumption - technology that can rapidly inform on the drug content of these products is highly desirable at the Point-of-Care. We previously reported on the development of a device capable of detecting of SCs and THC from e-cigarettes/e-liquid [21]. We now show that this device can be used directly on the surface of edible type products, where we report an accuracy 94% on a testing set of 31 samples. In this testing set, two false negative results were obtained for THC-infused ketchup and honey samples (articles 1.9, 1.12). These products contained 0.15 and 0.25 mg/g THC respectively, very low concentrations relative to other tested products, where this range is below our limit of detection. The device performed with 100% accuracy on solid candy/chocolate type samples. We therefore suggest this device could be used by schools/police or drug testing services to rapidly identify drug content of similar edibles products.

## Limitations

This study reports the first quantitative analysis of THC and MDMB-4en-PINACA concentrations in edible products seized by UK police, where we used a validated LC-MS/MS approach. This study does however have important limitations. Edible products were selected for analysis by convenience sampling only; batch one was provided by a single seizure from Merseyside police and contained commercial products from the same supplier 'magical munchies', and batch two was a sample set of eight products provided by Avon and somerset police. As batch one contained articles manufactured by one supplier, we cannot extrapolate on the dosing discrepancies reported for this batch to the wider landscape of THC edibles in the UK. Batch two was more varied in sample types, with a mix of edibles presenting in commercial packaging in addition to products with a homemade appearance, with one from eight products containing the synthetic cannabinoid MDMB-4en-PINACA. The small sample size of this batch also means we cannot comment on the wider prevalence of SCs in the UK edible supply.

## Conclusions

The aims of this study were to analyse packaging and quantify the drug content of two batches of edibles seized by UK police from two force areas using LC-MS/MS. To our knowledge, this is the first study of its kind in the UK. We show that 79% of products analysed were imitation items that reference popular/known brands, where risk of accidental consumption is high owing to 'attractive nuisance' of this marketing technique. We further show significant discrepancies in labelled dosing vs actual THC content across batches one and two, and inter- and intra-product variation of edibles claiming to contain identical THC doses. We further report the first quantification of the synthetic cannabinoid MDMB-4en-PINACA in edibles, where this compound has previously been linked to overdose deaths in the UK. Taken together, our results highlight the risk of using edibles in the UK and the value of drug testing, including point of care detection, for monitoring and harm reduction. To this effect, we report on a device that can be used to rapidly and reliably screen samples with high accuracy (94% of all samples), capable of identifying THC and SCs directly from 100% of solid samples. This technology could be used for harm reduction/identification through schools, the police, and drug checking services, and further, the monitoring of drug trends in the UK.

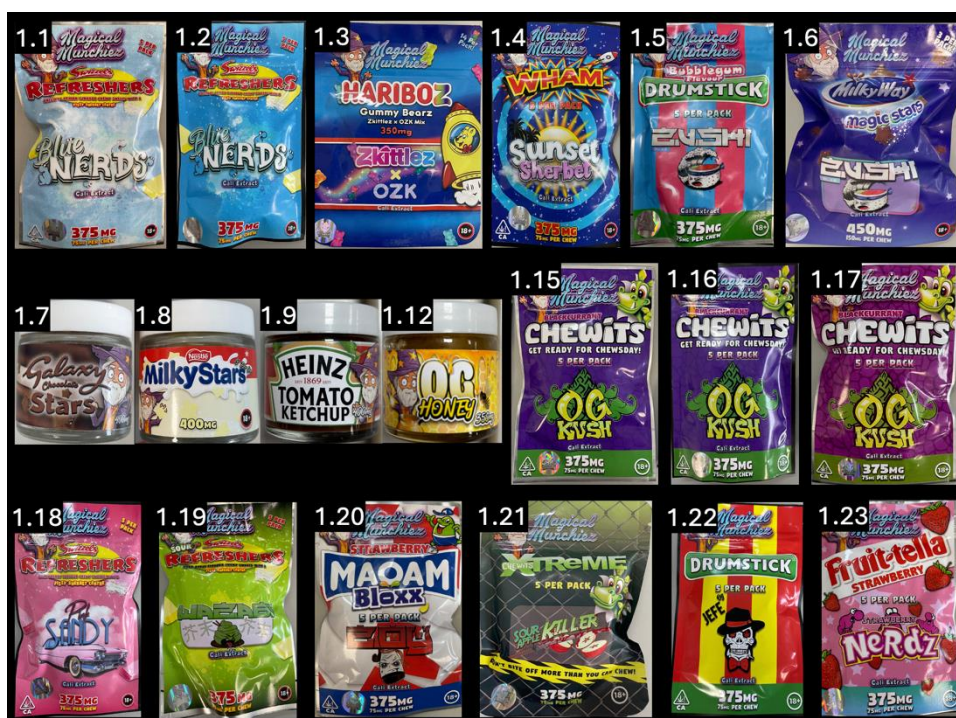
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## Figures and Tables



**Figure 1.** External packaging of 23 edible products from batch one. Duplicate Ketchup and honey samples not shown.



**Figure 2.** External packaging of eight edible products from batch two.

**Table 1.** Branding of articles from batch one and commercial product imitated on packaging.

Article number	Package label	Imitating (brand-product):	Product type
1.1	Refreshers – Blue Nerds	Swizzles - Refreshers	Candy
1.2	Refreshers – Blue Nerds	Swizzles - Refreshers	Candy
1.3	HARIBOZ – Zkittlez x OZK	Haribo - Starmix	Candy
1.4	WHAM – Sunset Sherbert	Swizzles - WHAM Bar	Candy
1.5	DRUMSTICK - ZUSHI	Swizzles - Drumsticks	Candy
1.6	Magic Stars -ZUSHI	Milky Way – Magic Stars	Chocolate
1.7	Milky Stars	Nestle – Milky Bar	Chocolate
1.8	Galaxy Stars - Levels	Galaxy - Revels	Chocolate
1.9	Heinz Tomato Ketchup Skilatti	Heinz- Tomato Ketchup	Tomato sauce
1.10	Heinz Tomato Ketchup Skilatti	Heinz- Tomato Ketchup	Tomato sauce
1.11	Heinz Tomato Ketchup Skilatti	Heinz- Tomato Ketchup	Tomato sauce
1.12	OG HONEY	NA	Honey
1.13	OG HONEY	NA	Honey
1.14	OG HONEY	NA	Honey
1.15	Chewits – OG Kush	Cloetta - Chewits	Candy
1.16	Chewits – OG Kush	Cloetta - Chewits	Candy
1.17	Chewits – OG Kush	Cloetta - Chewits	Candy
1.18	Refreshers – Pink Sandy	Swizzels - Refreshers	Candy
1.19	Refreshers – Wazabi	Swizzels - Refreshers	Candy
1.20	MAOAM Bloxx - ZOY	Haribo - MOAM	Candy
1.21	Chewits Extreme – Sour Apple Killer	Cloetta - Chewits Extreme	Candy
1.22	Drumstick – Og JEFE	Swizzles - Drumsticks	Candy
1.23	Fruit-tella – Strawberry Nerdz	Perfetti - Frutella	Candy

**Table 2.** Branding of articles from batch two and commercial product imitated on packaging.

Article number	Package label	Imitating (brand-product):	Type
2.1	No Branding	NA	Candy
2.2	Starbuzz	Wrigley - Starburst	Candy
2.3	Nerdz – Gummy clusters	Willy Wonka - Nerds	Candy
2.4	Doobie snacks	Scooby Doo – Scooby snacks	Candy
2.5	Zootella	Perfetti - Frutella	Candy
2.6	No Branding	NA	Candy
2.7	No Branding	NA	Candy
2.8	No Branding	NA	Candy

**Table 3.** LC-MS/MS qualitative and quantitative analysis of edible samples from police seizure one. Dose and concentration (mg/g) per edible are given as a mean value of three replicates for each edible  $\pm$  standard deviation. Mean values for edible mass, dose and concentration are also given for three edibles analysed from each product. NDD = no drug detected.

Article	Sample (edible)	Mass of edible (g)	Qualitative analysis	Quantitative analysis (mg/g)	Quantitative analysis (mg/edible)	Claimed THC dose (mg per edible)
1.1	A	5.65	THC	3.07 $\pm$ 0.03	17.36 $\pm$ 0.18	75
	B	7.23	THC	4.04 $\pm$ 0.07	29.22 $\pm$ 0.53	75
	C	6.11	THC	3.556 $\pm$ 0.10	21.74 $\pm$ 0.58	75
	Mean	6.33 $\pm$ 0.81		3.56 $\pm$ 0.49	22.77 $\pm$ 6.00	
1.2						
	A	6.04	THC	2.23 $\pm$ 0.02	13.44 $\pm$ 0.14	75
	B	5.85	THC	2.49 $\pm$ 0.17	14.57 $\pm$ 0.97	75
	C	5.99	THC	2.00 $\pm$ 0.08	11.99 $\pm$ 0.49	75
	Mean	5.96 $\pm$ 0.10		2.24 $\pm$ 0.25	13.33 $\pm$ 1.29	
1.3						
	A	0.52	NDD	NA	NA	25
	B	0.52	NDD	NA	NA	25
	C	0.47	NDD	NA	NA	25
	Mean	0.50 $\pm$ 0.03		NA	NA	
1.4						
	A	5.50	THC	2.71 $\pm$ 0.08	14.93 $\pm$ 0.44	75
	B	5.22	THC	2.89 $\pm$ 0.10	15.08 $\pm$ 0.54	75
	C	5.89	THC	2.61 $\pm$ 0.06	15.37 $\pm$ 0.36	75
	Mean	5.54 $\pm$ 0.34		2.74 $\pm$ 0.14	15.13 $\pm$ 0.23	
1.5						
	A	4.62	THC	1.31 $\pm$ 0.04	6.07 $\pm$ 0.16	75
	B	6.33	THC	2.54 $\pm$ 0.01	16.10 $\pm$ 0.06	75
	C	6.40	THC	1.55 $\pm$ 0.03	9.93 $\pm$ 0.17	75
	Mean	5.78 $\pm$ 1.01		1.80 $\pm$ 0.65	10.70 $\pm$ 5.06	
1.6						
	A	8.80	THC	1.55 $\pm$ 0.04	13.66 $\pm$ 0.32	150
	B	8.82	THC	1.55 $\pm$ 0.05	13.68 $\pm$ 0.42	150
	C	8.23	THC	1.57 $\pm$ 0.03	12.94 $\pm$ 0.20	150
	Mean	8.62 $\pm$ 0.33		1.56 $\pm$ 0.01	13.43 $\pm$ 0.42	
1.7						
	A	8.87	THC	1.04 $\pm$ 0.03	9.23 $\pm$ 0.27	133
	B	9.28	THC	1.116 $\pm$ 0.00	10.35 $\pm$ 0.03	133
	C	8.72	THC	1.103 $\pm$ 0.06	9.62 $\pm$ 0.49	133
	Mean	8.96 $\pm$ 0.29		1.09 $\pm$ 0.04	9.73 $\pm$ 0.52	
1.8						
	A	8.80	THC	0.83 $\pm$ 0.01	7.25 $\pm$ 0.08	133
	B	8.84	THC	0.79 $\pm$ 0.02	7.00 $\pm$ 0.18	133
	C	8.92	THC	0.81 $\pm$ 0.04	7.222 $\pm$ 0.35	133
	Mean	8.85 $\pm$ 0.06		0.81 $\pm$ 0.02	7.16 $\pm$ 0.57	
1.9		62.09	THC	0.15 $\pm$ 0.00	9.05 $\pm$ 0.24	400
1.10		61.34	THC	0.33 $\pm$ 0.02	20.15 $\pm$ 1.04	400
1.11		66.45	THC	0.20 $\pm$ 0.00	13.28 $\pm$ 0.15	400
	Mean	63.29 $\pm$ 2.76		0.23 $\pm$ 0.09	14.16 $\pm$ 5.60	

1.12		69.66	THC	$0.25 \pm 0.01$	$17.17 \pm 0.42$	350
1.13		71.13	THC	$1.28 \pm 0.01$	$91.18 \pm 0.88$	350
1.14		70.08	THC	$0.29 \pm 0.00$	$20.54 \pm 0.19$	350
	Mean	$70.29 \pm 0.76$	THC	$0.61 \pm 0.59$	$42.96 \pm 41.79$	
1.15						
	A	5.86	THC	$2.52 \pm 0.06$	$14.75 \pm 0.34$	75
	B	4.44	THC	$1.93 \pm 0.04$	$8.58 \pm 0.17$	75
	C	6.96	THC	$2.65 \pm 0.02$	$18.47 \pm 0.11$	75
	Mean	$5.76 \pm 1.27$		$2.37 \pm 0.38$	$13.93 \pm 5.00$	
1.16						
	A	5.29	THC	$2.95 \pm 0.09$	$15.59 \pm 0.45$	75
	B	5.68	THC	$2.57 \pm 0.10$	$14.60 \pm 0.56$	75
	C	5.12	THC	$3.12 \pm 0.17$	$15.98 \pm 0.89$	75
	Mean	$5.36 \pm 0.29$		$2.88 \pm 0.28$	$15.39 \pm 0.71$	
1.17						
	A	6.65	THC	$3.10 \pm 0.09$	$17.73 \pm 2.78$	75
	B	5.24	THC	$2.57 \pm 0.09$	$13.47 \pm 0.44$	75
	C	5.26	THC	$2.85 \pm 0.06$	$15.02 \pm 0.32$	75
	Mean	$5.72 \pm 0.81$		$2.81 \pm 0.27$	$15.40 \pm 2.15$	
1.18						
	A	6.69	THC	$3.33 \pm 0.12$	$22.30 \pm 0.83$	75
	B	6.49	THC	$3.01 \pm 0.02$	$19.52 \pm 0.10$	75
	C	5.84	THC	$3.50 \pm 0.04$	$20.41 \pm 0.21$	75
	Mean	$6.34 \pm 0.44$		$3.28 \pm 0.28$	$20.74 \pm 1.42$	
1.19						
	A	5.20	THC	$2.38 \pm 0.07$	$12.36 \pm 0.37$	75
	B	6.18	THC	$2.12 \pm 0.06$	$13.07 \pm 0.34$	75
	C	5.98	THC	$1.432 \pm 0.01$	$8.57 \pm 0.03$	75
	Mean	$5.79 \pm 0.52$		$1.98 \pm 0.49$	$11.33 \pm 2.42$	
1.20						
	A	5.64	THC	$2.43 \pm 0.01$	$13.73 \pm 0.08$	75
	B	4.50	THC	$1.82 \pm 0.08$	$9.09 \pm 0.42$	75
	C	5.61	THC	$2.52 \pm 0.05$	$14.15 \pm 0.25$	75
	Mean	$5.42 \pm 0.37$		$2.26 \pm 0.38$	$12.32 \pm 2.81$	
1.21						
	A	5.27	THC	$2.32 \pm 0.06$	$12.22 \pm 0.30$	75
	B	6.48	THC	$2.39 \pm 0.04$	$15.47 \pm 0.28$	75
	C	7.46	THC	$2.42 \pm 0.02$	$18.01 \pm 0.14$	75
	Median	$6.40 \pm 1.09$		$2.38 \pm 0.05$	$15.23 \pm 2.91$	
1.22						
	A	5.47	THC	$1.56 \pm 0.03$	$8.54 \pm 0.19$	75
	B	5.18	THC	$2.83 \pm 0.06$	$14.64 \pm 0.31$	75
	C	5.83	THC	$1.81 \pm 0.07$	$10.57 \pm 0.39$	75
	Mean	$5.49 \pm 0.33$		$2.07 \pm 0.67$	$11.25 \pm 3.11$	
1.23						
	A	5.32	THC	$4.04 \pm 0.07$	$21.52 \pm 0.36$	75
	B	4.55	THC	$3.61 \pm 0.12$	$16.41 \pm 0.55$	75
	C	4.57	THC	$4.08 \pm 0.12$	$18.67 \pm 0.54$	75
	Mean	$4.82 \pm 0.44$		$3.91 \pm 0.26$	$18.87 \pm 2.56$	

**Table 4.** LC-MS/MS qualitative and quantitative analysis of edible samples from police seizure one. Dose and concentration (mg/g) per edible are given as a mean value of three replicates for each edible  $\pm$  standard deviation. Mean values for edible mass, dose and concentration are also given for three edibles analysed from each product. NDD = no drug detected.

Article	Sample (edible)	Qualitative analysis	Mass of edible (g)	Quantitative analysis (mg/g)	Quantitative analysis (mg/edible)	Claimed THC dose (mg per edible)
2.1						
	A	MDMB-4en-PINACA	17.65	$0.72 \pm 0.17$	$12.70 \pm 0.29$	NS
	B	MDMB-4en-PINACA	16.30	$0.70 \pm 0.00$	$11.42 \pm 0.07$	NS
	C	MDMB-4en-PINACA	16.16	$0.60 \pm 0.01$	$9.70 \pm 0.11$	NS
	Mean		$16.70 \pm 0.83$	$0.67 \pm 0.06$	$11.27 \pm 1.51$	
2.2						
	A	THC	4.20	$1.41 \pm 0.02$	$5.94 \pm 0.06$	30
	B	THC	3.37	$1.37 \pm 0.06$	$4.62 \pm 0.21$	30
	C	THC	4.37	$1.26 \pm 0.02$	$5.51 \pm 0.09$	30
	Mean		$3.98 \pm 0.54$	$1.35 \pm 0.08$	$5.36 \pm 0.67$	
2.3						
	A	NDD	1.97	NA	NA	60
	B	NDD	1.78	NA	NA	60
	C	NDD	2.00	NA	NA	60
	Mean		$1.91 \pm 0.11$			
2.4						
	A	THC	6.23	$8.21 \pm 0.19$	$51.15 \pm 1.18$	50
	B	THC	7.10	$8.23 \pm 0.14$	$58.37 \pm 0.97$	50
	Mean		$6.66 \pm 0.61$	$8.22 \pm 0.01$	$54.76 \pm 5.11$	
2.5						
	A	THC	18.03	$4.68 \pm 0.17$	$84.39 \pm 2.97$	60
	B	THC	20.34	$1.60 \pm 0.09$	$32.48 \pm 1.91$	60
	C	THC	19.20	$1.70 \pm 0.04$	$32.68 \pm 0.67$	60
	Mean		$19.19 \pm 1.15$	$2.66 \pm 1.75$	$49.85 \pm 29.91$	
2.6						
	A	THC	3.38	$2.89 \pm 0.00$	$9.75 \pm 0.01$	NS
	B	THC	3.09	$2.81 \pm 0.02$	$8.67 \pm 0.07$	NS
	Mean		$3.23 \pm 0.21$	$2.85 \pm 0.06$	$9.21 \pm 0.77$	
2.7						
	A	THC	1.65	$3.39 \pm 0.48$	$5.58 \pm 0.79$	NS
	B	THC	1.31	$3.84 \pm 0.02$	$5.04 \pm 0.02$	NS
	C	THC	1.53	$4.01 \pm 0.12$	$6.13 \pm 0.18$	NS
	Mean		$1.50 \pm 0.17$	$3.75 \pm 0.32$	$5.58 \pm 0.54$	
2.8						
	A	THC	9.34	$0.86 \pm 0.03$	$7.98 \pm 0.24$	NS
	B	THC	8.22	$0.75 \pm 0.02$	$6.13 \pm 0.20$	NS
	C	THC	7.69	$0.80 \pm 0.02$	$6.16 \pm 0.13$	NS
	Mean		$8.42 \pm 0.84$	$0.80 \pm 0.05$	$6.76 \pm 1.06$	

**Table 5.** Portable device analysis of edible products. Measurements were performed on individual edibles from same products as quantified samples unless indicated by an asterisk\*. Controls represent unique items from Haribo ‘Starmix’ and Cadbury chocolate button. NDD = no drug detected. True positives (TP), true negatives (TN), false positives (FP), false negatives (FN).

Article number	Qualitative analysis	Device Indication	Time taken for device indication	Result
1.1	THC	Positive - THC	10s	TP
1.2	THC	Positive - THC	10s	TP
1.3	NDD	Negative	30s	TN
1.4	THC	Positive - THC	10s	TP
1.5	THC	Positive - THC	10s	TP
1.6*	THC	Positive - THC	10s	TP
1.7*	THC	Positive - THC	30s	TP
1.8*	THC	Positive - THC	10s	TP
1.9	THC	Negative	30s	FN
1.12	THC	Negative	30s	FN
1.15	THC	Positive - THC	10s	TP
1.18	THC	Positive - THC	10s	TP
1.19	THC	Positive - THC	10s	TP
1.20	THC	Positive - THC	10s	TP
1.21	THC	Positive - THC	10s	TP
1.22	THC	Positive - THC	10s	TP
1.23	THC	Positive - THC	10s	TP
2.1	MDMB-4en-PINACA	Positive - SC	~0s	TP
2.2	THC	Positive - THC	10s	TP
2.3	NDD	Negative	10s	TN
2.4	THC	Positive - THC	30s	TP
2.7	THC	Positive - THC	10s	TP
2.8	THC	Positive - THC	10s	TP
Control 1	NDD	Negative	30s	TN
Control 2	NDD	Negative	30s	TN
Control 3	NDD	Negative	30s	TN
Control 4	NDD	Negative	30s	TN
Control 5	NDD	Negative	30s	TN
Control 6	NDD	Negative	30s	TN
Control 7	NDD	Negative	30s	TN
Control 8	NDD	Negative	30s	TN