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First systematic chemical profiling of cocaine police seizures in Finland in the framework of an intelligence-led approach

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ABSTRACT

For the first time in Finland, the chemical profiling of cocaine specimens was performed at the National Bureau of Investigation (NBI). The main goals were to determine the chemical composition of cocaine specimens sold in the Finnish market and to study the distribution networks of cocaine in order to provide intelligence related to its trafficking. An analytical methodology enabling through one single GC-MS injection the determination of the added cutting agents (adulterants and diluents), the cocaine purity and the chemical profile (based on the major and minor alkaloids) for each specimen was thus implemented and validated. The methodology was found to be efficient for the discrimination between specimens coming from the same source and specimens coming from different sources. The results highlighted the practical utility of the chemical profiling, especially for supporting the investigation through operational intelligence and improving the knowledge related to the cocaine trafficking through strategic intelligence.

1. Introduction

Traditionally, cannabis and amphetamine-type-substances (ATS) have prevailed the illicit drugs market in Finland. Cocaine has been appearing on the Finnish market more frequently in the past 10 years, but it still remains rather a marginal drug [1]. According to the most recent wastewater analyses, significant abuse of this substance was especially reported at weekends, even though limited to larger cities in Southern Finland [2,3]. The number of cocaine specimens (i.e. different physical units coming from one or several seizures) sequestered by the police or customs is limited, when compared to the total number of illicit drug cases (approximately 3%), but it slightly increases every year. For example, in 2012 and 2013 respectively, 140 specimens covering 24.6 kg and 192 specimens covering 4.1 kg were seized. This trend led to the development of a project by the National Bureau of Investigation (NBI) to study the composition of the cocaine specimens that can be found on the Finnish market and to gather knowledge about the distribution networks of cocaine.

Illicit drug profiling (i.e. the drug physical and chemical characterization) has been proven to be a relevant approach to discover and understand phenomena of a complex nature such as cocaine trafficking. Around the world several institutions have implemented and promoted profiling programs to provide relevant information for authorities involved in issues related to illicit drugs (e.g. prevention, monitoring, control strategies) [4–11]. In this research, the implementation of a chemical profiling methodology at NBI was specifically studied. Such approach requires a thorough reflection about the level of source the laboratory would like or could address [12–14]. In the chemical profiling framework, the notion of source is not that trivial and could have various definitions. Source may be defined at different levels like a geographical origin, a clandestine laboratory, a synthesis pathway, a production batch or a physical unit [11,12,14]. The level of source that is investigated sets requirements to the selection of both proper reference population and suitable analytical methodology (e.g. the choice of the analytical method and the target compounds used to create the profile). The chemical profile can be based on trace level impurities, occluded solvents, major or minor alkaloids and even stable isotopes [11,12,14]. This study focused on the use of a profile based on the major alkaloids present in a cocaine specimen. Considering the available specimens as well as the analytical and statistical methodologies implemented, the level of source that was inferred corresponded to the physical unit. This aims to determine that different cocaine specimens, coming from one or several police seizures, were originally part of the same

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physical unit before the latter was split. For instance, customs could seize pellets smuggled by a drug mule. Using chemical profiling, we will therefore evaluate if these specimens were coming from the same physical unit. If so, we will then argue that specimens are coming from the same source and a link will be highlighted between them. Otherwise, we will argue that they are coming from different sources.

The information conveyed by the illicit drug profiling may be used in two fundamentally different frameworks addressing two distinct levels of information [11]. In the first one, the profiling results are considered as a piece of evidence to be presented in court and profiling comparisons are only performed between samples coming from specific caseworks which are selected according to inquiry information. In the second one, the profiling results may be used as a piece of intelligence to support police investigation as well as to provide knowledge about the structure and organisation of the drug trafficking, therefore contributing to forensic intelligence through operational and strategic perspectives. They may provide phenomenological knowledge on the criminal activity and may support proactive and preventive approaches [9]. Forensic intelligence has been defined as being the timely, accurate and usable product of logically processed forensic case data [15,16]. In the intelligence context, a systematic profiling of each illicit drug specimen as well as the storage of the results in a pre-existing organised memory (i.e. a database) is compulsory for an efficient analysis or exploitation of the information. This memory offers the possibility to perform retrospective comparisons between new cases and those already stored into it [9]. When combined with traditional police information (surveillance and telecommunication intercepts for example), this may lead to the confirmation of suspected or pre-established relationships and even to the identification of unsuspected connections [14].

The NBI, which is part of the Finnish police organisation, is a centralised laboratory as far as analysis and drug intelligence routine are concerned. Since 2012, a coordination centre has been created in which a crime analysis unit uses drug profiling along with other forensic information to generate timely and accurate intelligence related to illicit drug trafficking. NBI is daily using profiling results of amphetamine-type-substances (ATS) (amphetamine, methamphetamine or MDMA specimens). However, no cocaine profiling has ever been performed at NBI nor in Finland and no studies ever investigated the composition of cocaine sold in the market or described the distribution networks. Therefore, this study investigated these two aspects through the analysis of specimens seized by police or customs and coming from different places in Finland. In order to monitor the evolution of the cocaine market in time and space, a database was created and fed with information for every cocaine specimen.

The article presents validation aspects of the analytical methodology, which is mandatory to assess not only the efficiency but also the precision in a long-term perspective of the chemical profiling. The added value of the cocaine profiling results in an intelligence-led perspective is presented and discussed.

2. Analytical methodology and validation

2.1. Selection of the chemical profiling methodology

The chemical profiling methodology is defined by the following key process: the sample preparation (Section 2.4), the parameters of the analytical method (Section 2.5), the choice of the target compounds that will form the profile, the statistical data pre-treatment (Section 2.6) and the similarity measurement performed between the profiles. The entire methodology implemented in this study was adapted from the one described in ref. [17].

The selected analytical methodology uses GC-MS and enables through one single injection the separation and the detection for both the major and minor alkaloids, the main cutting agents along with the estimation of the cocaine purity of each specimen. Furthermore, the profile extracted through this methodology (peak area values of 8 target alkaloids, see Table 1) has proven to be stable and discriminatory [17].

After the statistical pre-treatment of the peak area values for every target compound (see Section 2.6), the similarity values between the profiles for all the cocaine samples are measured by the Pearson correlation coefficient. The degree of similarity is evaluated according to a chosen threshold value. The way to choose the proper combination of statistical pre-treatment, similarity measurement and threshold value is critical and must thus be addressed (see Section 2.2) [18]. Specimens showing similar profiles according to the selected threshold are grouped into a specific chemical class within a global database [11].

2.2. Validation and sampling

The analytical validation must consider the three following specificities of the chemical profiling methodology applied in this study.

2.2.1. Chemical characterisation in one single GC-MS analysis

Regarding the way the profile is determined (see Section 2.1 above), we must be sure that the analytical methodology provides suitable precision (repeatability, intermediate precision) for each target compound. The repeatability and intermediate precision study was performed for two specimens – considered as quality control (QC) specimens – selected to be representative of the street specimens, which have been analysed at the NBI laboratory. The use of two different specimens allowed us to evaluate the impact of different relative concentrations in the target compounds as well as the influence of a difference in the cutting agents. The repeatability was expressed as the relative standard deviation (RSD) calculated between the normalized areas obtained after six repeated injections of the same sample for both QC specimens. The intermediate precision describes the inter-days measurement and was evaluated through the everyday analysis of 5 replicates for each QC specimen, during 4 weeks. RSD values were calculated between the normalized areas obtained for the respective replicates (about 100 replicates were analysed for each QC specimen over the intermediate precision study).

Concerning the assessment of the quantitation capability of the method, the investigated parameters were linearity, limit of detection (LOD), limit of quantification (LOQ), precision, precision with matrix effect, accuracy and accuracy with matrix effect as proposed in the literature [19]. The linearity was assessed by the analysis of seven independent calibration levels (i.e. pure cocaine standard) of known concentrations (2.5, 5, 10, 25, 50, 75 and 100% cocaine purity corresponding to approximately 0.25, 0.5, 1, 2.5, 5,

Table 1
List of the target compounds to establish the chemical profile [17] (NB: cocaine is not used in the chemical profile).

Peak number	Compounds	RRT (min)	**Target ion**, qualifiers (*m*/*z*)
1	Ecgonine methyl ester	0.216	**82**, 96, 147
2	Ecgonine	0.256	**82**, 96, 182
3	Tropacocaïne	0.452	**124**, 245, 82
4	Benzoylecgonine	0.68	**240**, 82, 105
5	Norcocaïne	0.692	240, 105
6	*Cis*-cinnamoylcocaïne	0.752	182, 82, 96
7	*Trans*-cinnamoylcocaïne	0.836	**182**, 82, 131
8	3,4,5-trimethoxycocaine	1.0048	**182**, 393, 94