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Technical Note

Effect of drug precursors and chemicals relevant to clandestine laboratory investigation on plastic bags used for collection and storage

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ABSTRACT

In the area of clandestine laboratory investigations, plastic bags are used to collect and store evidence, such as solvents, precursors, and other compounds usually employed for the manufacturing of drugs (although liquids may be stored in glass containers within the bags first). In this study, three different types of plastic bags were provided by the NSW Police Force and investigated for their suitability for evidence collection: two different types of low-density polyethylene (LDPE) bags and one type of polyvinyl chloride (PVC) bag. Three different experiments were carried out: (1) storing relevant chemicals in the bags for up to three months; (2) exposing the bags including their content to accelerated conditions using a weatherometer, and (3) simulating an expected real case scenario. This study indicates that drugs and related chemicals stored in plastic bags may lead to a change in the composition of the chemical and an alteration or degradation of the plastic bag. All experiments led to the same conclusion: the polyvinyl chloride bags appeared to be the most affected. LDPE bags seem to be more appropriate for routine use, although it has been established they are not suitable for the collection of liquids (unless pre-packaged in, for instance, a glass container).

When a search warrant is executed for possession of illegal products, such as drugs, whether for personal consumption or manufacturing in clandestine laboratories, most types of evidence are stored in plastic bags. This procedure is accomplished according to the legislation, rules and policies in force in the proper jurisdiction. Different types of plastic bags are currently used in New South Wales, Australia, for storage of evidence. Anecdotal evidence shows that, after storage, the bags may be compromised depending on the chemicals stored in them, suggesting an interaction occurring between the chemicals and the bags. Numerous parameters can lead to this result, and they all depend on many conditions such as, for instance, the nature of the chemical, the nature of the plastic bag, the temperature of the room where the bag is stored and the duration of the storage [1]. During an investigation, an essential aspect is the chain of custody that has to be maintained throughout the whole process from the crime scene until the evidence is presented in court. Therefore, containers must be sealed to preserve this chain of custody. Moreover, they must be sufficiently robust to permit transportation of the evidence to the laboratory. A type of container that covers all these requirements is the plastic bag. Indeed, plastic bags are flexible, unaffected by water, and available in a range of materials and sizes [2]. Laboratories are now using bags on a routine basis for storing evidence. Over the years, it has been verified that bags are more convenient than cans and jars for field investigators [3]. However, their resistance to chemicals is variable and during laboratory analyses, the contamination of evidence also has to be taken into account [4]. For instance, this contamination can be due to the presence of solvents used during the manufacturing process, cross contamination, or chemical and thermal parameters [5].

Different types of plastic bags are currently used, with various compositions. The two polymers used majoritively to manufacture the plastic bags are low-density polyethylene (LDPE) and polyvinyl chloride (PVC) [6]. Besides, polymer resistance can be increased by adding various compounds during the manufacturing process, aiming to prevent their degradation occurring via different factors such as oxygen and radiation (UV, light, heat) [7]. Therefore, one of

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the aims of this study concerned the degradation process of the plastic bags when directly exposed to chemicals or extreme weathering conditions, using a QUV® tester [8]. This instrument can reproduce the damage that would occur if the samples were exposed to outdoor conditions, caused by sunlight, rain or dew. The purpose is to accelerate these parameters to reproduce in a few days or weeks the damage that occurs naturally over months or years outdoors. Even if evidence bags may not be exposed to outdoor conditions, this experiment allowed us to draw conclusions regarding the resistance of plastic bags and interactions occurring between chemicals and polymers, by testing extreme conditions.

All the precursors and solvents used to manufacture drugs in a clandestine laboratory may be present in the final products and are stored in the bags when seized in a police operation. Their nature varies considerably, and the interaction between such reagents and the polymer used in the bag manufacture was one of the main parameters taken into account in this study. Thus, the primary aim of this study was to assess three types of plastic bags currently used or considered by the NSW Police Force for their suitability for evidence collection in routine clandestine laboratory cases. The approach included a worst case scenario where conditions were elevated to the extreme, i.e. directly pouring a liquid chemical into the bags. Even if this particular case would rarely occur in a real case scenario, it permits to assess the resistance of plastic bags if corrosive and toxic chemicals were to be put in direct contact with the polymers, because of leaking or spreading vapours into the plastic bags.

Knowing the properties of the plastic bags as well as the chemicals provided, the purpose was to observe and contrast any possible effect of typical precursors and solvents on the different types of bags. Several drugs and their precursors and solvents were considered in this study, including common ones such as safrole, isosafrole, gamma-butyrolactone (GBL) and amyl nitrite [9]. Safrole and Isosafrole are two precursors used in the manufacturing of 3,4-methylenedioxymethamphetamine (MDMA) [10]. GBL, when ingested, is converted in the active drug gamma-hydroxybutyrate (GHB) in the body [11]. Amyl nitrite is a common recreational drug also known as poppers [12]. In the past few years, the interest for these products has increased, leading to an increase in the manufacturing in clandestine laboratories. More specifically, the study was carried out to investigate the stability of the plastic storage bags when in contact with various chemicals over a three months period, under accelerated weathering conditions and in a simulated real case scenario. Besides, the stability of the precursor chemicals under these circumstances was also monitored using gas chromatography–mass spectrometry (GC–MS).

The outcomes of these experiments lead to recommendations for field investigators especially for operational purpose on crime scenes.

1. Materials and method

1.1. Material provided

Three different types of bags were provided to compare the distinct properties of the various plastic bags used by the NSW Police Force (Table 1). Thirteen common solvents found in clandestine laboratories, supplied by Sigma-Aldrich were used for the experiments (Table 2). Other precursor chemicals investigated included GBL, isosafrole, safrole and amyl nitrite that had been previously seized by the NSW Police Force and were awaiting destruction.

Table 1
Three classes of bags investigated.

Class	Type of polymer	Dimensions (cm)	Number of tapes sealing the bag
A	LDPE	22.2×38.2	1 (Bags made by Manufacturer A)
B	PVC	25.8×48	5 (Bags made by Manufacturer B)
C	LDPE	29.2×52	1 (Bags made by Manufacturer C)

Table 2
Solvents and acids used for the experiments.

Solvents	Molecular formula
Formic acid	$HCOOH$
Hydrogen peroxide	H_2O_2
Hydriodic acid	HI
Hydrochloric acid	HCl
Hydrobromic acid	HBr
Phosphoric acid	H_3PO_4
Acetic acid	CH_3COOH
Methylamine	CH_3NH_2
Nitroethane	$CH_3CH_2NO_2$
Methanol	CH_3OH
Acetone	$(CH_3)^2CO$
Acetonitrile	CH_3CN
Ethyl acetate	$CH_3COOC_2H_5$

1.2. Macroscopic observation

The visual alteration or degradation of the polymeric structure of the different types of bags was assessed using a Leica EZ4D macroscope. The lighting applied was a direct oblique reflection white light. All the observations were photographed using the $12.5\times$ objective.

1.3. Fourier transform infrared (FTIR) spectroscopy

Another general observation of the surface of the bags was carried out with an Attenuated Total Reflectance (ATR)-FTIR spectrometer. ATR-FTIR spectra were acquired at a resolution of $4\,cm^{-1}$ using an Agilent Cary 630 FTIR spectrometer equipped with a diamond ATR accessory. The spectra were collected using 32 scans over the range from 400 to $4000\,cm^{-1}$. Before testing, reference spectra were collected for the internal and external surface of the bags [13]. For each class of bag, ten bags were analysed, with three replicas per bag to be able to obtain accurate intravariability and intervariability regarding the composition of the polymers.

1.4. Storage experiment

This experiment was conducted over three months to observe changes in the characteristics of polymers. Bags were filled with 50 ml of each chemical available for this study. As the solvents used were pure compounds, they were diluted depending on their affinity with the polymers (Table 3) [14,15]. All the dilutions were realised with ultra pure water as chemicals were soluble in it, and water being a neutral compound it prevented from biased results as no interaction would occur with the polymers.

The bags were stored at ambient temperature (20–24 °C) for three months, in an upright position to expose the maximum surface area of the bag to the solution [16]. After three months, the surface was achieved and characterised using a macroscope, FTIR spectroscopy and tensile and tear testing.

1.5. QUV® accelerated weathering tests

The weathering test involves exposing the samples to alternate cycles of UV light and moisture at controlled and elevated temperatures. The QUV® simulates the effects of sunlight with