

Know your poison: the festival chemical safety net



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How analytical chemistry helps reduce the harms of drug use

Imagine that you, like millions of people in the UK each year, are at a music festival. You emerge from your muddy tent into music, sunshine and fun – including the temptations of alcohol and even illegal drugs. But such temptations can turn the fun to tragedy, as happened in the case of 18-year-old Christian Pay at the Kendal Calling festival in Cumbria. Like most users, he was unaware of exactly what was in what he thought were ecstasy pills – and what they contained killed him.

Risks like this motivated chemist Guy Jones to exploit the expertise gained from his weekday job working for an analytical equipment supplier. For years, at weekends, he has been volunteering to help drug users stay safer at music festivals.

In 2012, he signed up with the charity Kosmicaid to care for festival-goers having a bad time after taking drugs. Helping people who 'aimed for the moon and overshoot' was fulfilling, but also frustrating, because he couldn't prevent them ending up in the welfare tent in the first place.

Guy therefore set up a website offering chemistry-based tests so people could check their drugs themselves, at home. It turned into the company Reagent Tests UK, which sells liquids that react with drugs and change colour for a few pence a test. 'They change colour roughly according to the functional groups in the molecule,' Guy explains. 'We give a reference chart that lists a number of drug compounds along the left hand side and then you follow it across to see what colour it should go. If it changes to a different colour people immediately know that they don't have the drug they expect.'

Hidden risks

While this tells people whether they have the drug they think they do, better analysis is still needed. That's because pills and powders often contain more than just one substance, as Ian Blagbrough's team at the University of Bath has shown using nuclear magnetic resonance (NMR) spectroscopy. They get samples of drugs from amnesty bins at Glastonbury and in night clubs, from Avon and Somerset police.

'The mixtures are complex and often not good for you,' Ian says. He emphasises stories of drug dealers mixing their product with powdered glass are not true. Instead, they use cutting agents like sugar and creatine, a molecule sold legally to help with body-building, to bulk out pills or powders. They also often mix in other cheaper and easier-to-get drugs, including formerly legal highs – known as novel psychoactive substances (NPS) – which are now banned.

This is apparently what killed Christian Pay. His pills did contain some MDMA, the molecule commonly known as ecstasy, but they also contained PMA, which has been involved in a number of deaths in the UK, peaking at 29 in 2013, but down to three in 2016.

Similarly, the Bath scientists have found samples of the NPS flephedrone mixed with benzocaine, which is a cheap local anaesthetic drug used in cough sweets. 'It is in there to fool you,' Ian says. It makes your face tingle but doesn't get you high. Worse still, it's in flephedrone samples in such high amounts it could cause internal bleeding. 'You're meant to be taking 1-2 mg of benzocaine, not 50-100 mg.'

In the loop

Such dangerous doses are what often causes harm with drugs, be they legal or illegal. 'Two paracetamol will take away the headache, but 32 will kill you,' Ian stresses. 'It's all about dose. If you go and buy ecstasy in nightclubs, you don't know the dose.' Ian's team's work supports those concerns: they've found some ecstasy tablets to contain twice as much MDMA as others.

And it's to help reduce the harms of unknown mixtures and doses that Guy has embarked on his current chemical festival adventures. In 2013, an unusual new drug testing charity, The Loop, appeared at nightclubs, and then at the 2014 Parklife festival in Manchester. Guy heard about its work and approached the director and University of Durham criminologist, Fiona Measham, to see if he could help. He now puts his scientific skills to use as a senior chemist for the charity.

Fiona had previously followed police testers at events in their large mobile labs, watching the chemistry tests they used for evidence and intelligence. She realised that offering festival-goers similar testing could help reduce harm from contaminated or strong drugs. She therefore set up The Loop to give information to users on the true content of substances they are considering taking.

Yet, Guy and Fiona's ambitions were still thwarted at first. The Loop was initially only allowed to support emergency services at festivals that weren't big enough for the official police labs to attend. This way, they could prove the tests were good enough and to overcome legal questions around offering drug checking directly to festival-goers. But they could also already point to other evidence that such systems helped.

Molecular fingerprints

The 'drug checking' idea seemed radical in the UK when Fiona first started pushing it because nothing similar had ever existed in the country. But in Spain, Energy Control has tested drugs and offered users advice since 1999. Many other European countries today have similar services.

For example, groups in Austria and Switzerland use chromatography for their testing. In liquid and gas chromatography coupled with mass spectrometry (LCMS and GCMS), molecules stick to the solid columns more or less strongly depending on their structure. The molecules in a drug sample move at different speeds as gas or liquid flows down the column, and get separated. When, one by one, the molecules finally reach the column's end, a mass spectrometer measures their molecular weight, giving an important clue to their identity.

To do this, Austrian service ChEckIT! uses a converted van as its lab. That's partly because its old but affordable chromatography equipment is difficult to move – weighing as much as a small person – and takes hours to set up. And then if it's disturbed, perhaps by an accidental nudge, it needs lengthy retuning. Chromatography is also slow, and together these issues make it hard to meet demand.

So The Loop uses briefcase-sized infra-red (IR) spectrometers instead. They're easy to use, as samples can be put straight on their 'testing stage' after being crushed. Guy compares an IR spectrometer to how we see something blue in white light because it absorbs all the other colours and reflects blue. The spectrometer shines several shades, or wavelengths, of IR light one by one at the sample and measures how strongly each wavelength is absorbed. 'It does that in about 30 seconds' Guy explains. The spectrum showing absorption at each wavelength depends on the bonds within the molecule and is unique for each substance, like a fingerprint is for a person.

An uncertain start

At his first event for The Loop, the lack of separation step worried Guy. 'I thought, "Really, is this going to work?";' he recalls. 'Nobody else was doing infra-red for drug checking.'

Ian Blagbrough also has doubts about using IR spectroscopy for drug analysis. 'The strengths are it only requires a tiny amount, and it's rapid,' he says. 'But it's looking at the spectrum against a database. That is a weakness, because there are lots of new drugs not in the database. And then if you have a mixture of two things in the database you might not pick either up.' That's why Ian prefers NMR, which is similar to IR spectroscopy in producing a fingerprint-like spectrum, but with radio waves rather than light. However, NMR instruments are even bigger than GCMS ones. 'Obviously you can't do that in a nightclub or at a festival,' Ian concedes.

The Bruker Alpha IR spectrometers The Loop uses quickly won Guy over. 'I have been just blown away', he remarks. When testing mixtures, they use sophisticated software to identify different components in the spectrum. The system's database includes mixtures, adds Henry Fisher, who is policy director of drug think tank Volteface and also a senior chemist for The Loop. For example, there's a reference spectrum for a 1:1 mixture of cocaine and benzocaine. A 60:40 sample gives a close match to this reference, Henry says.

Hard to take

Finally, at the Secret Garden Party and Kendal Calling in 2016, The Loop was able bring its services directly to festival-goers. Ecstasy is one of the drugs The Loop sees most, alongside cocaine and ketamine, and it does vital work estimating ecstasy pill doses. It estimates doses using a simple mass loss test on pills handed over by festivalgoers anonymously. Henry, Guy and the team crush the pills and dissolve the drug molecules using methanol, leaving only inactive cutting agents and dyes behind. The difference between the pill's mass before and after washing gives a dose estimate. 'It's very low-tech, but it's very reliable,' Henry says.

One batch of pills handed to The Loop at the Secret Garden Party 2016 was particularly strange. 'When we tried to crush it, we couldn't figure out why it was so hard,' Henry recalls. 'When we came to analyse it, we realised it was solid concrete. We've also had antimalarial tablets crushed up and boric acid sold as cocaine. That's unpleasant, especially if they take a lot because it's not doing anything. We also often get paracetamol. It's not just professional criminals, it's also probably chancers who realise they've got a packet of paracetamol they can sell to make their festival ticket price back.'

This year, The Loop added Boomtown to the festivals it checks at, and hopes to do four more.

It is also introducing a new MDMA dose-finding method that should be more accurate: ultra-violet (UV) light absorption. The Loop team first weighs, crushes and checks to see a pill contains MDMA using the IR spectrometer. They then put it in a tube and add a certain amount of solvent depending on the pill's weight. Finally, they put it in the spectrometer, which measures how much ultraviolet light it absorbs. By comparing the pill's spectrum with a calibration curve, a spectrum for a known amount of MDMA, they can work out how much was in the pill.

The goal is to give people useful information. 'They need to know if their pill is a typical MDMA dose or more,' Henry says. 'We can then give advice, like that they split them in quarters if they do take them.'

Chemistry starts conversations

People were cautious about using The Loop's drug checking service at first, Henry adds. 'But as they realised we were genuinely offering this service with police support, they were enthusiastic,' he says. 'When we give them their results back you have some groups where you hear a cheer. With other groups there's an awkward silence, when they've just found out that they've been putting boric acid up their nose.'

If the drugs aren't what people hoped, they often hand them over to The Loop. 'Sometimes they've said they'll go and have a word with their dealer,' Henry says. 'That means our information is having a knock-on effect.'

The confidential 10-minute chat about reducing risks of taking drugs that comes with the results is exactly what Guy has long wanted to give people. 'My initial concern was they're not going to listen, but because they've given us the drugs there's no reason to hide anything so they can have a really honest conversation.'

What would the advice be for a GCSE student, for example? 'There's no such thing as safe drug use,' Henry begins. 'Any drug use carries some risks. The way you reduce those risks is learning more about the substances. Read useful harm reduction advice.'

'But I'd also recommend that these drugs are particularly risky for people under 18. Your brains are still developing and you're smaller and lighter than a full-grown adult. Consequently, a smaller amount is going to have more of an effect.' You're less familiar with dealing with that experience and so it becomes a much riskier thing to do if you're underage. I'd really advise against taking these substances at that age.'

Article by Andy Extance, a science writer based in Exeter, UK.