Photolability of Drugs in Hair

Atlas SUNTEST® CPS+ and its use for photolability testing of drugs of abuse in human hair

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Background

Hair analysis is a valuable tool in clinical and forensic toxicology to demonstrate drug exposure when cases of chronic intoxication, use, abuse, or single dose consumption need to be diagnosed in the context of facilitated crimes, withdrawal controls, doping controls, or workplace drug testing, with a large window from weeks to months/years for drug detection. However, scalp hair is exposed to sunlight and/or artificial light for many hours per day; hence, the action of light on hair could alter the content of drugs/illicit drugs and/or metabolites and the xenobiotics can gradually disappear from the hair shaft or be transformed into other compounds having different structure from the parent molecule. Thus, light exposure should be considered as a potential confounder in studies investigating xenobiotics in hair giving rise to reduced drug concentrations or even false negative results. On the other hand, the formation of new photodegradation products could lead to the identification of new markers of abuse useful in forensic evaluations.

In order to better understand the role and mechanisms of solar radiation exposure in decreasing hair concentrations of drugs and following our previous photodegradation studies on UVA and UVB induced changes (Drug Test Anal 2014,6,78-84), we have studied the degradation of cocaine (COC) and its metabolite benzoylecgonine (BZE) by irradiating true positive hair samples, containing COC: 0,16-40 ng/mg, and BZE: 0,05-19 ng/mg), in the photostability test chamber (Atlas SUNTEST® CPS+), thus reproducing the complete spectrum of natural solar radiation.

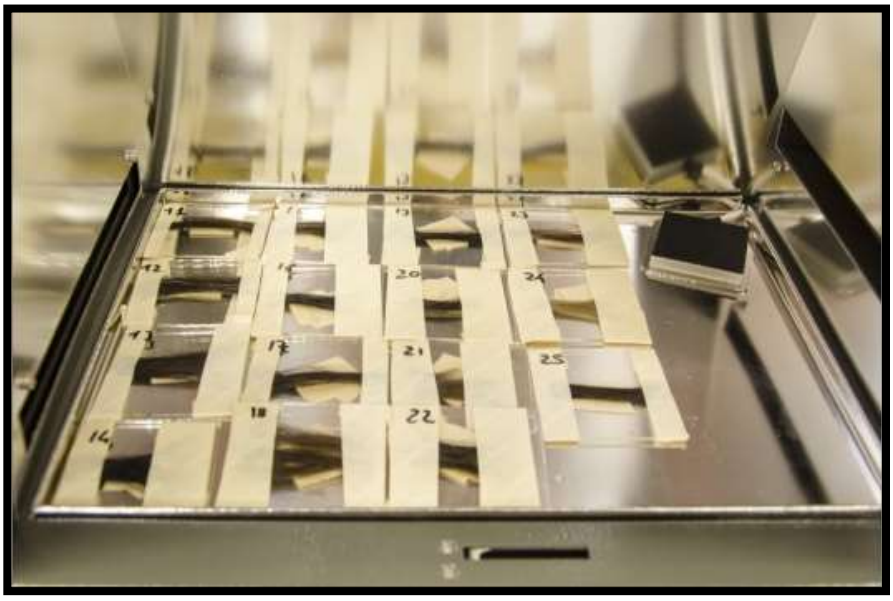

Figure 1. Hair samples positioned for radiation exposure inside SUNTEST CPS+

SUNTEST CPS+ Test Setup

The SUNTEST CPS+ was equipped with a1500 W xenon-arc lamp. The optical Solar ID65 filter (cut-off ~320 nm) provided the spectrum as defined in ICH Guideline Q1B (Option 1). Further, a water-cooled specimen table with circulating water bath was used for contact cooling of the hair samples during radiation exposure (Figure 1).

Test Conditions and Results

Hair samples were exposed for 48 hours at an irradiance level of 765 W/m^2 (@300-800 nm) inside SUNTEST CPS+ while cooled by the water-cooled specimen table; then a micro-pulverized extraction was made before the Orbitrap LC-HRMS analysis.

Hair samples (70%) exhibited a decrease of cocaine (COC) concentration in post-irradiation samples, and in 53% of samples benzoylecgonine (BZE) decreased from initial concentration; in 17% of samples BZE increased from and in 30% of samples both COC and BZE contents did not vary. BZE increase was observed only in samples that exhibited COC decrease, suggesting that photodegradation of the parent compound generates BZE that remains incorporated into the hair shaft (Figure 2).

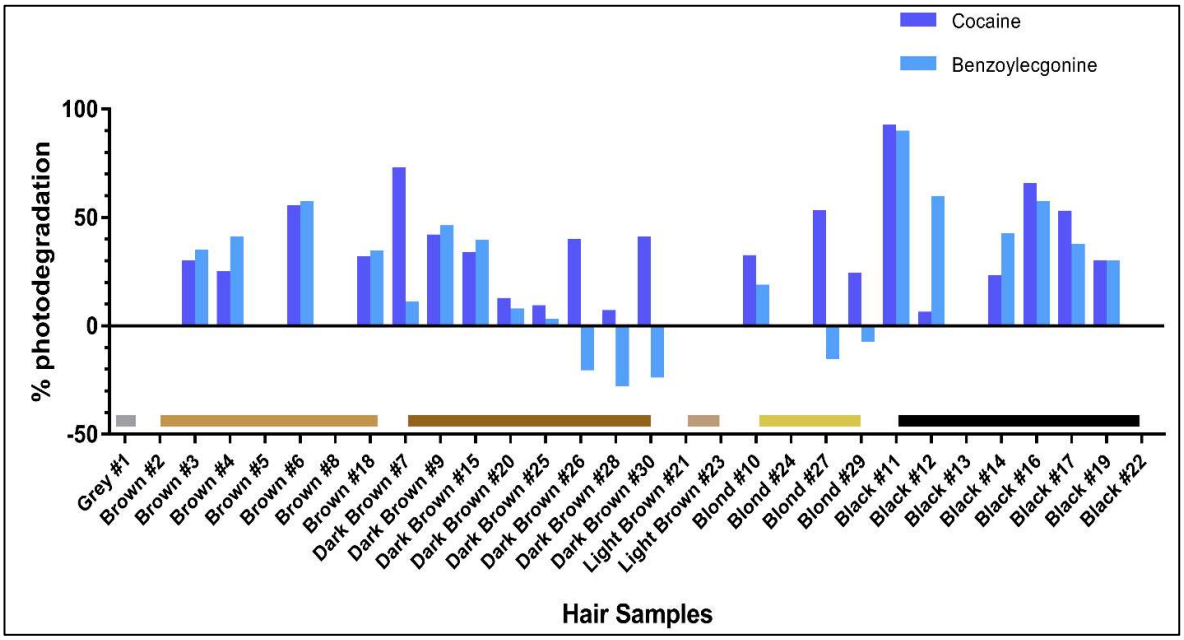

Figure 2. % photodegradation = [100*(drug concentration in the dark-drug concentration after exposure to SUNTEST CPS+.radiation)/drug concentration in the dark.

No relation could be found with hair color. The possible contribution of hair damage is under investigation by imaging techniques. Therefore, the experiments performed in the photostability chamber evidenced a similar percent of "degraded" hair samples (69% photostability chamber vs 62% UVA/UVB) but a higher photodegradation yield of COC (mean 37% vs mean 10% respectively).

The increase of concentration of a metabolite upon concomitant degradation of its parent compound highlights the peculiar role of the full-spectrum solar radiation and prompts for further studies, including other classes of compounds.