Crystal Clean?

Alex Mayer and Gordon Miskelly
School of Chemical Sciences, The University of Auckland

INTRODUCTION

Methamphetamine is an illegal and highly addictive psychostimulant drug. Manufacture and recreational use of methamphetamine causes widespread contamination of the local environment. Passive exposure to methamphetamine residue has been linked to adverse health effects including respiratory distress, sensory irritation, and behavioural changes,[1] therefore it is important to employ effective remediation strategies to protect public health. Destruction of methamphetamine by cleaning chemicals, such as hydrogen peroxide, is currently poorly understood. This makes it hard to evaluate the efficacy of cleaning methods and accurately estimate any hazards involved with the remediation process.

RESEARCH AIMS

Hydrogen peroxide is a common oxidant in chemical decontamination products employed by the methamphetamine remediation industry. This research investigated the reaction products from peroxide-based degradation of methamphetamine to provide a deeper understanding about the efficiency and safety of current remediation methods.

Photo: Rene Walter, obtained from https://www.flickr.com/photos/nerdcoreblog/12798818245/

METHODOLOGY

Two formulations containing hydrogen peroxide were investigated:

- a proprietary decontamination solution (Bio-Oxygen® Chem Decon, Artemis Bio-Solutions)
- an alkaline solution with a peroxide catalyst, Fe-TAML (Figure 1), which can degrade environmental pollutants[2] and agents of chemical and biological warfare[3].

Each solution was applied to samples of methamphetamine hydrochloride. Oxidation products were isolated from the reaction mixtures using solid phase extraction (SPE) and analysed by gas chromatography-mass spectrometry (GC-MS).

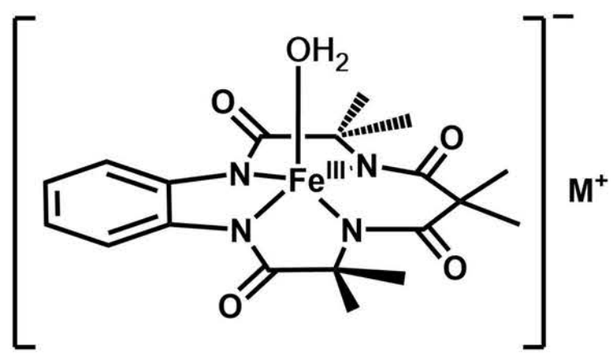

Figure 1. Chemical structure of the Fe-TAML catalyst.

RESULTS

The Bio-Oxygen® Chem Decon removed **92%** methamphetamine over **2 h.** The major mechanism of decomposition was via N-oxidation (Figure 2-a) to form phenylacetone oxime.

The Fe-TAML catalysed reaction was very rapid, removing **90%** methamphetamine after **5 min**. This increased to 98% with a second dose of hydrogen peroxide. The major mechanism of decomposition was via α-carbon oxidation (Figure 2-b, c). This occurred at two sites on methamphetamine, forming two major products: phenylacetone *N*-methylimine and phenyl-2-propanone (P2P).

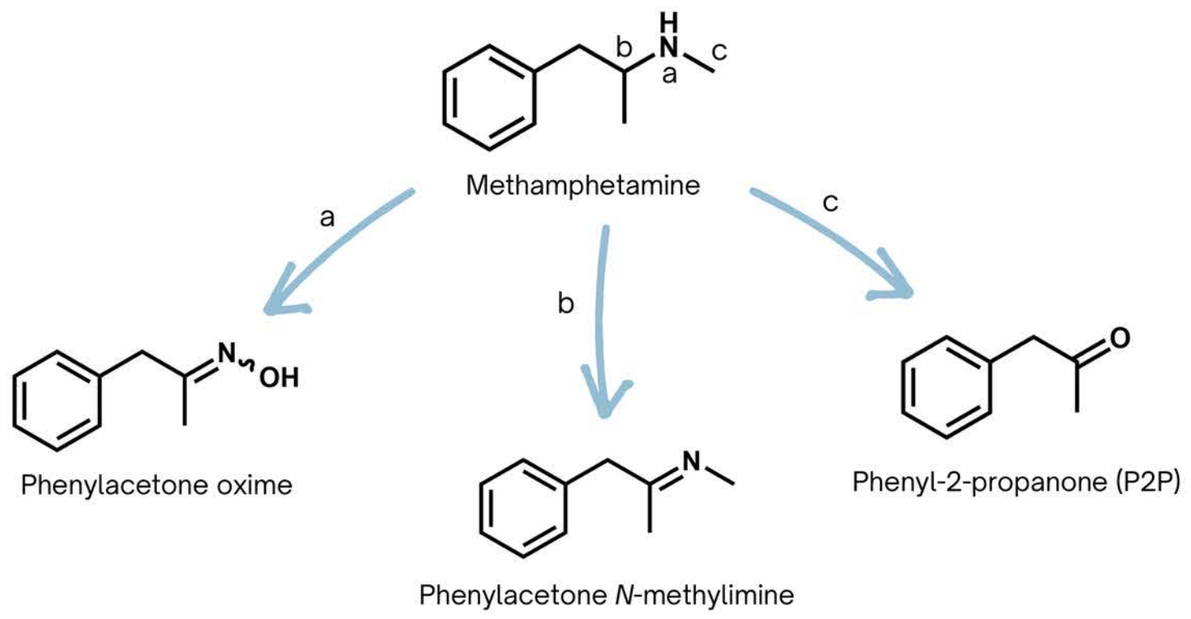

Figure 2. Reaction pathways for the oxidation of methamphetamine using hydrogen peroxide-containing decontamination solutions.

CONCLUSION

The use of hydrogen peroxide cleaning products for the chemical decomposition of methamphetamine significantly decreased the amount of drug residue in solution.

Fe-TAML catalysis is worth investigating for commercial applications.

Further research is required to understand the health implications of the identified oxidation products.

REFERENCES

[1] Wright J, Kenneally M, Ross K, Walker S. Environmental methamphetamine exposures and health effects in 25 case studies. *Toxics*. **2020** 8(3):61. doi: 10.3390/toxics8030061.
[2] Kundu S, Chanda A, Thompson JVK, Diabes G, Khetan SK, Ryabov AD, Collins TJ. Rapid degradation of oxidation resistant nitrophenols by TAML activator and H2O2. *Catalysis Science and Technology.* **2015** 5(3): 1775-1782. doi: 10.1039/c4cy01426j.
[3] Collins TJ. Energy efficient catalytic activation of hydrogen peroxide for green chemical processes. Grant Report: DE-FG02-03ER63587-DOE-COLLINS **2004** https://www.osti.gov/servlets/purl/834329