

# **THE SYNTHESIS AND CHEMICAL PROFILING OF 3,4-METHYLENE- DIOXYMETHAMPHETAMINE (MDMA) AND ANALOGUES**

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the degree of

**Doctor of Philosophy**

under the supervision of Assoc. Prof. Andrew McDonagh  
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## Certificate of Original Authorship

I, Erin Heather, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Science at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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## List of Abbreviations

<b>APAAN</b>	<i>alpha</i> -Phenylacetoacetonitrile
<b>ATS</b>	Amphetamine type stimulant
<b>DIBAH</b>	Diisobutylaluminium hydride
<b>GC-MS</b>	Gas chromatography - mass spectrometry
<b>HPLC</b>	High performance - liquid chromatography
<b>LC-MS/MS</b>	Liquid chromatography tandem mass spectrometry
<b>MDA</b>	3,4-Methylenedioxyamphetamine
<b>MDMA</b>	3,4-Methylenedioxymethamphetamine
<b>MDMA·HCl</b>	3,4-Methylenedioxymethamphetamine hydrochloride
<b>MDP2NP</b>	3,4-Methylenedioxyphenyl-2-nitropropene
<b>MDP2P</b>	3,4-Methylenedioxyphenyl-2-propanone
<b>MMDMG</b>	Methyl 3-[3',4'-(methylenedioxy)phenyl]-2-methyl glycidate
<b>MW</b>	Molecular weight
<b>NMR</b>	Nuclear magnetic resonance
<b>NPS</b>	New psychoactive substances
<b>P2P</b>	1-Phenyl-2-propanone
<b>PMA</b>	<i>p</i> -Methoxymethamphetamine

## List of Publications

### Journal Articles

**Erin Heather**, Ronald Shimmon and Andrew McDonagh. Organic impurity profiling of 3,4-methylenedioxymethamphetamine (MDMA) synthesised from catechol and eugenol via 4-allylcatechol. *Forensic Science International* 309 (2020) 110176.

**Erin Heather**, Adam Bortz, Ronald Shimmon and Andrew McDonagh. Synthesis and organic impurity profiling of methylone and its precursors. *Drug Testing and Analysis* 9 (2017) 436 – 445.

**Erin Heather**, Ronald Shimmon and Andrew McDonagh. Organic impurity profiling of 3,4-methylenedioxymethamphetamine (MDMA) synthesised from catechol. *Forensic Science International* 248 (2015) 140 – 147.

Rebecca Tam, **Erin Heather**, Ronald Shimmon, Brandon Lam, Andrew McDonagh. Synthesis and organic impurity profiling of 4-methoxymethamphetamine hydrochloride and its precursors. *Forensic Science International* 272 (2017) 184 – 189.

### Conference Presentations

Organic Impurity Profiling of 3,4-Methylenedioxymethamphetamine (MDMA) Synthesised from Catechol, 2014, 22nd International Symposium on the Forensic Sciences of the Australian and New Zealand Forensic Science Society

Organic Impurity Profiling of Methylone Synthesized from Catechol, 2015, 7th European Academy of Forensic Science Conference

Organic Impurity Profiling of the MDMA Precursor Safrole and Methylone Synthesised from Catechol, 2016, 23rd International Symposium on the Forensic Sciences of the Australian and New Zealand Forensic Science Society

## Abstract

This work examines the organic impurity profiles of 3,4-methylenedioxymethamphetamine (MDMA) and its analogue methylone that were synthesised from uncontrolled 'pre-precursors'. Methylone was synthesised from catechol by one synthetic route. Safrole was synthesised from catechol by two synthetic routes (Routes 1 and 2) and from eugenol by one synthetic route (Route 3). MDMA was synthesised from catechol- and eugenol-derived safrole via two routes (Routes A and B), which resulted in the synthesis of MDMA from catechol via four routes (Routes 1A, 1B, 2A and 2B) and from eugenol via two routes (Routes 3A and 3B).

Five organic impurities were identified in methylone, and fourteen organic impurities were identified in the three intermediate compounds. Neither the catechol precursor nor the 1,3-benzodioxole intermediate could be identified based on the impurities detected in methylone using standard techniques, which demonstrated limitations in the determination of the precursor chemical and synthetic pathways used.

Eight organic impurities were identified in safrole synthesised from catechol via Routes 1 and 2, and seven organic impurities in safrole synthesised from eugenol via Route 3. Importantly, nine impurities had not previously been reported in literature. Seven, four and seven route specific impurities were identified in safrole from Routes 1, 2 and 3, respectively. The route specific impurities indicated both the use of the 'pre-precursors' catechol and eugenol, and the route used to synthesise safrole from the respective 'pre-precursor'.

Thirteen organic impurities were identified in MDMA synthesised by Route 1A, ten organic impurities in MDMA from Route 1B, twelve organic impurities in MDMA from Routes 2A and 2B, and eleven organic impurities in MDMA from Routes 3A and 3B. Importantly, thirteen impurities had not previously been reported in literature. Six impurities in MDMA from Route 1A, four impurities in MDMA from Routes 1B, 2A, and 2B, and three impurities in MDMA from Routes 3A and 3B were considered specific to the use of catechol- or eugenol-derived safrole.

The route specific impurities identified in MDMA indicated that the 'pre-precursors' catechol and eugenol were used in the respective synthetic pathways. The route specific impurities identified in MDMA also indicated the route used to synthesise safrole from the respective 'pre-precursor', and the route used to synthesise MDMA from the safrole intermediate. Thus, the use of the 'pre-precursors' catechol and eugenol, and the synthetic routes that were used in its preparation, could be ascertained by the organic impurity profiling of MDMA under the conditions used here.