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Forensic Instability and Poor Recovery of Cannabinoids in Urine, Oral Fluid, and Hair

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Instability and Poor Recovery of Cannabinoids in Urine, Oral Fluid, and Hair[a]

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ABSTRACT: Cannabinoids including, but not limited to Δ^9-tetrahydrocannabinol, 11-hydroxytetrahydrocannabinol, and (–)-11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid are known to toxicologists and synthetic chemists as difficult compounds because they are subject to numerous degradative pathways. It is the purpose of this short review article to discuss common pathways that result in the disappearance of cannabinoids — such as conjugate formation, adsorption to surfaces, chemical reactions, microbial action, thermal decomposition, chemical bonding, photosensitivity, sample handling, analytical methodology, and micelle trapping — and to point out possible ways to avoid such degradation.

KEYWORDS: Absorption, adsorption, cannabidiol, cannabinol, cannabitriol, hair, 11-hydroxytetrahydrocannabinol, Intercept, micelle, (–)-11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid, 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid glucuronide, Oracol, oral fluid, Quantisal, Salicule, saliva, Salivette, silanization, siliconization, StatSure, Δ^8-tetrahydrocannabinol, Δ^9-tetrahydrocannabinol, THC, THC acid A, THC acid B, urine.

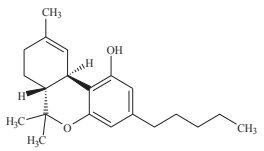
INTRODUCTION

General

In urine toxicology, the analysis of 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (THCCOOH), the major metabolite of Δ^9-tetrahydrocannabinol (Δ^9-THC, THC), is recognized as moderately challenging because the total amount in urine most often is in low ng/mL concentrations and moderately unstable. THCCOOH may be found as the free substance, the glucuronide conjugate, or a combination of both [79,100]. The parent drug, Δ^9-THC (or THC), may be detected in urine [75], but usually is not reported. To complicate the analysis and interpretation of urine THCCOOH results even further, THCCOOH may adhere to the walls of the container in which the urine or other biofluid is stored either by adsorption ("stickiness") or absorption (inclusion into materials such as polyethylene without a specific physicochemical interaction). Almost all carboxylic acids may be decarboxylated if heated to a sufficiently high temperature [9], giving THCCOOH the same potential. Since THCCOOH contains a six-membered ring with a single carbon-carbon double bond, THCCOOH also has the potential to be dehydrogenated to an aromatic ring in a fashion similar to the dehydrogenation of THC to cannabinol [89]. Temperature and pH generally play major roles in in vitro degradation processes [59]. In addition, THCCOOH is known to be structurally altered by microbial action [72]. Thus, in vitro, THCCOOH, a Phase I end product of the metabolism of THC, also is subject to multiple further chemical modifications.

In oral fluid, the parent THC appears to be a more useful analyte than the metabolite THCCOOH; especially when cannabis use is questioned. However, due to low levels of THC in oral fluid and THC's instability (photosensitivity, propensity for adsorption/absorption, and ease of oxidation [22,58]), which appears to be even greater than that of THCCOOH, the analysis of THC presents its own set of analytical challenges. Like the metabolite THCCOOH, the parent drug THC may interact with the containers in which biofluids are stored. The combination of THC and, when present, THCCOOH in oral fluid presents analytical and interpretative challenges beyond the relatively simple analysis of THCCOOH in urine.

Although the analysis of cannabinoids other than THC and THCCOOH in biological matrices such as blood and blood products may be required under a number of circumstances, the most commonly encountered analytes — THC and THCCOOH in urine, oral fluid, and hair, which are the matrices currently of interest to the National Laboratory Certification Program (NLCP) — are the primary cannabinoids addressed in this limited review.



Structure 1. (–)-*trans*-Δ^9-Tetrahydrocannabinol (Δ^9-THC or THC).

[a]Opinions expressed in this paper are not necessarily those of the Substance Abuse and Mental Health Services Administration (SAMHSA), the Department of Health and Human Services (DHHS), or the National Laboratory Certification Program (NLCP).

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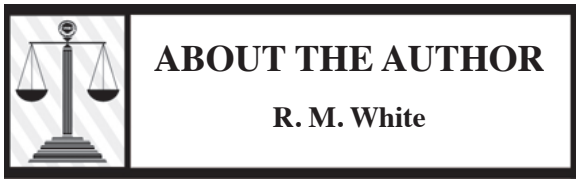

ABOUT THE AUTHOR

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Robert M. White, Sr. received a B.A. in chemistry from Vanderbilt University (Nashville, TN) in 1967 and a Ph.D. degree in physical organic chemistry from the University of Florida (Gainesville, FL) in 1972. Dr. White recently retired from the Center for Forensic Sciences, RTI International (Research Triangle Park, NC).

Upon completing his education, Dr. White served two and a half years of active duty in the US Army. He then undertook a postdoctoral in clinical chemistry with Dr. John Savory at the University of North Carolina (Chapel Hill, NC). Dr. White has served as the biochemist at Presbyterian Hospital (Charlotte, NC); director of life insurance testing at SmithKline-BioScience (Nashville, TN); co-director for chemistry and toxicology at Naples Community Hospital and Diagnostic Services (Fort Myers, FL); blood bank director at North American Biologicals, Inc. (Fort Myers, FL); and health care risk manager for Montgomery Eye Center (Naples, FL). Dr. White was also the scientific director for the Diagnostic Services, State of Florida Toxicology Laboratory and responsible person for the NLCP-certified laboratory (Fort Myers, FL). He also served as an adjunct professor at Florida Gulf Coast University and Hodges University in Naples/Fort Myers, FL. Dr. White was a full member of the Naples Community Hospital Department of Medicine (Naples, FL). He has qualified as an expert in toxicology in the criminal, administrative, and civil courts of the State of Florida and Federal Administrative proceedings. Dr. White's major research interests include oral fluid drug testing, biological matrix stabilization for drug testing, urine substitution and adulteration, hair drug testing, and method development.

Dr. White is licensed as a clinical laboratory director in Florida with specialties in chemistry, serology/immunology, and molecular pathology. He is also licensed in the State of Tennessee as a clinical laboratory director and licensed by the State of Florida as a health care risk manager. Dr. White is a member of the American Chemical Society, the American Association for Clinical Chemistry, the American Academy of Forensic Sciences, and the Society of Forensic Toxicologists. Dr. White is a fellow in the American Board of Forensic Toxicologists and a diplomate to the American Board of Clinical Chemistry in clinical chemistry, toxicological chemistry, and molecular diagnostics.