

Deterra® Activated Carbon Retention of Tramadol and Zolpidem Using Modified Waste Extraction Testing

**William Fowler
Verde Technologies, Inc**

Abstract

Unused medications can lead to serious health and environmental risks. Proper, timely disposal will mitigate these dangers. The Deterra Drug Deactivation System utilizes activated carbon to adsorb and deactivate prescription drugs, rendering them inert, unavailable for misuse and safe for the environment. Verde previously demonstrated medications deactivated by Deterra are not extracted when exposed to acidic solutions utilized in the Toxicity Characteristic Leaching Procedure (TCLP) developed by the Environmental Protection Agency. California has produced an additional procedure, Waste Extraction Testing (WET), for determining the potential for solid wastes to leach hazardous materials in landfill conditions. While Deterra does not contain hazardous materials, Verde examined the potential for tramadol and zolpidem to be extracted from Deterra activated carbon using a modified WET procedure. Our findings indicate Deterra will retain adsorbed tramadol and zolpidem when exposed to WET conditions.

Introduction

The number of prescriptions, leftover medications and deaths as a result of opioid misuse and abuse in American households are staggering:

- In 2016, 4.5 billion prescriptions were dispensed¹.
- A Medicare study found most unused medications were kept in a cabinet, thrown in the trash, or flushed down the toilet².
- Between 2012 and 2016, approximately 1.2 billion opioid prescriptions were written³.
- A Johns Hopkins survey found 67% to 92% of patients reported leftover opioids and that the rate of disposal was low⁴.
- In 2017, 11.1 million people misused prescription opioid pain relievers⁵.
- In 2016, more than 42,000 people died from opioid overdoses⁶.

In 2009 the Environmental Protection Agency (EPA) reported there were over 1000 publications concerning the occurrence of active pharmaceutical ingredients in sewage, surface waters, ground waters, and elsewhere⁷.

Improper disposal of unused medications contributes to environmental stress and may contribute to abuse. To lower the potential for abuse, a partnership between the U.S. Fish and Wildlife Service, the American Pharmacists Association, and the Pharmaceutical Research and Manufacturers of America produced the SMAR_xT Disposal Campaign. It encourages consumers to not flush medications down the drain (unless they are on the list that FDA advises to flush). Rather, if take-back programs are not available, medications are to be mixed with an undesirable substance like cat litter, used coffee grounds

or sawdust and thrown in the normal trash. The FDA has produced similar guidance for disposal of unused medications. Verde has demonstrated these mixtures are ineffective in deactivating drugs, allowing for abuse and exposure to the environment⁸.

In contrast, Verde's Deterra Drug Deactivation System, utilizes activated carbon for complete and effective deactivation of unused medications. Deterra was developed under a Small Business Innovation Research (SBIR) contract with the National Institute on Drug Abuse (NIDA). Third party testing was performed by the College of Pharmacy at Mercer University. A total of 20 medications in multiple formulation types were examined including tablets, capsules, liquids, sublingual films and transdermal patches. Mercer demonstrated Deterra was highly effective in adsorbing and deactivating all drugs tested, with an average of 89% of API adsorbed within the first 8 hours, and greater than 99% deactivated within 14 days⁸. Mercer also demonstrated that the activated carbon was effective in rendering adsorbed pharmaceuticals unrecoverable by simple means – such as extraction with 30% alcohol.

The EPA provides a method for waste generators to determine if their waste contains hazardous materials that may be leached when exposed to landfill conditions. Known as the Toxicity Characteristic Leaching Procedure (TCLP, SW-846 Method 1311), materials are exposed to an acetic acid solution for 18 hours and the presence of known hazardous leachates are measured. While Deterra does not contain hazardous materials, Verde has demonstrated exposure of carbon to the TCLP solution does not result in extraction of previously bound naproxen, ibuprofen or acetaminophen. Thus, these drugs are not expected to leach from carbon when exposed to landfill conditions¹⁰.

The State of California has established an additional extraction test method for determination of the presence of hazardous leachates. The Waste Extraction Test (WET) exposes materials to a citric acid solution for 48 hours to determine if known hazardous materials are expected to be leached in landfill conditions. The present study examined the potential for Deterra-treated tramadol and zolpidem to be extracted from carbon after exposure to the WET extraction solution.

Procedure: Modified Waste Extraction Testing Study

Materials

Deterra SP pouches containing 15 grams of proprietary activated carbon in a water soluble pod, tramadol HCl (50 mg tablets, Sun Pharmaceuticals, Mumbai India), zolpidem tartrate (10 mg tablets, Qualitest Pharmaceuticals, Huntsville, Alabama), citric acid (monohydrate, Sigma-Aldrich, St. Louis, Missouri), citric acid (trisodium salt dihydrate, Sigma-Aldrich, St. Louis, Missouri), plastic jars (10 ounces, Uline, Pleasant Prairie, Wisconsin), distilled water.

Method

Drug adsorption by Deterra. For each drug, 15 tablets were added to each of two Deterra pouches. Fifty (50) ml of warm distilled water was added to each pouch. Pouches were sealed and placed on a rocker table (40 revolutions per minute) for 7 days. Pouch contents were analyzed for presence of drugs by UV-Vis spectrophotometry (Cecil CE 2041). Tramadol and zolpidem were not detected in any pouches – indicating complete adsorption and deactivation of both medications.

November 28, 2018

Extraction testing. The WET procedure utilizes a 10-fold dilution of the solid portion of the waste to extractant solution (0.2 M citric acid buffer, pH 5.0). The diluted solids are exposed to agitation, such as that experienced in a rotary extractor, in order to maintain a suspension for 48 hours.

Contents of Deterra pouches containing deactivated tramadol and zolpidem were transferred to plastic jars. Water was replaced with 150 ml citric acid buffer (0.2M, pH 5.0). Jars were placed on a rocker table (40 revolutions per minute) for 7 days (as surrogate for 2 day exposure on rotary extractor). Contents were analyzed after 2 and 7 days by UV-Vis spectrophotometry for presence of extracted drug.

Results

Less than 0.01% of either drug was extracted from Deterra activated carbon at either time point:

Drug	% Extracted	
	Day 2	Day 7
Tramadol	<0.01%	<0.01%
Zolpidem	<0.01%	<0.01%

Discussion

Deterra activated carbon retains bound, deactivated tramadol or zolpidem when exposed to WET extraction solution for 7 days. Combined with the observations from Verde's TCLP testing, the results demonstrate deactivated medications will be retained by Deterra activated carbon when exposed to acidic landfill conditions.

References

1. Aitken M and Kleinrock M. "Medicines Use and Spending in the U.S. A Review of 2016 and Outlook to 2021." Quintiles IMS Institute, May 2017.
2. Maeng DD, et. al. "Unused medications and disposal patterns at home: findings from a Medicare patient survey and claims data." J. Am. Pharm. Assoc., 2016, 56(1): 41 - 46.
3. <https://www.cdc.gov/drugoverdose/maps/rxrate-maps.html>
4. Bicket MC, Long JJ, et. al. "Prescription opioid analgesics commonly unused after surgery. A systematic Review." JAMA Surgery, 2017, 152(11): 1066 - 1071.
5. McCance-Katz EF. "The National Survey on Drug Use and Health: 2017." <https://www.samhsa.gov/data/sites/default/files/nsduh-ppt-09-2018.pdf>
6. <https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates>
7. Daughton CG and Ruhoy IS. "Environmental footprint of pharmaceuticals: the significance of factors beyond direct excretion to sewers." Environ. Sci. Technol., 2009, 28(12): 2495 - 2521.
8. Fowler W. "Deterra System deactivation of unused drugs: comparison between Deterra Ingredients and others recommended in Federal and SmartRx disposal guidelines." Available upon request.

9. In-Home Deactivation System for Psychoactive Drugs (SBIR Phase 2). September 2016. Contract No. HHSN271201400068C. <https://deterrasystem.com/wp-content/uploads/2018/03/NIDA-Final-Report.pdf>
10. Fowler W and Anderson C. "Deterra activated carbon retention of pharmaceuticals using the toxicity characteristic leaching procedure extraction solution." Available upon request