

Evaluation of Oleoresin Capsicum (Pepper Spray) Canisters for Chemical Content and Reliability



A program to characterize the chemical compositions and the physical characteristics of pepper spray products has been established in the Organic Analytical Methods Group at the request of the NIST Office of Law Enforcement Standards (OLES) and with funding from the National Institute of

Justice. A variety of products representing a cross section of those used by law enforcement agencies have been selected for study. The identities and concentrations of the active ingredients are determined by liquid chromatography/electrospray mass spectrometry and the identities of carriers and propellants by gas chromatography. Physical testing includes measurement of the number of 1-second bursts in a canister, a range test, a spray pattern test, drop tests, and, for the products that produce fogs, the droplet size. Improved analytical methods have been developed for the determination of the active ingredients.

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Pepper spray is used by law enforcement officers to subdue non-cooperative individuals. It is effective 85% to 90% of the time, and its use reduces the number of injuries to officers and suspects, and the number of use-of-force complaints. The causes of failures have not been established, but may include low concentrations of the active ingredients, poor delivery, and variable subject response. The goal of this study is the determination of the identities and concentrations of the ingredients and the mechanical performance of pepper spray units to establish potential modes of failure and hazards in handling.

An improved liquid chromatographic (LC) separation for eight naturally occurring capsaicinoids, the active ingredients in pepper spray, and two internal standards, N-vanillyl octanamide and decanamide, has been developed. Satisfactory quantitative results have been demonstrated for the measurement of the analytes in mixtures with positive ion atmospheric pressure ionization electrospray mass spectrometry (API-ES-MS) for detection. Authentic samples of the compounds have been purchased or synthesized and their purity determined. The analytical method has been tested on several naturally occurring capsaicin mixtures and on pepper sprays.

New instrumentation has been developed to support this effort. A test chamber has been constructed for physical

testing. Semi-automated devices have been fabricated and tested for determining canister spray capacity, for performing pattern and range tests, and for performing drop tests. Environmental chambers have been constructed for storage of canisters under controlled conditions. Phase Doppler interferometry instrumentation has been set up to measure particle sizes near the point of impact within the test chamber.

Tests have been performed on several canisters that have failed in actual field use. The composition of one such



canister, reported to have caused injuries during a training exercise, was characterized by API-ES-MS. The spray was consistent with a synthetic (rather than natural) product, and the total level of active constituents was comparable to sprays formulated with natural pepper extracts.

A second canister reported to have failed during use was found to exhibit a weak spray pattern that was not centered in the direction in which the canister was aimed.

Chemical and physical measurements are in progress for approximately 1000 canisters. The resulting data are expected to provide indications of the presence/absence of design flaws or manufacturing defects that might lead to failures. The facility and capabilities will be made available to assist in determining the likely causes of future reported failures.

Impact: A reliable set of quantitative chemical and physical measurements on a representative set of canisters is expected to provide a basis for determining the most likely causes of failures in the field and to provide a benchmark against which manufacturers can assess the performance of their products.

Future Plans: New tasks have been funded by OLES to continue this effort. This work will focus on 1) improvement of the reproducibility and accuracy of the range and pattern tests, 2) development of a product testing protocol standard for pepper sprays, and 3) preparation of a Standard Reference Material suitable for use in the chemical analysis of commercial pepper sprays.