TESTING FOR MOSQUITO REPELLENT RESIDUES

High-quality reference materials advance analysis, save time and reduce cost.

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Abstract

Residues of mosquito repellent left on consumable foodstuff and other products pose a potential health and environmental risk. Repellents containing *N,N*-Diethyl-3-methylbenzamide (DEET) reportedly have adverse effects on non-target organisms, and may be unsafe for use by pregnant women and children.

The Liquid Chromatography-Mass Spectrometry (LC-MS) analytical technique is commonly employed for testing procedures involving pesticides and residues of insect repellents in food commodities. Honeywell Fluka™ Analytical Standards are appropriate for quantification in LC-MS applications where deuterated standards (e.g., the mosquito repellent DEET-d) are used. Their high deuteration grade and assay provide reliable and accurate results, which is important for legal defensibility and reproducibility.

In addition to providing comprehensive technical documentation to characterize its Fluka reference materials, including a detailed Certificate of Analysis (CoA), Honeywell offers technical support from experts who have been developing, producing and testing standards for decades. Customers have a direct line to laboratory specialists with extensive experience in the analysis of pesticides, insect repellents and other related compounds.

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Figure 1: Cases of mosquito-born virus diseases have led to the increased use of repellents for protection.

Introduction

Insect-borne diseases are a global health problem, especially in tropical and subtropical climates. Mosquitoes transmit many diseases, ranging from yellow fever and malaria, to several forms of encephalitis and filariasis. For example, malaria has been estimated to kill three million people each year, including over one million children.

Despite intense pressures to eliminate the use of public health insecticides, the U.S. Centers for Disease Control and Prevention (CDC), World Health Organization (WHO) and other public health agencies agree that mosquitocides should remain available for disease prevention.

The increasing cases of mosquito-born viruses have caused many people to use repellents to try to protect themselves from the Aedes Aegypt mosquito that transmits these diseases. There are a variety of products that have different ingredients, concentration, times of action and prices. However, not all repellants can be used by children and pregnant women, and in some cases, medical guidance is required.

Risks with Mosquito Repellents

Insect repellents are organic chemicals whose function is to prevent the ability of mosquitoes and other insects to land on a surface. These compounds have been found in the environment and may pose a risk to non-target organisms.

Classified as cosmetics, the most commonly used and effective mosquito repellents contain *N*,*N*-diethyl-3-methylbenzamide (DEET), ethyl 3-(*N*-acetyl-*N*-butylamino) propionate. Icaridin (Picaridin) or oil of lemon eucalyptus(containing *p*-menthane-3,8-diol, PMD) as active ingredients.

United States Department of Agriculture (USDA) chemists created DEET in the 1940s for use by the US military. It has been commercially available since 1957 and has become commonplace.
A slightly yellow liquid at room temperature, DEET can be prepared by converting *m*-toluic acid (3-ethylbenzoic acid) to the corresponding acyl chloride using thionyl chloride ($SOCl_2$), and then allowing that product to react with diethylamine.[1][2]

Although DEET is a readily available and frequently used mosquito repellent, it has been reported to have adverse effects, with some being severe enough to cause sensory disturbances and affect motor capacity, memory, and learning ability[3–9]. In addition, DEET is not recommended for children because high concentrations of the substance can cause encephalopathy and other side effects[10, 11].

In Germany DEET residues are regularly reported in some raw food commodities such as chanterelles, blueberries, herbal infusions and spices. Generally, DEET is not applied to crops before harvest, or during storage or transport of harvested plant products. As the affected foods are handpicked and DEET is commonly used in insect repellent, it can reasonably be assumed that DEET may be transferred from treated skin/hands to food during handling.

There are several official methods recommended by government agencies to monitor the contamination level of DEET in environmental samples and various types of foodstuff. To date, 16 DEET-containing insect repellents have been authorized in Germany in the framework of the Biocidal Product Regulation (EU) 528/2012.[12]

Common Analytical Techniques

The combined technique of Mass Spectrometry (MS) and High Performance Liquid Chromatography (HPLC) is commonly known as Liquid Chromatography-Mass Spectrometry (LC-MS). Pairing these two analytical methods reduces experimental error and improves accuracy in critical testing procedures such as those involving pesticides and residues of insect repellents in food commodities.

Chromatographers have found that LC-MS is an effective technique that can precisely determine the identities and concentration of compounds within laboratory samples. Surpassing many traditional technologies, it delivers analytical speed, sensitivity, and selectivity for a variety of applications in pharmaceuticals, food and beverage, and related industries.

With continual improvement in instrumentation design and quality control, analytical testing labs have been able to apply LC-MS techniques for purposes such as mosquito repellent residue screening. Such technology leverages the advantages of both LC and MS (e.g., simultaneous separation and detection of various classes of compounds) and makes it possible to minimize sample preparation and analysis times by employing multi-residue screening.

Use of Reference Materials

A reference material is a sample or substance whose property value is sufficiently homogeneous and well established for use in calibration of an apparatus, assessment of a measured method, and for assigning values to materials in analytical testing.

With many laboratories developing methods to analyze for multiple analytes within a sample rather than searching for residuals individually, demand for suitable reference materials is increasing.

Experience has shown that the combination of a high-purity solvent solution and a well-characterized reference material can lessen the risk of a pharmaceutical or food and beverage company releasing a product to the marketplace that doesn't have the proper purity and identity.

In the case of mosquitocides and other insect repellents, the use of reference materials is not only mandatory to assure accuracy and precision in the analytical testing of repellent formulations, but also for the detection of residues in foodstuff and environmental samples.

Honeywell Fluka™ Standards

Honeywell Research Chemicals has formulated a portfolio of Fluka™ Analytical Standards that make it easier for laboratories to verify the safety of a wide range of products. These high-quality inorganic and organic reference materials have been a market leader for almost 30 years and are quantitatively tested to confirm their composition. Because the standards are developed and QC-tested in Honeywell's ISO 9001-accredited laboratory in Seelze, Germany, they also help satisfy audit and regulatory requirements.

Figure 2: Fluka Analytical Standards are appropriate for quantification in LC-MS applications where deuterated standards are commonly used.

Specific Fluka standards have been carefully developed to meet the needs of analytical chemists working in a host of different industries.

Honeywell recently launched over 500 Fluka-branded reference materials intended mainly for pharmaceutical, food and beverage, agricultural and petrochemical analyses. Many of the products are pesticides and drugs, including their metabolites and labeled compounds. Honeywell is continuously expanding its offering of high-purity reference materials and solutions.

Fluka Analytical Standards are appropriate for quantification in LC-MS applications where deuterated standards (e.g., the mosquito repellent DEET-d_{10}) are commonly used. These labeled compounds are not present in environmental, biological or other natural matrixes and are ideal as internal standards in mass spectrometry. Their high deuteration grade and assay provide reliable and accurate results, which is important for legal defensibility and reproducibility.

Availability of Custom Standards

All-too-often, quality control and analytical testing labs are faced with preparing their own in-house working standards. They take a standard from a recognized organization such as the National Institute of Standards and Technology (NIST) and then prepare their own standard solutions, which are traceable through the institute. Such an approach requires considerable effort on the lab's part, and does not provide a CoA from a qualified external standards provider. This documentation is especially important to pass audits intended to validate testing. Test results based on internally sourced working standards are generally scrutinized much more closely than results associated with an external standard.

Honeywell is one of the few suppliers worldwide with the knowledge, resources and flexibility to provide tailor-made standard solutions to the analytical marketplace. Unlike suppliers focused on providing catalog standards, Honeywell can develop custom standards to meet the customer's unique requirements.

Honeywell's broad analytical background and capabilities enable it to efficiently produce and test custom analytical standards for less than it would cost the customer to produce working standards in-house.

With all necessary facilities at one location, Honeywell can develop, test and manufacture tailor-made organic standards and multi-component solutions. Because these custom standards are guaranteed to have the correct specification and come with full documentation, laboratories can be certain their analysis is reliable and accurate.

Value of Product Documentation

Honeywell Fluka Analytical Standards are provided with comprehensive technical documentation. They come with a printed Certificate of Analysis (CoA) and are eligible for free expert technical support – ensuring analytical chemists have the information they need to quickly start an analysis and pass relevant audits.

The CoA describes quantitative analytical results related to the customer's test application. It also provides proof of identity for the product along with information about its structure and impurity profile.

Unlike other standards suppliers, Honeywell identifies the analytical method on its CoA. This information helps customers understand and track the specific techniques employed to obtain analytical results. Honeywell also includes specific details about identity test measurements so laboratory chemists can be sure they are using the right substance for a particular test. They also gain confidence that they have chosen a product with the right impurity profile to meet their needs.

Additional Honeywell documentation includes a safety data sheet prepared according to strict compliance guidelines with valuable information about possible product hazards. In addition, a label is provided in a consistent format for all analytical products in the company's portfolio. It has important details such as lot number, physical properties, and contact and hazard information.

Honeywell's detailed CoA illustrates its technical competence. Every certificate includes:

- Contact and technical support details
- Expiration date
- Product number, name and batch
- General product information
- Lot-specific analytical results
- Purity test by HPLC, GC, LC-MS, GC-MS and Titration
- Identity test by NMR, FT-IR or Mass Spectrometry

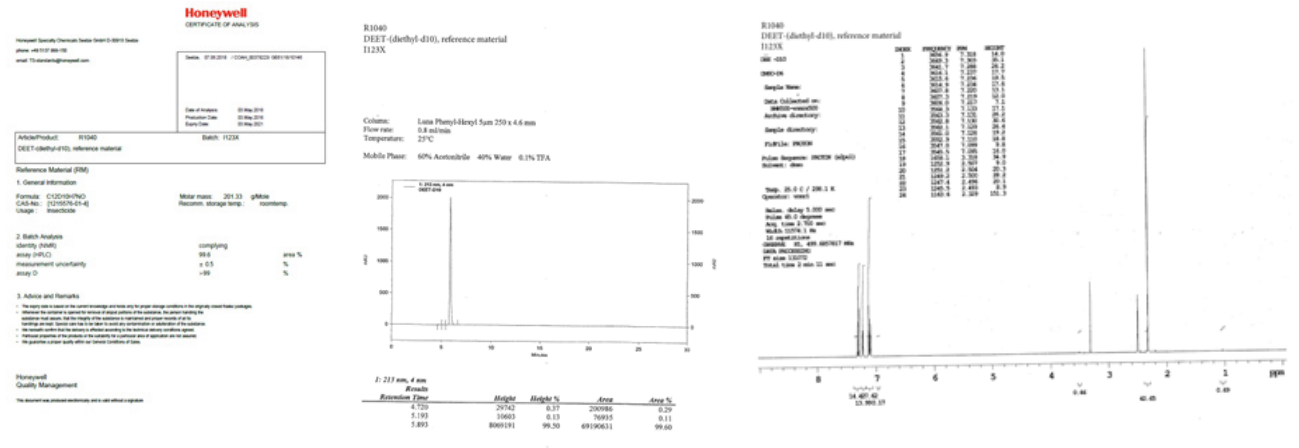
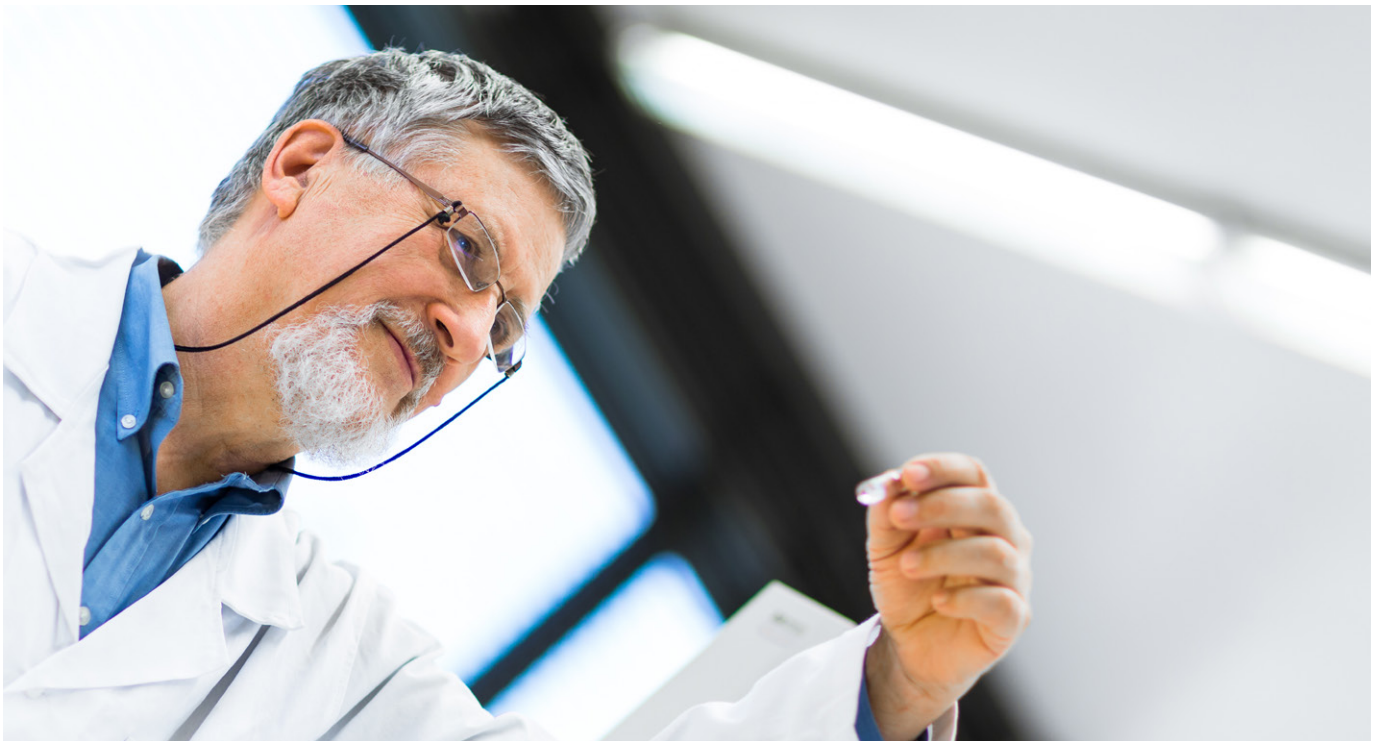


Figure 3: Example CoA of DEET-d^{10} (R1040-10MG), including purity and identity test results.

Benefits of Technical Support



Whereas other major suppliers offer a generalized technical support capability covering everything from serums to solvents, Honeywell provides expert support services focused exclusively on analytical standards.

For critical questions not addressed by product documentation, Honeywell provides technical support from specialists who have been developing, producing and testing standards for decades, ensuring customers get timely, effective help with application questions, and potentially reducing significant costs and saving hours of lab work.

If a customer has a technical issue such as product solubility, they can consult directly with a knowledgeable standards expert to address the problem, conduct internal testing, and find a suitable solution.

The Honeywell laboratory support team has extensive experience in the analysis of pesticides, insect repellents and other related compounds.

Dedicated technical support is offered for all types of standards, to help solve queries related to:

- **SOLUBILITY ISSUES**
- **ANALYTICAL METHODS**
- **APPEARANCE AND FORM**
- **ADDITIONAL TEST PARAMETERS**
- **CHEMICAL STRUCTURE**
- **HANDLING ISSUES**
- **SOURCING REQUESTS**

Honeywell can solve the majority of customer product inquiries after one email or telephone call. More complex application troubleshooting is normally resolved within five working days.

Conclusion

Residues of mosquito repellent left on consumable foodstuff and other products pose potential health and environmental risks. Effective analytical tools are needed to test for these compounds and help companies ensure the purity, identity and safety of their products.

Honeywell Research Chemicals provides well-known Fluka branded analytical standards for demanding analytical applications in pharmaceuticals, food and beverage, and other industries.

Honeywell's high-quality reference materials are designed to advance analysis, save time, and reduce cost. They are recognized for their high quality, exceptional purity, and ability to enable the most accurate test results.

Honeywell also provides complete technical documentation with its reference materials, and maintains a dedicated team of analytical experts offering unmatched flexibility and expertise in standards customization.

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