Application Note AN-RS-026

Trace Detection of Diphenylamine in Baby Food

Protecting consumer safety with Misa

Diphenylamine (DPA) is used as a dye fixative and antioxidant in industrial applications and as a produce preservative in agricultural operations. Despite its low toxicity to humans and the environment, there is controversy about its application on fruits and vegetables post-harvest to ensure long-term storage. Food safety advocates are concerned that daily ingestion of DPA, particularly in foods meant for babies, could have negative effects on children's health. To mitigate potentially toxic effects of DPA, both the US and EU stipulate a maximum residue limit (MRL) of 5 µg/g for whole pears and a stringent MRL of 10 ng/g for all processed baby foods.

Misa (Metrohm Instant SERS Analyzer) provides a user-friendly and cost-effective alternative to traditional analytical methods used for detecting DPA in foods, such as GC-MS and GC-NPD. With Misa, trace level detection of DPA in infant food is achieved quickly and easily in a format that is easily adapted to diverse sample matrices.

INTRODUCTION

This application note describes a simulated test procedure for detecting DPA in pureed pears marketed as food for infants. The assay is based on the acquisition of SERS-specific spectra for diphenylamine in chloroform extracts using Misa and gold nanoparticles (Au NPs).

REFERENCE MATERIAL AND LIBRARY CREATION

To establish a reference spectrum, a pure DPA standard (100 µg/g in ethanol) was analyzed using Au NPs. The unique SERS spectrum shown in Figure 1 can be used to create a library entry for DPA.

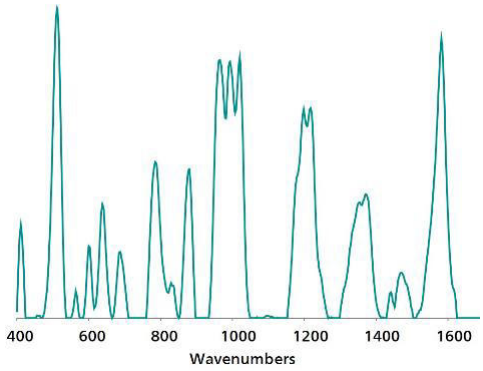

Figure 1. Standard gold nanoparticle SERS reference spectrum of diphenylamine.

EXPERIMENT

Serial dilutions of a stock solution of DPA in ethanol were spiked into purchased pureed pears sold as baby food to provide a range of test samples: 100, 50, 25, 10, 5, 2.5, and 1 µg/g. Samples were mixed with a vortex, then 0.5 mL chloroform was added, and samples were mixed again for 1 minute. After allowing phase separation for 10 minutes, 100 µL of the bottom chloroform layer was siphoned with a pipette and transferred to a glass vial for evaporative heating. The extract residue was suspended in 450 µL of Au NPs and 50 µL of 0.5 mol/L NaCl. Each vial was vigorously shaken and immediately placed into the vial attachment on Misa for measurement.

Table 1. Experimental parameters

Instrument		Acquisition	
Firmware	0.9.33	Laser Power	5
Software	Misa Cal V1.0.15	Int. Time	5 s
Misa Vial Attachment	6.07505.040	Averages	10
ID Kit - Au NP	6.07506.440	Raster	ON

RESULTS

Overlaid of baseline-corrected spectra acquired for each tested concentration shows high-resolution DPA detection down to 1 µg/g (Figure 2).

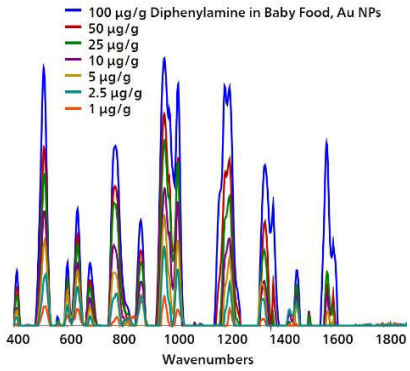

Figure 2. Gold NP SERS spectral profile for diphenylamine in pureed pears, demonstrating detection down to 1 µg/g.

FIELD TEST PROTOCOL

Detection of diphenylamine in the field

Add baby food to glass vial until approximately 1/4 full. Using a pipette, add chloroform to the same vial until halfway full. Shake mixture vigorously for 1 minute, and then rest for 10 minutes to permit separation. Using a pipette, carefully remove half of the *bottom layer*, avoiding the top layer. Transfer this solution into a *clean glass vial* and heat until dry on a hotplate (5 minutes). Using clean pipettes, add Au NPs to vial until halfway full, then add 2 drops of NaCl solution. Cap vial and shake to mix, then allow to rest for 5 minutes before inserting into the vial attachment on Misa for testing.

Table 2. Requirements for field test protocol

ID Kit - Au NP	6.07506.440
includes:	Gold nanoparticles (Au NP)
	Scoop
	Disposable pipettes
	2 mL glass vials
Reagents	
Chloroform	
NaCl solution	3 g NaCl in 100 mL water
Test settings	Use ID Kit OP on MISA

CONCLUSION

With successful, sensitive detection of diphenylamine in baby food, Misa is demonstrated to be a reliable QC tool for monitoring food safety, especially safeguarding the health of children. Misa is a portable and fully contained system, ideal for on-site testing and uniquely tailored for operation in a wide range of different environments.

Additionally, operators in postharvest produce treatment facilities who are at risk of high-level occupational exposure, for instance, would benefit greatly from a mobile monitoring system for such chemical hazards.

CONTACT

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CONFIGURATION

MISA Advanced

Metrohm Instant SERS Analyzer (MISA) is a high performance, portable analyzer system used for rapid, trace level detection / identification of illicit materials, food additives and food contaminants. MISA features a high-efficiency spectrograph equipped with Metrohm's unique Orbital-Raster-Scan (ORS) technology. It has a minimal footprint and extended battery life, perfect for on-site testing or mobile laboratory applications. MISA offers various Laser Class 1 attachments for flexible sampling options. Analyzer operation is available through BlueTooth or USB connectivity.

The MISA Advanced package is a complete package that allows the user to perform SERS analyses using Metrohm's nanoparticle solutions and P-SERS strips.

The MISA Advanced package includes a MISA Vial Attachment, a P-SERS Attachment, a ASTM Calibration Standard, a USB Mini Cable, a USB Power Supply and MISA Cal software for operating the MISA instrument. A ruggedized protective case is also provided to securely store the instrument and accessories.

ID Kit – Au NP

The ID Kit - Au NP contains the components a Mira / Misa user requires to perform a SERS analysis using gold colloidal solution. The kit contains a disposable spatula, dropper, sample vials and a bottle of gold colloid.