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Sess-442

Analysis of Heavy Metals in Baby Food Using ICP-MS

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1. Introduction

- Babies are more vulnerable to the effects of toxic metals, and baby food therefore requires careful testing.
- US and EU regulations[1)–3)] set limits for toxic metals in baby food.
- This study analyzed five baby foods using the ICPMS-2040/2050 (Fig. 1) and evaluated spike recovery and long-term stability.

2. Sample

- Infant Formula
- Rice Cereal
- Strained Corn
- Strained Pumpkin and Sweet Potato
- Apple Jelly

Fig. 1 ICPMS-2040/2050

3. Sample Preparation

The sample preparation procedure is shown in Fig. 2.

I. Add ~0.5 g sample, 4 mL nitric acid, 1 mL hydrogen peroxide, and 0.5 mL hydrochloric acid to each vessel. Add target element standards to some samples for recovery tests.

II. Heat in a microwave digestion system at 200 °C for 20 minutes.

III. Cool to room temperature, then dilute to 25 mL with pure water (50-fold dilution).

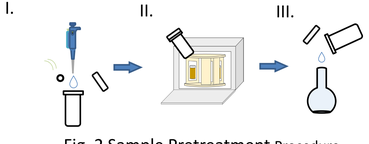
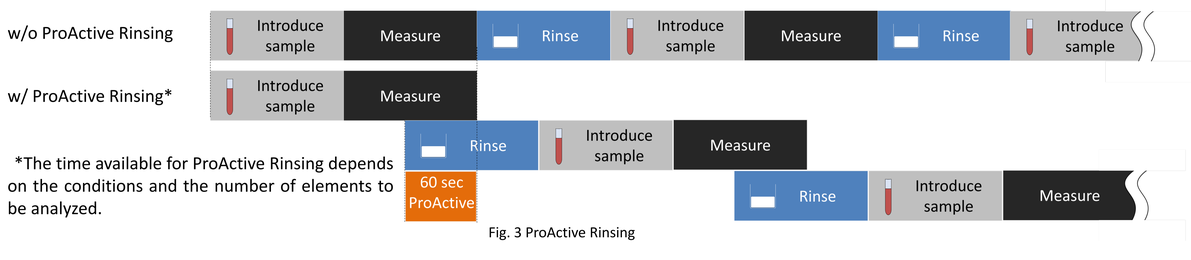


Fig. 2 Sample Pretreatment Procedure



*The time available for ProActive Rinsing depends on the conditions and the number of elements to be analyzed.

Fig. 3 ProActive Rinsing

4. Analysis Conditions

- Analysis conditions are shown in Table 1. Two rinse solutions were used: pure water (Rinse 1) and an acid solution (Rinse 2). LabSolutions™ ICPMS applies Rinse 2 only after high-concentration samples, reducing carryover.
- As shown in Table 2, the addition of Rinse 2 for 240 s significantly reduced carryover. For Se and Hg, carryover was reduced to below the detection limit.
- To minimize time spent cleaning the sample introduction system, ProActive Rinsing was used (Fig. 3). Starting the rinse during measurement shortens the total analysis time for multiple samples.

Table 1 Analysis Conditions

RF Power:	1.20 kW
Sampling Depth:	5 mm
Pump Speed:	15 rpm
Plasma Gas Flow Rate:	9.0 L/min
Auxiliary Gas Flow Rate:	1.10 L/min
Carrier Gas Flow Rate:	0.45 L/min
Dilution Gas Flow Rate:	0.40 L/min
Rinse Solution 1	Pure water
Rinse Solution 2	HNO_3 8 % v/v, HCl 2 % v/v

Table 2 Effect of Rinse Solution 2 on Carryover

Element	Cell condition	IDL (µg/L)	Without Rinse 2 (µg/L)	With Rinse 2 (µg/L)
^{78}Se	He	0.01	0.12	<
^{202}Hg	He	0.0006	0.001	<

<: below the limit of detection

5. Quantitative Analysis and Spike Recovery Test

- Thirteen elements, including regulated As, Cd, Pb, Hg, Ni, and Sn, were analyzed in five baby foods with different matrices. The results are shown in Fig. 4 and Table 3.
- To evaluate the impact of the matrix on the analysis values, spike recovery tests were conducted. Recovery rates of 88–110% for all samples and elements were obtained, indicating that the impact of the sample matrix on the analytical results was sufficiently minimized. This result falls within the FDA EAM 4.7 range of 80–120%.
- Fig. 5 shows the regulatory limits and detection limits; the method provided sufficient sensitivity even for the strictest iAs limit under the Baby Food Safety Act 2021.

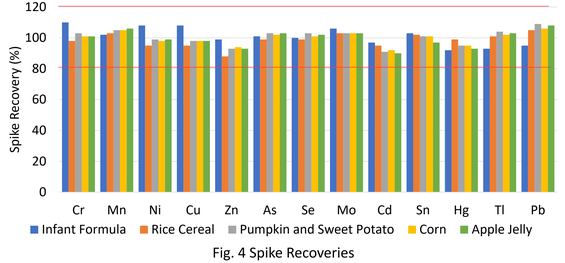


Fig. 4 Spike Recoveries

Table 3 Results of Baby Food Analysis

Element	Cell gas	ISTD	IDL (µg/kg)	Quantitative Results in the Sample (µg/kg)				
				Infant Formula	Rice Cereal	Pumpkin and Sweet Potato	Corn	Apple Jelly
^{52}Cr	He	^{71}Ga	1	33	171	6	9	15
^{55}Mn	He	^{71}Ga	0.2	379	9500	422	881	168
^{60}Ni	He	^{71}Ga	1	9	123	10	23	13
^{65}Cu	He	^{71}Ga	0.2	3620	2190	238	247	128
^{66}Zn	He	^{71}Ga	2	33000	74500	1100	2800	90
$^{75}As^{*1}$	He	^{128}Te	0.2	5.4	110	1.3	0.9	3.3
^{78}Se	He	^{128}Te	0.5	91.5	130	<	<	<
^{95}Mo	He	^{71}Ga	0.2	54.0	654	39.5	18.5	3.8
^{111}Cd	He	^{71}Ga	0.1	5.9	7.5	1.8	1.1	1.0
^{118}Sn	He	^{71}Ga	0.4	1.9	2.7	1.6	6.5	99.9
^{202}Hg	He	^{193}Ir	0.03	<	1.49	<	<	0.26
^{205}Tl	He	^{193}Ir	0.1	0.4	0.4	2.5	0.6	0.8
^{Sum}Pb	He	^{193}Ir	0.05	3.30	0.90	0.90	1.50	2.55

*1: Total As

<: below the limit of detection

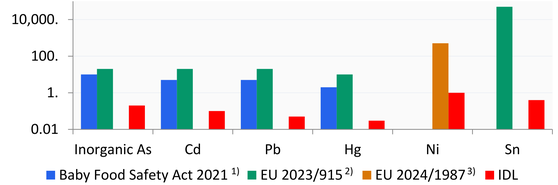


Fig. 5 Regulatory Values and Detection Limits

6. Long-Term Stability

- To evaluate long-term (~6 h) stability, 50 samples of infant formula, a high-matrix material, were analyzed continuously.
- Initial calibration verification (ICV), Continuing calibration verification (CCV), and Continuing calibration blank (CCB) results met the FDA EAM 4.7 requirements, and all CCB results were below enough.
- Fig. 6 shows that all ICV and CCV recoveries were within 90–110%.

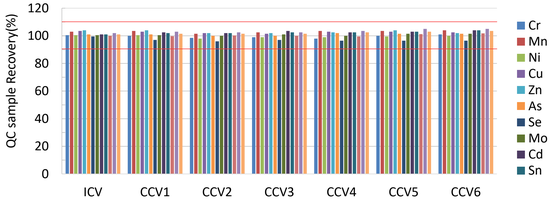


Fig. 6 ICV and CCV Recoveries

7. Conclusion

- Elemental analysis of baby food was conducted using ICP-MS.
- We achieved detection limits that met stringent standards. The spike recovery tests provided good results for all samples with different matrices, confirming the validity of the analysis. Additionally, we analyzed 50 samples of infant formula with a high matrix approximately six hours and confirmed good stability.

Reference

1) US House of Representatives, The Baby Food Safety Act of 2021, accessed Jan 2026
2) COMMISSION REGULATION (EU) 2023/915 of 25 April 2023 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006
3) COMMISSION REGULATION (EU) 2024/1987 of 30 July 2024 amending Regulation (EU) 2023/915 as regards maximum levels of nickel in certain foodstuffs