



Application Note AN-P-085

自然来源中监测碘

Superior method for iodide analysis by IC and amperometry

Dairy products are amongst the top three natural sources of iodine—the other two being seafood and eggs [1,2]. Iodine is an essential mineral for human health, where it is necessary for e.g., the production of thyroid hormones [1–3]. These hormones are especially important for brain and neural development in infancy. However, excessive intake of this trace element may also cause health issues [1–3]. Therefore monitoring iodine intake for humans as well as its content in natural sources are of major interest.

The presented method describes the

determination of free iodide in milk samples using **Metrohm Low Volume Inline Dialysis** for automated sample preparation prior to injection into an ion chromatograph (IC) and subsequent amperometric detection in direct current (DC) mode. An **automatic cleaning cycle** using a dedicated flexiPAD method was applied to guarantee continuous and reproducible results when using DC mode.

Inline Dialysis reduces the time required for manual sample preparation which helps increase sample throughput, labor efficiency, and repeatability via automation.

SAMPLES AND SAMPLE PREPARATION

Three different commercially available milk samples were analyzed for their iodide content. The milk

samples were manually diluted with ultrapure water with a dilution factor of 20 prior to analysis.

EXPERIMENTAL

Metrohm Low Volume Inline Dialysis was used as an automated sample preparation technique. The analyte of interest (i.e., iodide, I⁻) can pass through the dialysis membrane (0.2 m, cellulose acetate), whereas larger molecules (e.g., proteins and enzymes which are present in milk) cannot pass through and are transferred to the waste.

The Metrohm IC Amperometric Detector in DC mode was used for electrochemical detection of iodide. A silver working electrode was used in a thin layer cell

together with an Ag/AgCl reference electrode.

Historically, the detection of iodide with IC using DC mode has resulted in low reproducibility during longer sample series due to signal reduction caused by passivation of the working electrode over time. Thus, an additional flexiPAD method was developed for this situation and applied to automatically clean the working electrode after each determination to avoid electrode fouling. The reproducibility of the results is guaranteed, even for longer sample series.

RESULTS

Three different milk samples were analyzed for their iodide content (**Tables 1–3**). The natural iodide concentration in the samples ranged from below the detection limit of the method up to 141 g/L. A study with three different spiking concentrations was

performed for all three samples, where the recoveries were in the range of 94–107%.

Recovery values were calculated using the following formula:

$$R = \frac{[100 \cdot c_f]}{[c_u + c_a]}$$

R recovery [%]

c_f concentration of fortified sample [g/L]

c_u concentration of unfortified sample [g/L]

c_a concentration of analyte added to the sample [g/L]

Table 1. Results of the spiking study of organic whole milk. The sample was spiked with 50, 100, and 200 µg/L iodide.

Sample 1	I ⁻ concentration (g/L)	Recovery (%)
Natural [I ⁻]	141	—
Sample spiked with 50 g/L I ⁻	189	99
Sample spiked with 100 g/L I ⁻	251	104
Sample spiked with 200 g/L I ⁻	363	106

Table 2. Results of the spiking study of regular whole milk. The sample was spiked with 50, 100, and 200 µg/L iodide.

Sample 2	I ⁻ concentration (g/L)	Recovery (%)
Natural [I ⁻]	105	—
Sample spiked with 50 g/L I ⁻	157	101
Sample spiked with 100 g/L I ⁻	200	98
Sample spiked with 200 g/L I ⁻	304	100

Table 3. Results of the spiking study of another brand of organic whole milk. The sample was spiked with 50, 100, and 200 µg/L iodide.

Sample 3	I ⁻ concentration (g/L)	Recovery (%)
Natural [I ⁻]	<LOD	—
Sample spiked with 50 g/L I ⁻	78.4	107
Sample spiked with 100 g/L I ⁻	124	100
Sample spiked with 200 g/L I ⁻	210	94



Figure 1. Overlay of chromatograms from the spiking tests performed on Sample 2. Iodide analyses were performed with a 930 Compact IC Flex equipped with dialysis. Separation was performed on a Metrosep A Supp 17 - 150/4.0 column. Inlay: 1) The sample was measured and the natural iodide concentration was determined to be 105 µg/L. 2) The sample was spiked with 50 µg/L iodide and the determined concentration was 157 µg/L. 3) The sample was spiked with 100 µg/L iodide and the determined concentration was 200 µg/L. 4) The sample was spiked with 200 µg/L iodide and the determined concentration was 304 µg/L.

RESULTS

The limit of detection (LOD) for this method was determined according to the signal-to-noise ratio and also in accordance with DIN 32645. LOD was calculated as 36 g/L (S/N) and 27 g/L (DIN 32465),

$$LOD = \frac{CONC}{\frac{HGT}{3 \cdot Noise}}$$

respectively.

The following formula was used for the calculation of the LOD according to the signal-to-noise ratio:

LOD Limit of detection [g/L]
 CONC Analyte concentration [g/L]
 HGT Height of the analyte [nA]
 Noise Noise of the determination [nA]

CONCLUSION

This IC method offers a straightforward, fast, and sensitive solution for reproducible analysis of the iodide concentration in milk. The utilization of an automated cleaning method for the working electrode reduces electrode fouling and increases

sample throughput without any additional manual work. Low Volume Inline Dialysis enables automatic sample preparation, increasing the overall method efficiency and costs.

REFERENCES

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2. van der Reijden, O. L.; Zimmermann, M. B.; Galetti, V. Iodine in Dairy Milk: Sources, Concentrations and Importance to Human Health. *Best Pract Res Clin Endocrinol Metab* **2017**, 31 (4), 385–395.
3. Gunnarsdottir, I.; Dahl, L. Iodine Intake in Human Nutrition: A Systematic Literature Review. *Food & Nutrition Research* **2012**.

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CONFIGURATION



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858 Professional Sample Processor 2



858 Professional Sample Processor – Pump
858 Professional Sample Processor – Pump 500 L
500 mL , 800 Dosino



Metrosep A Supp 17 - 150/4.0

Metrosep A Supp 17 - 150/4.0 , 1.4 mL/min

Metrosep A-Supp-17