



## Application Note AN-P-085

# Iodine monitoring in natural sources

## 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<sup>-</sup>) can pass through the dialysis membrane (0.2 μm, 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 μg/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 recovery [%]

c<sub>f</sub> concentration of fortified sample [μg/L]

c<sub>u</sub> concentration of unfortified sample [μg/L]

c<sub>a</sub> concentration of analyte added to the sample [μg/L]

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

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

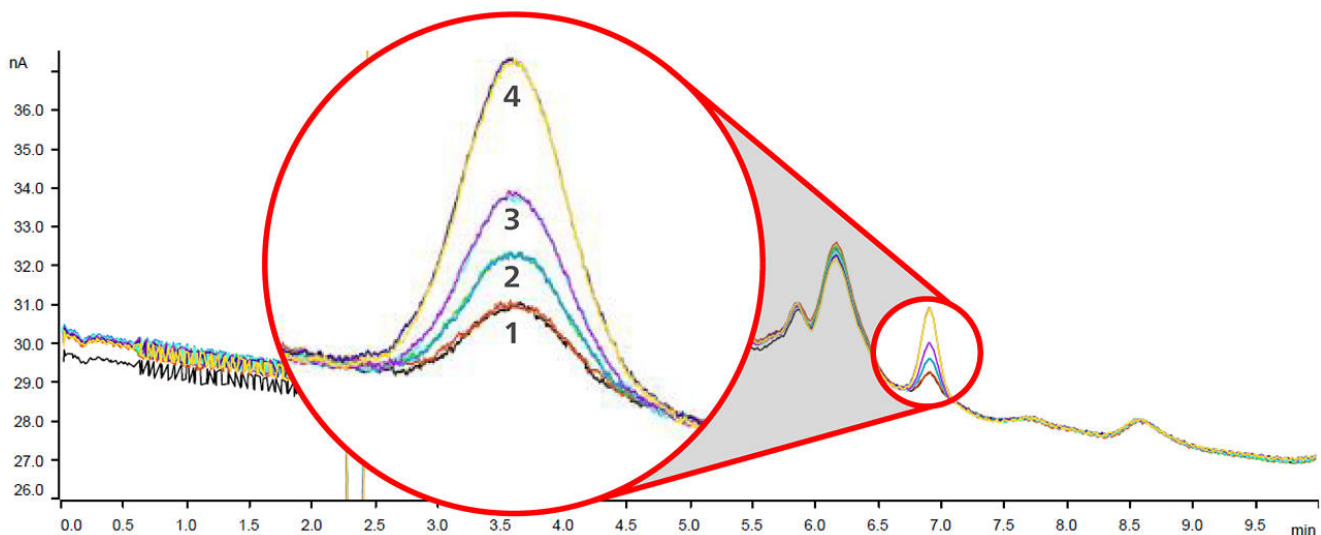
Sample 1	I <sup>-</sup> concentration (µg/L)	Recovery (%)
Natural [I <sup>-</sup> ]	141	–
Sample spiked with 50 µg/L I <sup>-</sup>	189	99
Sample spiked with 100 µg/L I <sup>-</sup>	251	104
Sample spiked with 200 µg/L I <sup>-</sup>	363	106

**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 <sup>-</sup> concentration (µg/L)	Recovery (%)
Natural [I <sup>-</sup> ]	105	–
Sample spiked with 50 µg/L I <sup>-</sup>	157	101
Sample spiked with 100 µg/L I <sup>-</sup>	200	98
Sample spiked with 200 µg/L I <sup>-</sup>	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 <sup>-</sup> concentration (µg/L)	Recovery (%)
Natural [I <sup>-</sup> ]	<LOD	–
Sample spiked with 50 µg/L I <sup>-</sup>	78.4	107
Sample spiked with 100 µg/L I <sup>-</sup>	124	100
Sample spiked with 200 µg/L I <sup>-</sup>	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.

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 µg/L (S/N) and 27

µg/L (DIN 32465), respectively.

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

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

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

## 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

1. Sakai, N.; Esho, O. Y.; Mukai, M. Iodine Concentrations in Conventional and Organic Milk in the Northeastern U.S. *Dairy* **2022**, *3* (2), 211–219.
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**.

Internal reference: AW IC CH6-1428-102020

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## CONFIGURATION



### IC: Low Volume

高速インライン透析のための付属品セット。858 Professional Sample Processorおよび追加の2チャンネルタイプのヘリスタリックポンプとの使用に。



### 858 Professional Sample Processor – Pump

858 フロフェッショナルサンプルプロセッサ - ホンプは、500  $\mu\text{L}$ から500 mLまでのサンプルを処理します。サンプルは内蔵式双方向性の2チャンネルのヘリスタリックホンプまたは800 トシーノ電動ヒュレットによって転送されます。



### Metrosep A Supp 17 - 150/4.0

分離カラムMetrosep A Supp 17 - 150/4.0 は、環境温度において高い分離性能と短い分離時間を要する陰イオン測定で選択されるカラムです。更に1.4 mL/minという最高流量により、測定を最適化することかてきます。Metrosep A-Supp-17カラムは、そのコストパフォーマンスの高さで際立っています。