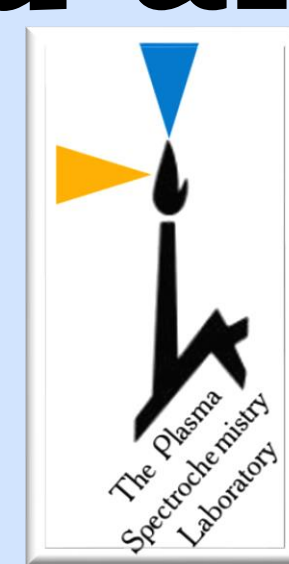


Determination of total iodine using ICP-MS in Israeli bottled and tap water: method development and application

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Introduction

- Desalination plants provide about 80% of the potable water used in households across Israel.
- The risk-reducing concentration of total I in drinking water is, according to the literature, 5 – 50 µg I L⁻¹.
- ICP-MS is a sensitive and high-throughput method, but iodine should be determined in alkali matrices because of volatility and memory effect problems. ICP technique faces a challenge from the alkali matrix.
- The problem with ICP-MS analysis of water samples at pH > 10 is the possible precipitation of Ca and Mg carbonates and, hence, the nebulizer clogging. To control the content of total I in drinking water, improvement of the ICP-MS method is required.

Materials and Methods

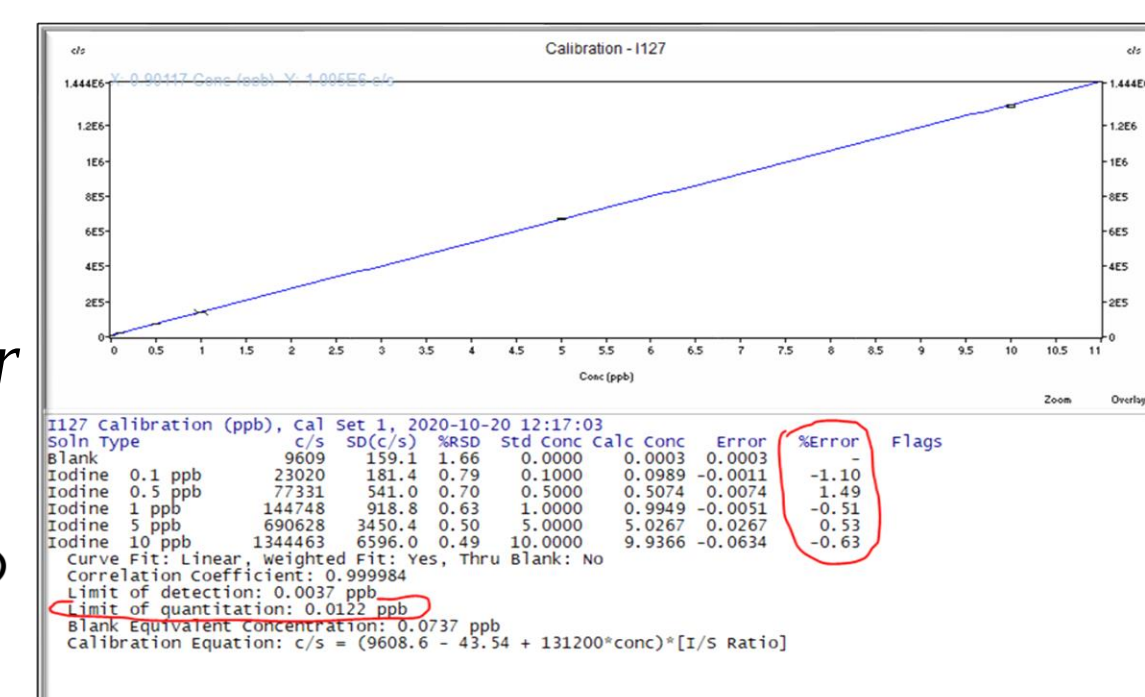
A PlasmaQuant Elite ICP-MS spectrometer (Analytik Jena, Germany) was used for the determination of iodine concentrations in mineral water samples using No Gas mode. Internal standard ⁷²Ge was used at 10 µg L⁻¹. The internal standard solution was prepared with the following matrix: 2% NH₄OH, 0.1% EDTA, and 0.01% Triton X-100 (w/w). Triton X-100 was used as a washing agent to reduce memory effect. The HR dual-view ICP-OES PQ9000 (Analytik Jena), equipped with concentric nebulizer and cyclonic spray chamber, was used for Ca and Mg concentration measurements.



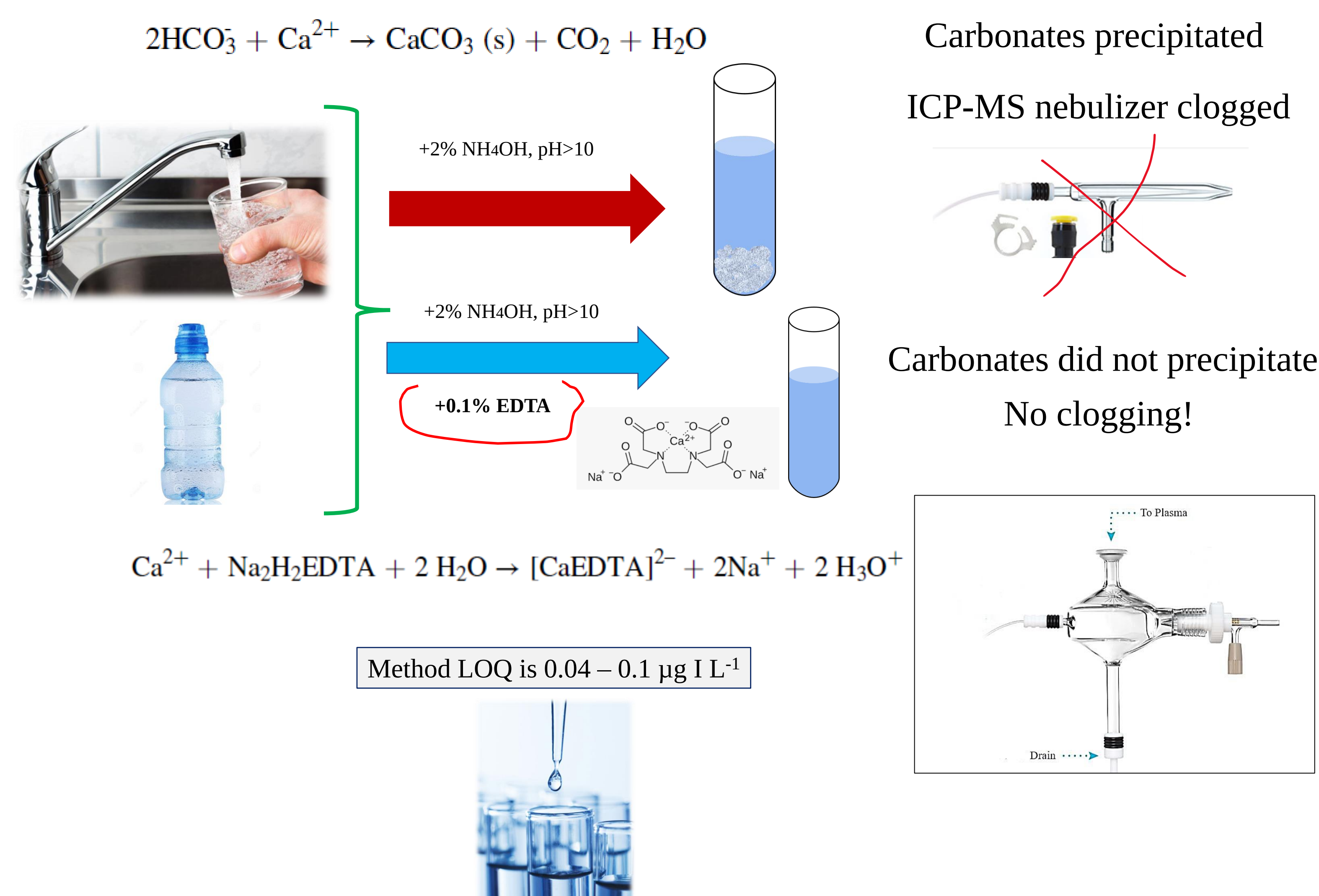
Determination of the pH for waters characterization was performed with a 905 Titrando (Metrohm) instrument, equipped with a combined pH electrode (Unitrode, Metrohm Company).

pH paper strips were used for routine approximate control of pH in the water samples.

ICP-MS calibration for ¹²⁷I isotope



Method Development



Does the chelating agent really work? Let's corroborate:

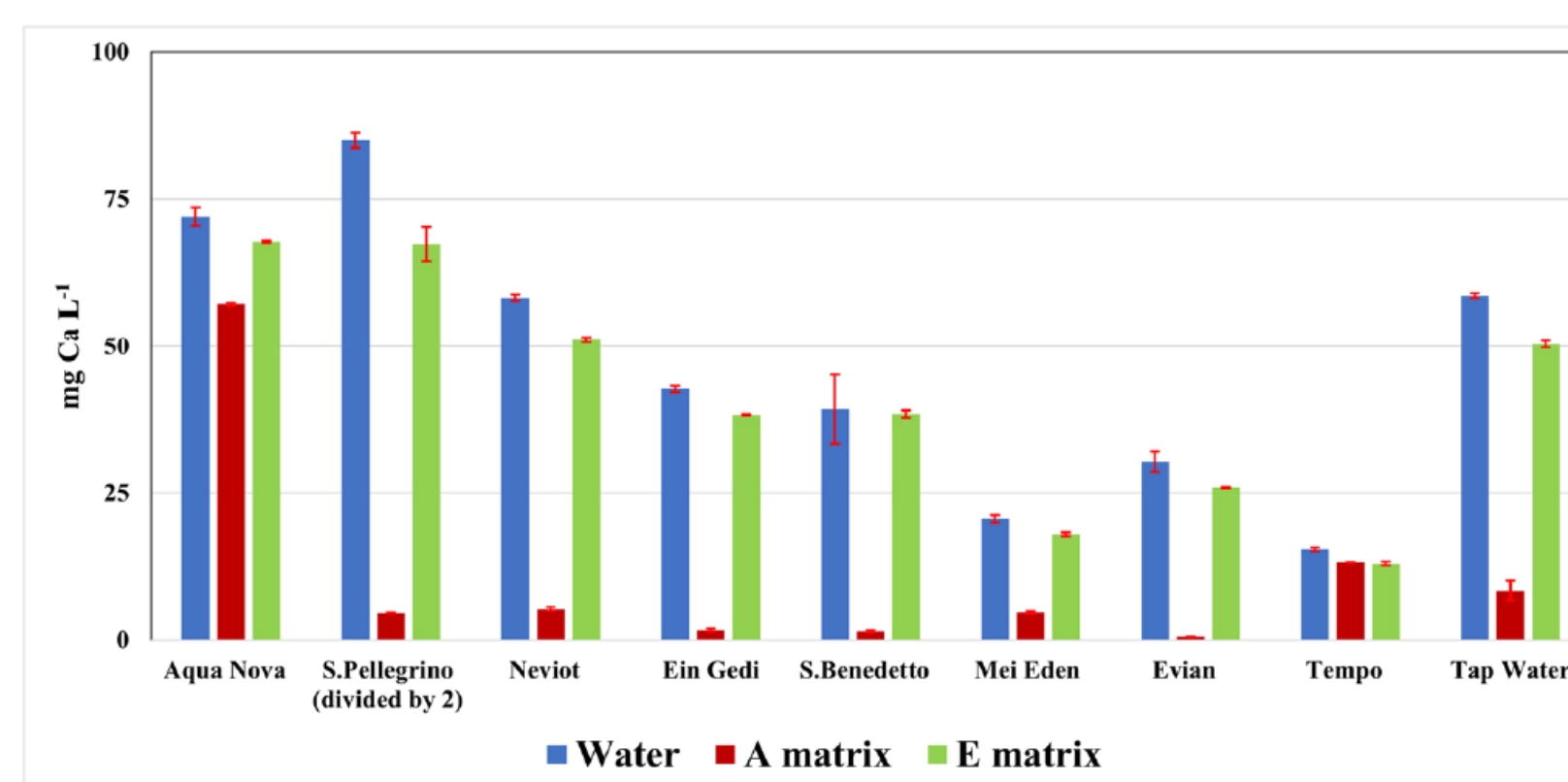


Fig. 1. Calcium concentrations in W, A and E matrices.

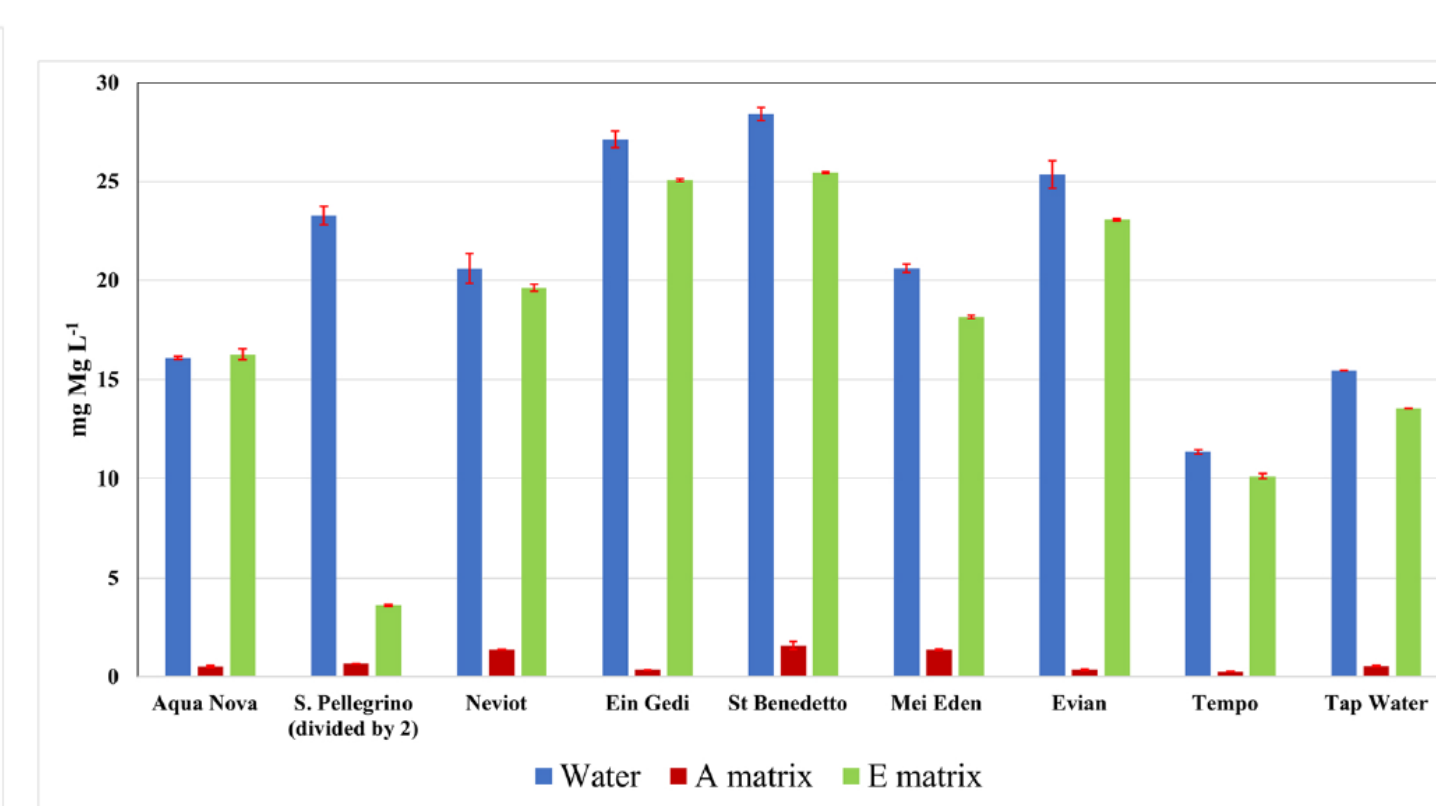
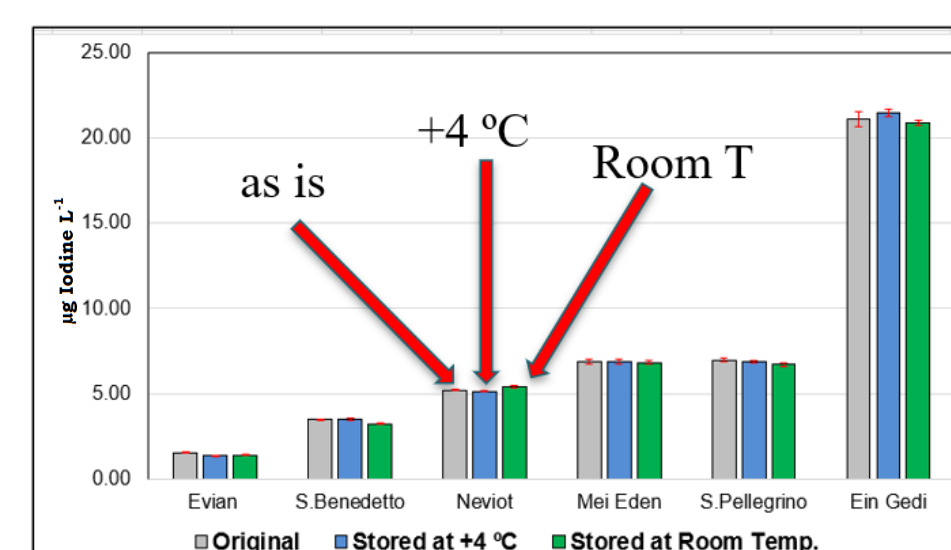


Fig. 2. Magnesium concentrations in W, A and E matrices.

What We Did: Water – samples “as is”, A matrix – Ammonia 2%, E matrix – 2% NH₄OH+0.1% EDTA. Water samples were diluted 2 times with A and E matrices, incubated overnight, filtered, then analyzed by ICP-OES for Ca and Mg content.

What We Found: For Ca concentrations, Tukey–Kramer test showed a significant difference between pairs W–A and A–E, but not between W–E. Thus, addition of EDTA prevented the formation of insoluble CaCO₃. A decrease of about 10% Ca concentration was observed in matrix E, which could also be attributed to analysis uncertainty due to the difference between W and E matrices (high pH and EDTA addition). In the sample of St. Pellegrino mineral water, the decrease in Ca concentration was even more pronounced, but note that the concentration of macrominerals in the San Pellegrino mineral water was about 2–3 times higher than in the other investigated samples, so, 0.1% EDTA was not enough for Ca+Mg in this sample. For Mg concentrations, One-way ANOVA and Tukey–Kramer test revealed differences between the three matrices for Mg that were similar to those found for Ca, but the calculations were performed without data from the San Pellegrino sample.



Drinking water samples may be stored for at least 2 weeks at either room temperature or +4 °C with no change in total iodine concentration.

EDTA addition did not affect the total iodine concentration in the alkaline matrix.

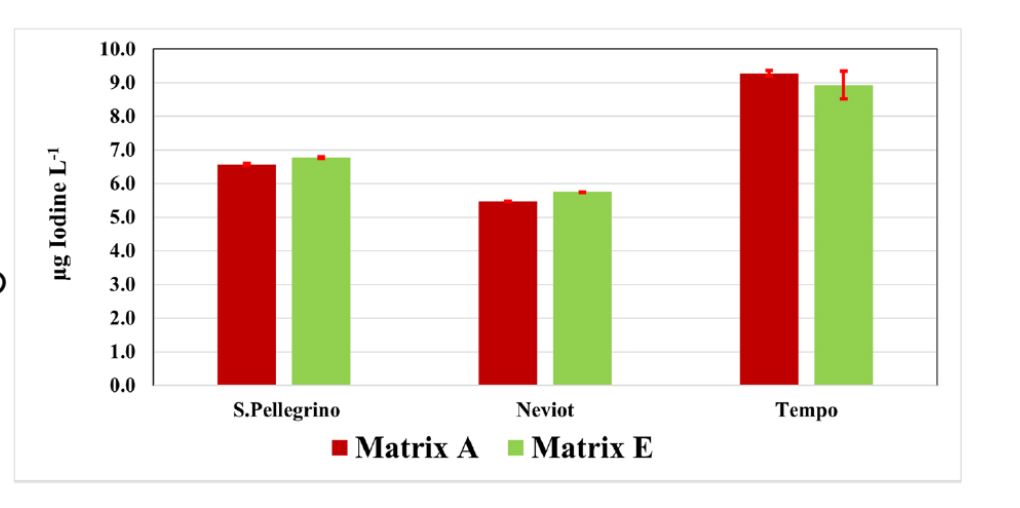
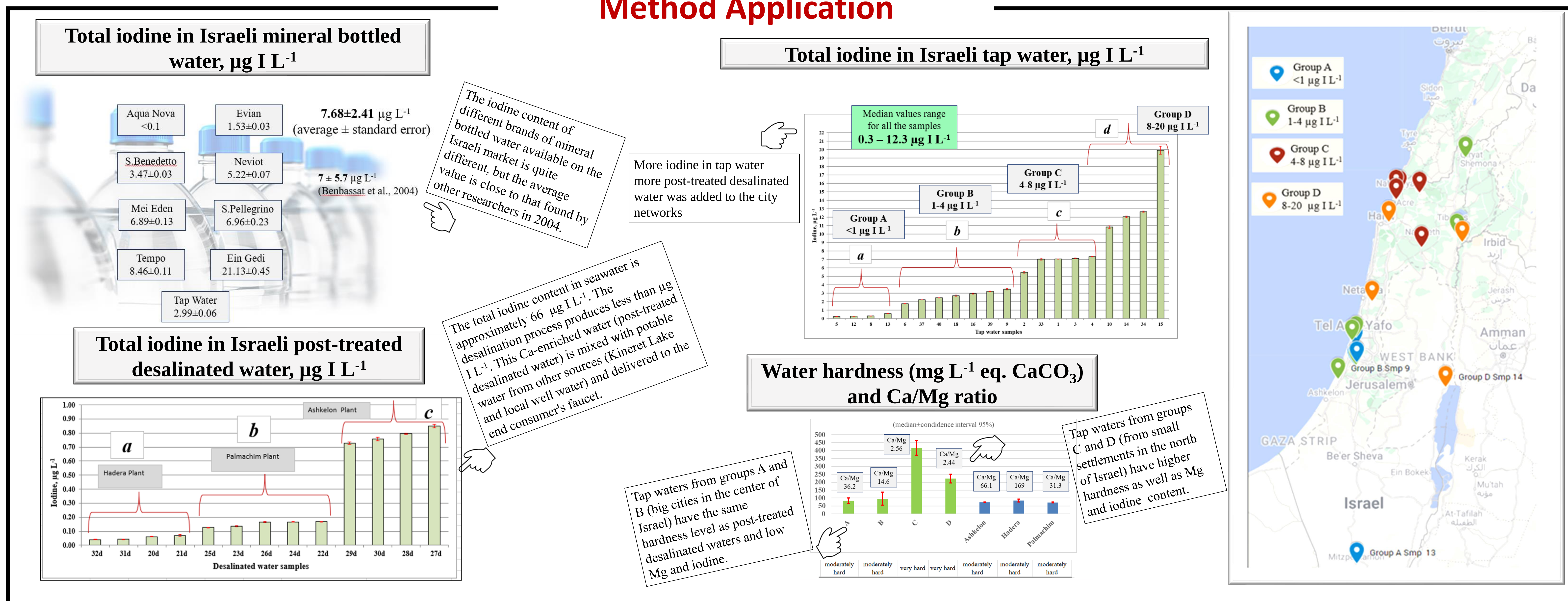


Fig. 3. Iodine concentration in A and E matrices of 3 natural waters.

This poster was presented at the European Winter Conference on Plasma Spectrochemistry, Ljubljana, Slovenia, January 29th – February 3rd, 2023

Method Application



Conclusions

- An accurate and precise method of iodine determination in drinking water using ICP-MS was developed. The method LOQ (considering 2-fold dilution of the sample and possible memory effect) was <0.1 µg I L⁻¹. Use of an alkaline matrix (2% NH₄OH + 0.1% EDTA) for sample dilution and calibration standard preparation prevented carbonate precipitation and, as a result, nebulizer clogging.
- Sampling of the bottled mineral water brands available in the Israeli market demonstrated relatively low average iodine content (7.68±2.41 µg I L⁻¹).
- The measurement of total iodine concentration in tap water samples across Israel revealed a decrease in the present-day iodine status compared with the data from literature sources. We observed 0.3 – 12.3 µg I L⁻¹ (median values); however, approximately 5 – 50 µg I L⁻¹ was recommended by other researchers as a risk-reducing concentration. Lower Mg concentration, a higher Ca/Mg ratio, and lower water hardness were observed in sample groups with lower iodine concentration, indicating a higher percentage of desalinated water in the final composed water blend supplied to consumers.
- The hourly and yearly dynamics of iodine concentration in the tap water of big cities, were found to be relatively high (12 – 151% as CV), thus pointing to constant mixing of water supplied to the final consumer. According to our calculation, the tap water used as drinking water in the communities supplied with a high percentage of desalinated water can provide only several percent of iodine Recommended Dietary Allowance for adults.

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