E3 Journal of Scientific Research. 5(2). pp. 028-032, December, 2016
Available online http://www.e3journals.org
ISSN: 2276-9897 © E3 Journals 2016
DOI: http://dx.doi.org/10.18685/EJMR(5)2_EJMR-16-011

Short communication

Urinary Iodine levels determined by inductive Couple Plazma Mass Spectrometry in the State of Kuwait

Amina Ali

Kuwait Institute for Scientific Research, P.O. Box 24885, Safat13109, Kuwait;Fax:0096524989059;E-mail:aahmed@kisr.edu.kw

Accepted 21 December, 2016

Iodine is an essential element which is utilized by the thyroid gland for the biosynthesis of the thyroid hormones. These hormones strongly influence an extended range of biochemical reactions. Immune defense and antibody production depend on reliable thyroid function. Iodine is obtained only through the diet and is mainly absorbed by the gastrointestinal tract as the inorganic anion, iodide. The status of iodine nutrition of a population is determined by measurements of iodine as urinary iodide (UI) concentration since it is considered an indicator of the adequacy of the iodine intake of that population. In general, it is assumed that most ingested iodine, such as sodium or potassium iodide, is excreted in the urine, and that equilibrium is established between dietary iodine intake and UI excretion. Inductively coupled plasma mass spectrometry provided reliable results for UI determination, collected from a Kuwaiti population. Results were found in accordance with World Health Organization (WHO) criteria(greater than 100 μg/L) and not more than 7% of the population with UI <50 μg/L. Only one severe deficiency case was observed with UI <10 μg/L.

Keywords: Thyroid; Hormones; Immune; Antibody; Diet

Introduction

Iodine is an essential component of the thyroid hormones that play an important role in human development, growth, and metabolism. Iodine deficiency disorders (IDDs), the effects of iodine deficiency, are still a major problem in public health in many parts of the world. According to the World Health Organization, the epidemiological criteria for IDD are as follows (median values): severe, <20 µg/L (0.16 µmol/L); moderate, 20–49 µg/L (0.16–0.38 µmol/L); mild, 50–99 µg/L (0.39–0.78 µmol/L); and no deficiency, >100 µg/L (0.79 µmol/L) . Urinary iodine (UI) concentrations directly reflect dietary iodine intake and consequently test biochemical assessment of the iodine status worldwide. Switzerland was one of the pioneering countries in the prevention of IDDs by iodizing table salt. In 1922, iodized salt became commercially available for human consumption in that country.

Inductively coupled plasma mass spectrometry (ICP-MS) has become a popular method for the reliable determination of trace elements in samples of biological and environmental origin. The appearance of commercial ICP-MS instruments offered the clinical laboratory fast, multielement determinations, reduced sample consumption, simplified sample preparation and access to a wider range of analytes at trace levels. Deposit these promises, limitations due to the sample matrix were encountered. Typically, with ICP-MS, an upper total dissolved solids (TDS) limit of 0.2% in the solution should not be exceeded to ensure continuous operation for an extended period. At TDS levels in excess of this limit, cone orifice blockage, plasma injector clogging and unacceptable levels of signal instability are commonly experienced. Thus, most clinical samples need to be diluted by a factor of 10-20 to overcome this limitation. At levels below 0.2% TDS good performance is expected. However, interferences due to the sample matrix may still be present. Interferences in ICP-MS fall into two categories-spectroscopic and non-spectroscopic: Non-

Table 1. ICP-MS operating conditions

Plasma	
Radiofrequency power	1.1 kW
Auxiliary gas flow rate	0.80 L/min
Cooling gas flow rate	15.0 L/min
Nebulizer gas flow rate	0.75 L/min
Vacuum conditions	
Expansion chamber interface	0.4 kPa
Quadrupole mass spectrometer	0.002 kPa
Data acquisition	
Monitored ions *(m/z)*	^{127}I, ^{129}I, ^{131}Xe
Read delay	90 s
Mode, normal resolution	Peak jump
Dwell time per peak (one point)	50 ms
Sweeps	20
Replicate sweeps	20
Wash-out time	150 s

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- The advantages of ICP-MS spectrometry include:
- Greater sensitivity and detection limits than other methods
- Direct analysis of some types of liquid samples
- Low spectral interference

spectroscopic interferences are indicated by a general suppression or enhancement of signals and are commonly handled by a combination of dilution and internal standards.

Spectroscopic interferences , or isobaric overlaps, are usually a results of the formation of polyatomic ions , typically between the plasma gases (e.g. Ar, O, N, H, C) and the major elements of the sample matrix (e.g. Na, Ca, Mg, C, Cl, S, P for clinically samples) . These polyatomic species cause deterioration of detection limits by increasing the background signal at the mass of interest.

EXPERIMENTAL

Instrumentation

A Perkin-Elmer Sciex Elan 6100 ICP-MS (See figure 1) equipped with the Perkin-Elmer AS90 auto sampler and a parallel path high solids nebulizer obtained from Technical Solutions were used. Because the efficiency of a pneumatic nebulizer is <10%, the major portion of the iodine was collected and pumped into a waste container. To avoid clogging the nebulizer orifice, which may lead to an erratic loss of signal intensity, the samples were centrifuged for 12 min at 5000 rpm. Additional details of the instrument and operating conditions are summarized in Table 1.

Calibration

Continued calibration of the instrument is a component of the overall quality control plan and should be performed by analyzing one mid-concentration standard after every 10 analyses. The relative percent difference (RPD) between the initial calibration and the continuing calibration should be less than 15 percent.

Sample Preparation

Reagents

Analytical grade ammonia (35%) solution was obtained from Merck. Potassium iodated (KIO_3) were obtained from Merck. Argon with a purity grade of 99.998% was supplied by Carbagas

Table 2 . Intensity reading of I calibration standards for range 0.0-50µg/

conc.	Intensity
0	2810
5	29565
10	55038
50	270712

Figure 1. A Perkin-Elmer Sciex Elan 6100 ICP-MS.

Standards

The calibration solution was the standard diluents with aliquots added of the working stock standard (1000 mg/L prepared from0.13g/100ml KIO) in ultra pure water to yield final concentrations of 0, 5,10, and 50 µg/L. A reagent blank and an I solution were measured at intervals of every 10th sample to detect any variation during the measurement period.

The results obtained should fall within the published range of acceptance values. When no control limits are provided, a range of 50 to 150 percent should be used. The urine samples came from (300) healthy and sick people. The samples were stored in polystyrene tubes. The analysis of samples stored for several weeks at -20C° did not show any variation in iodine concentration with respect to those analyzed earlier.

The sample solutions consisted of 0.5 ml of the 0.1% ammonia (35%) solution and 1ml of urine that were diluted to 10ml.

Results and Discussion

Iodine Calibration curve was measured prior to measurement of urinary iodine samples. The intensity readings of iodine Calibration Standards for Calibration Range 0.0 –15.0µg/L are shown in table 2 and figure 2. Table.3 shows part of the three hundred sample has been taken to sick and healthy people. Accuracy Preliminary validations were made by measuring various iodide solutions of known concentrations. Recovery that was investigated by adding a known amount of iodine concentration (10µg/L) to the selected sample was 91.2% is shown in table (4). So far, no urine control material that is certified for iodine has been available commercially. The repeatability, here defined as the ability of a method to give the same answer when repeated several times in a single day by a single analyst, was estimated and is summarized in table(5).

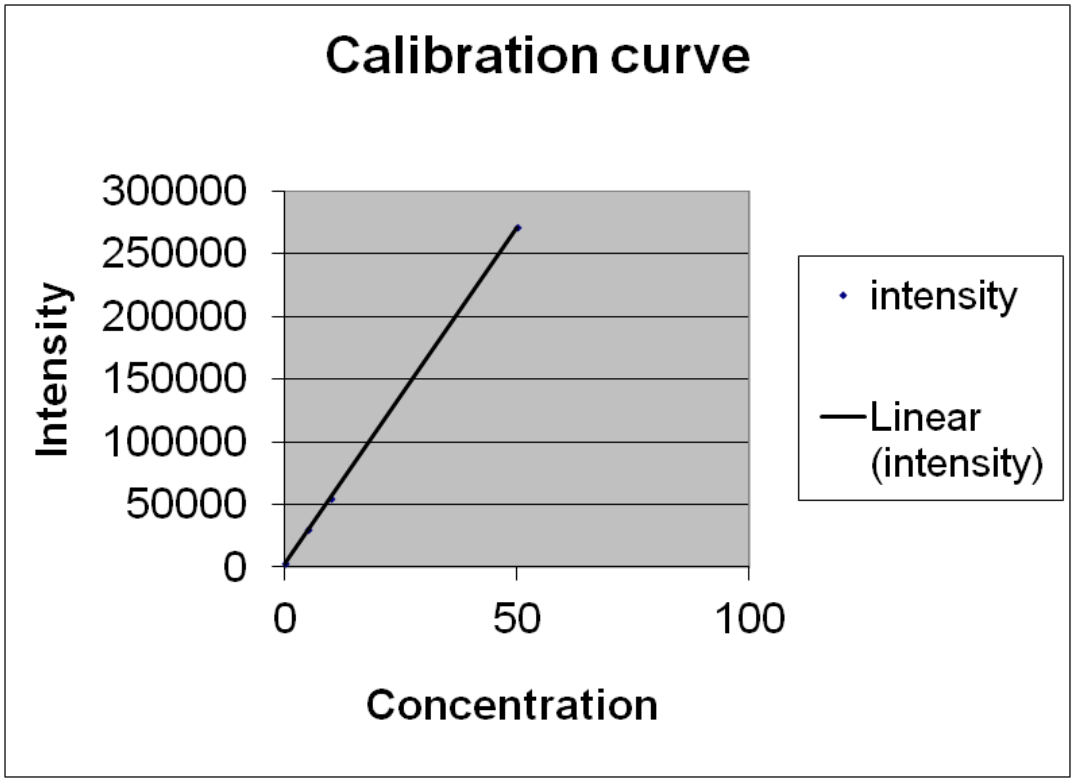

Figure 2. I calibration standards for range 0.0-50 µg/l

Table 3. Iodine Concentration for part of (300) People

Sample no	Iodine	Sample no	Iodine	Sample no	Iodine
1	379	13	717	25	56
2	308	14	590	26	61
3	365	15	485	27	32
4	277	16	865	28	51
5	407	17	444	29	53
6	379	18	258	30	35
7	373	19	338	31	69
8	493	20	838	32	54
9	1705	21	112	33	74
10	454	22	234	34	83
11	348	23	102	35	34
12	799	24	173	36	20

Table4. Recovery of Iodine Spiked Urinal Sample

Sample 12	Iodine Calculated (µg)	Iodine Measured (µg)	Recovery
diluted 10 times	-	79.9	-
diluted 10 times + 10 ppb I	89.9	87.6	91.2%

Table 5. Iodine Concentration results For Selected Samples And Their RSD.

Sample No.	Run a	Run b	Run c	Run d	Run e	RSD
21	112	115	117	115	121	2.86
22	234	240	238	244	246	1.98
23	102	99	103	103	102	1.61
24	173	165	172	176	178	2.88

Conclusions

The results of this study show that the proposed ICP-MS method provides a direct and accurate determination of iodine in human urine with sufficient precision over a wide range of concentrations.

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