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Determination of iodide in common salts consumed in Turkey by isotope dilution analysis

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Iodide traces in common salts consumed in Turkey have been determined by isotope dilution analysis. Iodide was precipitated by stoichiometric amount of $AgNO_3$. Iodide-131 was used as tracer. Electrophoresis was performed to separate $Ag^{131}I$ from excess $^{131}I^-$. Zone of $Ag^{131}I$ was cut off electrophoresis paper and counted with a NaI(Tl) scintillation counter. Count rates were plotted versus added KI concentrations. Unknown iodide amounts were found by using these linear plots. Iodide concentrations found in analyzed salts were 9–58 μg/g.

Introduction

Iodine is an important trace element for human health. It is a distinctive component of thyroid hormones and has an important role for growth and development. Daily iodine requirement is 80–150 μg.[1] If goitrogens are present, the requirement of iodine may be higher.[2] Iodine deficiency is a problem for almost all countries of the world. Goiter is its most obvious consequence, but other effects do more damage, particularly those on the developing brain. Social and public health consequences of iodine deficiency have been well documented in many publications.[1,3–6] Iodized salt and iodized oil are the most common iodine sources to protect iodine deficiency.

SINGH and GARG[7] have determined iodide amounts in common Indian salts by a modification of substoichiometric Isotope dilution analysis (IDA). They precipitated iodide as AgI containing ^{131}I tracer by using substoichiometric amount of $AgNO_3$. Unknown iodide amounts were found by counting unprecipitated ^{131}I. BILABINA et al.[8] have determined iodide amounts in African salts by potentiometric method. On the other hand, various methods such as spectrophotometry,[9] potentiometry,[8] inductively coupled plasma mass spectrometry,[10] intracavity laser spectroscopy[11] energy dispersive X-ray fluorescence spectrometry,[12,13] radiochemical neutron activation analysis[14] have been applied to determine iodide amounts in various biological samples (urine) and water. The most common way of iodide analysis is the kinetic-spectrophotometric method based on a catalytic redox reaction of As(III)–Ce(IV). However, there have been conflicting evaluations of the determination of iodide in the presence of excess of chloride by this method.[7]

The aim of this work is to develop a method for routine iodide analysis that can be applied environmental samples and is to define iodide concentrations in common salts consumed in Turkey.

Experimental

All chemicals were purchased from Merck. $Na^{131}I$ was supplied from Department of Nuclear Medicine. All solutions were prepared in doubly distilled water. Various brands of common salts, both crude and fine quality iodized salts of different origin, were purchased from local markets. 0.2N Na_2SO_3 and $2 \cdot 10^{-6}$N $AgNO_3$ solutions were prepared. Stock KI solutions were prepared as described earlier.[15]

Procedure

One gram salt sample was dissolved in 3 ml distilled water. Following procedure was applied similar to ÖZAKAY et al.'s study.[15] Equal volumes with increasing iodide concentrations and equal volumes of identical $^{131}I^-$ solutions are added to dissolved samples. Less than equivalent amounts $AgNO_3$ were added and they were rested for 15–20 minutes. Five μl of Na_2SO_3 to prevent oxidation of iodide and 5 μl of dioxan were added consecutively. Five μl of each test tube was transferred to cellulose acetate electrophoresis strips pre-moistened by buffer solution. Electrophoresis was performed with a Gelman electrophoresis chamber. Buffer solution was a mixture of *n*-butanol:water:acetic acid (4:2:1). Migration time and applied voltage were two hours and 300 V, respectively. While excess $^{131}I^-$ migrates due to electrophoresis on paper, $Ag^{131}I$ precipitate remains stationary and this fraction of paper is counted with a NaI(Tl) scintillation detector of multichannel analyzer using the gamma-peak of 364 keV of ^{131}I. These count rates were plotted versus iodide concentrations by using a computer Curve Fit program. A linear decreasing plot was obtained and used as a calibration curve. Five parallel experiments were performed with each brand of salt (see Table 1).

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Table 1. Iodide content (in μg/g) in common salt samples of various brands and in samples of mineral origin

Samples	Iodide concentration, μg/g n=5
Brand I (noniodized)	30.47 ± 0.12
Brand 1 (iodized)	58.19 ± 15.02
Brand 2 (noniodized)	16.16 ± 3.41
Brand 2 (iodized)	37.94 ± 0.54
Brand 3	13.38 ± 5.23
Brand 4	39.22 ± 4.88
Brand 5	15.37 ± 4.37
Brand 6	9.07 ± 0.57
Brand 7	33.43 ± 2.42
Brand 8	30.20 ± 6.27
Brand 9	12.27 ± 0.60
Mineral salt	29.48 ± 5.29

Results and discussion

The precision of the method was evaluated using standard solutions (7–7500 μg/l) previously described.[15] It was not higher than 10% even at 10 μg/g concentration range. RAO et al.[14] analyzed some food samples by radiochemical neutron activation analysis and the precision of their method was also 10% at ppb level. In this study, electrophoresis was applied for separation instead of precipitate centrifugation. This procedure has the following advantages: (1) Counting electrophoresis paper is easier than counting $Ag^{131}I$ containing vessels because of contamination problems, (2) electrophoretic separation is more efficient for routine applications, and (3) it is possible to use very small sample quantities.

The results obtained are shown in Table 1. According to these results, salts consumed in Turkey contain between 9–58 μg/g iodide and the mean iodide concentration is 27 μg/g. Brand 1 and Brand 2 (iodized) are products of well-known companies who sell their products with wide publicity assuring that the salt is iodized. Both manufacturers had assigned a minimum iodide concentration of 50 μg/g. The non-iodized product of Brand 1 also contains approximately 30 μg/g iodide. Brands 3, 5, 6 and 9 contain less than 30 mg/kg while iodide concentrations of Brands 4, 7 and 8 are higher than 30 μg/g. Mineral origin salt also contains iodide (29 μg/g).

Iodide concentration of salts vary in higher extent in other countries. In Latin America, the concentration of iodide is between 30–100 μg/g, in Europe between 10–20 μg/g,[2] in India 30 μg/g,[7] in some of the African countries, like Gobe, Moritan, 0.1 μg/g.[8] Turkey's salts have iodide concentrations similar to Indian salts, but much higher than Africa-Gobe salts.

LAMBERG[2] pointed out that iodized salt can be used for iodine prophylaxis but several factors have to be considered which amount of iodide requirement (100–150 μg/day), goitrogenic factor, daily salt consumption (Individual food habits), iodide concentration in salt, duration of prophylaxis, handling and distribution of salt, constant surveillance, political decisions etc.

Daily salt consumption largely depends on the individual food habits in Turkey. Iodination of salt in Turkey is not considered mandatory and subvention of iodination does not exist. As pointed out in some reports, mandatory prophylaxis is usually more effective than a voluntary one, but there are also examples of good results on a voluntary basis.[2,4] For this reason, iodine deficiency may not be prevented by iodinated salts. However, some reports have pointed out iodine deficiency disorders in Turkey.[16]

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