STABILITY OF IODINE CONTENT IN IODIZED SALT

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ABSTRACT

Stabilization of iodine in salt have been determined by using Isotope Dilution Analysis. Heating, heating with oxidizing agent, incubation by time was the parameters which have been tried. Over 80% of iodide were lost during the treatment with oxidizing agent in heat. In the case of heating without an oxidation agent, loss of iodine was fewer.

Key Words: Iodine stability, Isotope Dilution Analysis, Iodized Salt, Iodine-131

INTRODUCTION

Iodine is an essential trace element for human health. It plays an important role in mental and physiological development. World Health Organization (WHO) recommends daily iodine requirement as 50-200 μg/day depending on the age [1]. In the case of goitrogens in diet, iodine requirement may increases. WHO defines that the effects of iodine deficiency on growth and development by the term iodine deficiency disorders (IDD) [1]. Although WHO has aimed that have iodine deficiency disorders disappeared up to 2000, iodine deficiency disorders have still been seen in our country as many other countries in the world, and effects negatively development and economy [1-5, 8]. The most common consequences of iodine deficiency is goiter on all age groups. Goiter rate is accepted as reliable indicator of iodine deficiency in a population. Besides goiter low school success and low IQ level are the other important consequences of iodine deficiency. While some countries suffer iodine deficiency, some countries have excessive iodine in diet [1]. Not only lack of iodine also grossly excessive iodine (>20 mg/day) in diet may cause iodine deficiency disorder include endemic goiter and hypothyroidism[1]. Populations suffer from iodine deficiency should be supported by more iodine such as iodized salt, iodized oil, iodized bread etc, population consumes excess iodine or some population in older age suffer from thyroid disease who have not to consume no iodine, they should avoid excess iodine in their diet. That's why iodine concentration range in diet is very important for public health.

One of the method for protection of population from iodine deficiency is iodization of the consumed salts. Turkey is one of the country suffer from iodine deficiency. Iodization of salts in Turkey is mandatory since 1998 and recommended iodine concentration should be 50-70 mg/kg potassium iodide or 25-40 mg/kg potassium iodate [6]. Iodide may easily be oxidized to elemental iodine and it is known that elemental iodine may sublime, so storage conditions of iodide in food such as iodized salt is considerable.

Several methods such as High Performance Liquid Chromatography (HPLC) [9], Inductively Coupled Mass Spectrometry (ICP-MS) [10], Intracavity Laser Spectrometry [11], Energy Dispersive X-ray Spectrometry[12], Neutron Activation Analysis [14], Optimized Potentiometric Method [16] have been used for iodine analyses of biological and environment material. The other common way of iodide analysis is the kinetic spectrophotometric method based on a catalytic redox reaction of As(III)-Ce(IV) [13]. However, there have been conflicting evaluations of the determination of iodide in the presence of excess of chloride by this method. On the other hand, neutron activation analysis is also a sensitive and accuracy method for measuring inorganic iodide but it is not suitable for routine practice because the specialized facilities such as a neutron sources or a nuclear reactor needed [14]. Therefore, Isotope Dilution Analysis has been preferred in this study as earlier studies [2-5]. IDA is one of the radioanalytical methods which can be used to analyze trace elements in different media. Theoretical and experimental investigation on isotope dilution analysis (IDA) methods have been reported. IDA has been used for the analysis of biological and geological materials, water, soils, semiconductors, etc [2-5, 15, 17]. Because of the sensitively detection of radioactive tracers, IDA presents a suitable method for the determination of very small volumes of trace amounts of substances.

The aim of this study is to determine of parameters which can effect iodine stability in salt and to determine deiodination conditions in the case of desire to remove iodine in diet.

MATERIALS AND METHODS

All chemicals were purchased from Merck. $Na^{131}I$ was supplied from Department of Nuclear Medicine of Ege University. All solutions were prepared in doubly distilled water. A brands of iodized salt were purchased from local market. Below parameters were examined to determine iodide stabilization in salt.

1. Ten g of salt samples were heated at oven at 200 °C for 5 hrs, 17 hrs and 24 hours duration respectively.
2. 2 mg KI was added to salt samples then heated at the same conditions with parameter 1.
3. Another sample series were treated with 2 ml H_2O_2 solution of 3% as oxidant and then heated in the oven at the same conditions.
4. 2 mg KI was added additional 2 ml H_2O_2 as oxidant to these salts then heated at the same conditions with parameter 1.
5. A series of salt samples were employed as control.

Analyses were done by Isotope Dilution Analysis according to below prosedure. 0.1 N Na_2SO_3 and 2 x 10^{-6} N $AgNO_3$ solutions were prepared. Stock KI solutions were prepared as described earlier [2-5].

Procedure: One gram salt sample was dissolved in 3 ml distilled water. Following procedure was applied similar to earlier studies [2-5]. 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 microlitres 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 volts respectively. While excess $^{131}I^-$ migrates due to electrophoresis on paper, $Ag^{131}I$ precipitate remains stationary and this fraction of paper was counted by a Cd(Te) detector equipped with RAD 501 single-channel analyzer. 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. Three parallel experiments were performed with each sample.

RESULTS AND DISCUSSION

In our previous studies, we found the iodine concentrations in Turkey product salts were between between 9 – 58 µg/g iodide and the mean iodide concentration is 27 µg/g. [3,5].

Singh and Garg have determined iodide amounts in common Indian salts by a modification of substoichiometric IDA (Isotope Dilution Analysis) [15]. Wang et al have reported that the loss of iodine was greater when salt was stored in plastic bag than in glass bottle. Loss was greater under the storage of higher temperature and lower humidity. Cooking conditions also was effective for the loss of iodine [7].

Figure-1 shows loss of iodine per cent across the effects of heating time, presence of H_2O_2 concentration as an oxidizing agent, adding of KI amount. Iodine lost in samples containing H_2O_2 are similar each other while other samples not having H_2O_2 are similar.

Loss of Iodine during heating at oven at 200 °C

Heating at 200 °C up to 24 hours iodine was lost up to 73 per cent.

Effect of Oxidizing agent

When the iodized salt heated with oxidized agent iodine loss raises up to 82 per cent in 24 hours.

Loss of Iodine KI added Salts

2 mg KI was added to 10 g salt to investigate KI concentrations to iodine loss. Iodine lost was lower in the case of heating with the presence of H_2O_2. Iodine loss was 66% for KI added samples and 35% for KI and H_2O_2 added samples in 24 hours heating.

Loss of Iodine During the Storage of Iodized Salts

Iodine content of reference iodized salt was 38.53±6.92 on June 1997. After the salt was stored at room temperature with a relative humidity of 30 % -45% and in sealed paper bags for three years, iodine content changed to 18.25 ± 4.72. Thus 52.63 % of was lost in approximately 3.5 years. This means that standing time and storage conditions is very effective storage of iodine in food.

Cooking conditions is very effective on the stabilization of iodine. In the case of oxidants in diet loss of iodine is more effective, 82% of iodine may lost during the high temperature cooking and oxidized medium. So it is advised to consume iodide to put the food not before the cooking but after the cooking. On the other hand, if consuming of iodide not advised to people who have health problems with their thyroid, long term treatment at oven with an mild oxidant may loss 81% of iodine and 55% of iodine without an oxidants.

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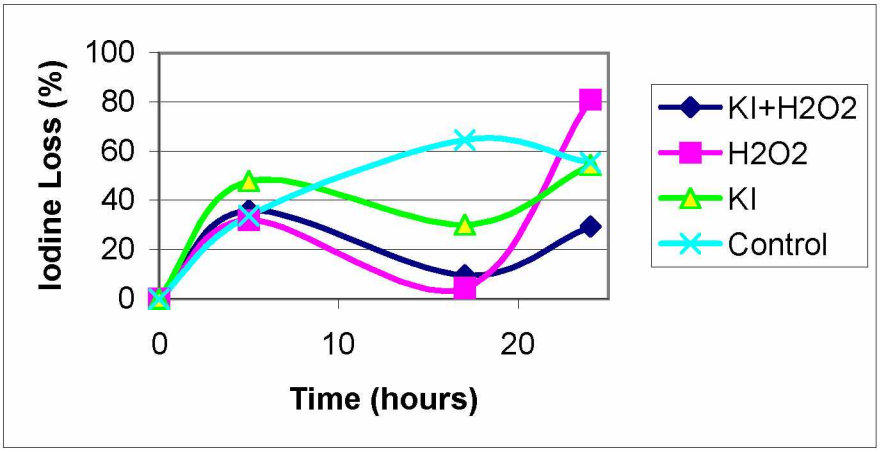


Figure-1 Loss of iodine per cent across the effects of heating time, presence of H_2O_2 concentration as an oxidizing agent, adding of KI amount.