Original Article

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Determining the Amount of Iodine in Edible Salts Obtained from Markets and District Bazaars in İstanbul

İstanbul Piyasasında Satılan Yemeklik Tuzlarda İyot Miktarı Tespitinin Yapılması

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ABSTRACT

Objective: Iodine is an element that is rarely found in water and soil in nature. Iodine is a component of thyroid gland hormones and is an essential element for human life. Iodine deficiency disease (IDD) is an important public health problem all over the world, which occurs as a result of iodine deficiency. Visible symptoms of iodine deficiency are defined as goiter. On the other hand, excessive intake of iodine into the body may disrupt thyroid hormone secretion and result in iodine deficiency.

Methods: In this study, the iodine amounts of 26 edible salt samples collected from markets and district bazaars in Istanbul were analyzed according to the method "Determination of Iodine in Iodized Salts with Iodized Ion" in TS 933 Edible Salt Standard, and the compliance of salts sold in the market with the Turkish Food Codex Salt Communiqué was investigated.

Results: Thirteen of 26 salt samples were appropriate at the level of 28.0-39.8 mg/kg (50%), high at the level of 44.0-52.9 mg/kg (27%) in 7 samples and low at the level of 2.0-20.0 (23%) in 6 samples have been found.

Conclusion: It has been determined that the amount of iodine in 50% of the salt samples was not appropriate. Iodine deficiency detected in salts in the market increases the risk of IDD, and excess iodine increases the risk of goiter. In this case, it is important that the sustainability of food control and inspection by administrative authorities is effective for the protection of public health.

Keywords: Iodine, salt, food control, public health

ÖZ

Amaç: İyot doğada sularda ve toprakta nadir olarak bulunan bir elementtir. İyot, tiroid bezi hormonlarının bir bileşeni olup insan hayatı için gerekli bir elementtir. İyot yetersizliği hastalığı (İYH), iyot eksikliği sonucu ortaya çıkan ve tüm Dünya'da önemli bir halk sağlığı sorunudur. İyot eksikliğinin gözle görülen belirtileri guatr olarak tanımlanmaktadır. Diğer yandan, iyotun vücuda fazla miktarda alınması tiroit bezi hormon salınımı bozup iyot eksikliği ile sonuçlanabilir.

Yöntemler: Bu çalışmada İstanbul'da marketlerden ve semt pazarlarından toplanan 26 yemeklik tuz örneklerinin iyot miktarları TS 933 Yemeklik Tuz Standardındaki "İyodat İyonu ile İyotlanmış Tuzlarda İyot Tayini" metoduna göre analizi yapılarak piyasada satılan tuzların Türk Gıda Kodeksi Tuz Tebliği'ne uygunluğu araştırılmıştır.

Bulgular: Yirmi altı tuz örneğinin 13'ü 28,0-39,8 mg/kg düzeyinde (%50) uygun, 7 örnekte 44,0-52,9 mg/kg düzeyinde (%27) yüksek ve 6 örnekte ise 2,0-20,0 düzeyinde (%23) düşük miktarlarda bulunmuştur.

Sonuç: Tuz örneklerinin %50'sinde iyot miktarlarının uygun miktarda olmadığı tespit edilmiştir. Piyasadaki tuzlarda tespit edilen iyot eksikliği toplumda İYH, iyot fazlalığı ise guatr riskini artırmaktadır. Bu durumda; idari otoriteler tarafından halk sağlığının korunması için gıda kontrol ve denetimlerinin sürdürülebilirliğinin etkin olması önemlidir.

Anahtar Sözcükler: İyot, tuz, gıda kontrolü, halk sağlığı

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Introduction

"Ioeides" means "purple" in Greek. Iodine is a very rare, black, solid and active element with symbol I, atomic number 53, and atomic weight of about 126.09 g/mol. It was defined by Gay Lussac in 1812 (1). Chemically, iodine is the least reactive of the halogens. Iodine has the least solubility in water, it dissolves in organic solvents. The most important inorganic iodine is hydrogen iodide, which is colorless. Iodine is mainly used in medicine, photography, and paint manufacturing. Many living things need trace amounts of iodine (1,2). Iodine, which is found in rocks, soil, minerals, sea water and underground water resources, is mostly found in dark colored algae (2,3). On earth, iodine is mostly taken from the surface layers of the soil with glacier, rain and snow, carried to the oceans and seas by wind, rivers and floods, and returns to the clouds as vapor and then to the soil as rain. In particular, seafoods are considered the best food sources rich in iodine (3).

Iodine is an essential element for the synthesis of the thyroid hormone. The body does not produce iodine, so it is an important part of the diet (4). If there is not enough iodine in the body, enough thyroid hormone cannot be produced. Therefore, iodine deficiency can cause thyroid enlargement, hypothyroidism and mental retardation in infants and children whose mothers are iodine-deficient during pregnancy. Iodine deficiency is the most common preventable cause of mental retardation (5). Iodine deficiency affects 30% of the world's population, especially in developing countries. In addition, iodine deficiency is common in pregnant women worldwide. Among the devastating consequences of this condition are cretinism and congenital abnormalities (3,6). When sufficient fetal iodine is not taken, it can lead to multiple iodine deficiency disorders such as maternal hypothyroidism, and neuropsychological developmental disorder and cretinism in children (6-8). Iodine deficiency is an important public health problem that concerns all countries (9). Iodine plays a key role in early growth and development of the organs, particularly the brain, between fetal life and post-adolescent life. It is stated that the main source of food in infants is breast milk during breastfeeding (10). Breastfeeding mothers who do not take iodine supplements are a risk group for iodine deficiency. In addition, breastfed newborns of mothers who do not take iodine supplementation have a low urinary iodine concentration and an increased risk of neurological disorders (9). Inadequate fertility, preeclampsia, postpartum hemorrhage, maternal anemia, and increased sensitivity of the thyroid gland to nuclear radiation are the main clinical manifestations in mothers with iodine deficiency. The effects of iodine deficiency on the fetus are early and late abortions, stillbirth, low birth weight, congenital malformations, microcephaly, increased perinatal mortality, cretinism, fetal goiter, and increased sensitivity of the thyroid gland to nuclear radiation. In newborns, neonatal goiter, neonatal hypothyroidism, a 13-fold increase in recall rate in congenital hypothyroidism screening, and an increase in the sensitivity of the thyroid gland to nuclear radiation can be seen. Goiter, hypothyroidism, increase in infant mortality, failure in phagocyte functions and late cellular immune response, physical developmental delay, failure in school, and increased sensitivity of the thyroid gland to nuclear radiation can be observed in infants, and childhood and adolescence periods. In adults, goiter and nodularity, hypothyroidism, mental dysfunction, insufficient physical performance, hyperthyroidism that may occur with iodine loading, and an increase in the risk of autoimmune thyroid diseases can be seen (4). In animals, decrease in reproduction, decrease in the number of live births, decrease in birth weight, increase in the rate of deformed birth, loss of strength, low yield in terms of meat, milk and wool can be seen (3).

The basic approach to iodine deficiency is to increase the daily iodine intake of individuals and the recommendations to ensure this are based on enriching frequently consumed foods with iodine (10). In order to eliminate iodine deficiency, many countries allocate large budgets to medicine for the production of iodine-enriched foods. The amount of iodine in meat, milk, eggs, cereals, and plant-based foods depends on the iodine level of the region, season, and reproductive conditions (2,11). The iodine levels of the soil during the cultivation of fruits and vegetables, irrigation water used and fertilization of the plants affect the iodine content in plant-based foods, while the iodine level of the feeds affects the iodine content of the animal based foods (5).

Patients with goiter mostly vary in relation to features such as geographical region and age of the patient (4,6-9,12). In prospective studies conducted in the USA and Japan, the incidence of goiter is 6% in school-age children living in areas where iodine deficiency is not observed, and different results are obtained in North America, Europe, Asia (Japan) and Oceania when goiter is frequent due to differences in iodine intake in Europe. The prevalence of endemic goiter in economically developed countries (New Zealand and Australia) was found to be 0-5%. According to the latest data, it is reported that goiter is still seen in adults in European countries such as Bulgaria, Czech Republic, Slovakia, Netherlands, Switzerland and Belgium, but it is rare in children. There are regions with high prevalence of goiter in Austria, Hungary, Poland, Yugoslavia and Western Russia (11). It is estimated that 37% of school-age children (285 million children) and approximately two billion people worldwide have iodine deficiency (12,13). It has been reported that iodine supplementation programs should be applied when clinical cases of iodine deficiency are seen in a region and when urinary iodine excretion is found to be low in parallel (2). In many studies, iodine deficiency is determined by combining clinical findings with urine iodine excretion analyzes. Four parameters for evaluation of iodine nutrition in the population are generally recommended to be used: Urinary iodine concentration (UIC), goiter size, serum tiroit stimulating hormone and serum Tg. These parameters are complementary to each other. As over 90% of dietary iodine eventually appears in the urine, UI is an excellent indicator of recent iodine intake (14). A cross-sectional national study was conducted in Switzerland in 2015 to assess the current iodine status in school-aged children, women of reproductive age, and pregnant women. As a result of this study, a longitudinal analysis was performed by the same team on UIC detected in the same population in 1999, 2004, 2009 and 2015, and the effect of increasing the iodine concentration in salt by 5 mg/kg was evaluated. As a result, the investigators observed a modest improvement in median UIC in children compared to the previous three national studies by increasing the salt iodine content from 20 mg/kg to 25 mg/kg. The investigators showed that iodine intake remained low in reproductive-age adult women and pregnant women, and that increasing iodine in salt by 5 mg/kg did not benefit women with higher dietary iodine requirements. The reason for this is that women working in Switzerland tend to prefer ready-to-eat foods, and since there has not been any study on the amount of iodine in ready-made foods and the salts used in these foods, a definite conclusion has not been reached on this issue. As a result, it was concluded that there was insufficient iodine nutrition in women of reproductive age and pregnant women. It was concluded that in Switzerland, when using continuous iodized salt, an overall increase in iodine intake of about 25 µg/day would likely to be sufficient to provide average iodine nutrition (15).

Seafoods and foods from iodine-rich soils may be suitable sources for iodine uptake (4). However, the contribution of iodine taken from different food sources to human health cannot be measured directly. However, it shows that a significant portion of daily iodine intake may come from sources other than salt, and iodized salt may partially compensate for the deficiency (15). Iodization of salt is currently the most common strategy to control and completely eliminate iodine deficiency disorder. However; for the amelioration of iodine deficiency to be fully effective, salt must be delivered to the entire affected population, particularly to susceptible individuals such as pregnant women and young children. Especially in production, iodized salt should be monitored. This type of monitoring requires close cooperation between public authority and the salt industry. Ideally, monitoring of the iodine content of the salt should be done internally by the salt producer at the iodization site, and also externally by the health authorities. Internal monitoring of the production process should be done routinely and external (public) monitoring should be done intermittently, and where possible, both of these monitoring systems should use the titration method to determine the iodine content of the salt (14).

Although the first legal regulation on the iodization of salt was made in our country in 1968, the most meaningful initiative to prevent iodine deficiency was supported by UNICEF and T.C. The issue was handled by the Ministry of Health AÇSAP General Directorate, and in this context, a real intersectoral cooperation was made to inform the public about the iodization and consumption of all table salt produced. This has been the most comprehensive cooperation in our country under the coordination of the Ministry of Health, with the contribution and participation of many organizations such as salt producers, the Ministry of Agriculture and Forestry, universities and some international organizations (3). During this period, trainings were organized for technical personnel in salt production facilities on the preparation of homogeneous salt in terms of iodine and titrimetric salt analysis. According to the Salt Communique numbered 2004/25 (16), which was out of date in our country, both KI and KI could be added to salts. However, since the titrimetric chemical analysis of KI is complex and difficult compared to KI, according to the current Turkish Food Codex Communique on Salt No. 2013/48 (17), adding potassium iodate at the rate of 25-40 mg/kg to table salt is mandatory. In this study, the compliance of potassium iodate amounts in the edible salt samples sold in the Istanbul market with the Turkish Food Codex Salt Communique No. 2013/48 was investigated.

Methods

Chemicals

Hydrochloric acid (25%), potassium iodide (KI) (15%), sodium thiosulfate and 0.5% (m/v) starch were obtained from Merck.

Determination and Collection of the Sample

Assuming that the inappropriate sample rate varied between 5% and 20%, it was calculated by power analysis that at least 26 samples should be studied, taking into account the 95% confidence level and 80% power coefficients, in order to reveal this frequency approximately. For this purpose, 26 salt samples, 50 grams each, were collected from the Istanbul market. Ethics committee approval of the study was obtained from Bezmialem Vakif University Non-interventional Research Ethics Committee with the decision dated 04.09.2018 and numbered 16/197. For the salt samples included in the study, it was stated on the labels that potassium iodate was added to the salts.

Analysis of Iodine Content in Salt

The amount of iodine analysis was made by the method of "Determination of Iodine in Iodized Salts with Iodate Ion" in TS 933 Edible Salt Standard (18). For this purpose, 0.1 g of 50 g salt sample was weighed on a precision balance (Ohaus Company, USA) and dissolved in 200 mL distilled water. 2.5 mL of 25% hydrochloric acid solution and 10 mL of 15% KI solution were added. The solution was titrated with 0.01 M sodium thiosulfate solution until the color of the solution became light yellow, then 2.5 mL of 0.5% (m/v) starch solution was added and the titration was continued with adding 0.01 M sodium thiosulfate solution without delay until the blue color disappeared. The total volume of sodium thiosulfate solution spent was recorded. The amount of iodine was calculated in terms of potassium iodate.

Statistical Analysis

Power analysis was performed to determine the number of samples. Collected salt samples were analyzed twice and the values were calculated as mean ± standard deviation.

Results

Potassium iodate analysis was carried out in 26 edible salts, which were stated to be iodized on their labels, which were offered for sale in different markets and neighborhood markets in Istanbul (Table 1). Iodine content was found to be 28.0-39.8 mg/kg in 13 of the analyzed samples, 44.0-52.9 mg/kg in 7 samples, and 2.0-20.0 mg/kg in 6 samples. While 50% of the salts were

Table 1. Evaluation of the results of the iodine amount analysis in terms of potassium iodate of 26 edible salt samples collected from the market according to the Turkish Food Codex Communiqué on Salt (2013/48). Results are given as mean ± standard deviation

n	Mean ± standard deviation (mg/kg)	Suitability
1	46.3±2.47	**High**
2	47.0±0.99	**High**
3	47.5±4.38	**High**
4	34.8±2.83	Appropriate
5	3.3±0.00	**Low**
6	39.5±0.71	Appropriate
7	47.5±0.49	**High**
8	38.7±1.41	Appropriate
9	44.0±0.28	**High**
10	44.4±2.69	**High**
11	20.0±1.20	**Low**
12	34.4±0.49	Appropriate
13	34.8±0.28	Appropriate
14	28.0±0.42	Appropriate
15	28.5±0.78	Appropriate
16	37.2±0.14	Appropriate
17	2.0±0.00	**Low**
18	33.7±0.85	Appropriate
19	22.5±0.00	**Low**
20	39.8±0.14	Appropriate
21	30.7±0.28	Appropriate
22	30.1±0.49	Appropriate
23	4.76±0.00	**Low**
24	52.9±0.00	**High**
25	2.05±0.78	**Low**
26	34.1±1.13	Appropriate

suitable according to the Codex, 23% were determined to have low iodine levels. Iodine content was high in 27% of salts.

Iodine deficiency, which is one of the most common micronutrient deficiencies in the world, is the main cause of mental retardation which can potentially be prevented in childhood, and morbidity series called iodine deficiency disorders (4,5). It is suggested that iodization of salt is the best way to prevent and cure many of these disorders (15). In this study, 26 samples of edible salt sold in the Istanbul market were taken and their potassium iodate amounts were evaluated in accordance with the Turkish Food Codex Salt Communiqué No. 2013/48.

As a result of the titrimetric analysis, it was determined that 50% of the iodized salts contained iodine in the appropriate amount according to the Turkish Food Codex Salt Communiqué, while 50% of the samples contained iodine in low or high amounts. On the other hand, iodine was not found in 8 (38%) of 21 salt samples collected and analyzed in Ankara in 2007 (19). All these results show that our country has made progress in terms of 'iodized salt' health policies. However; it was reported that an average of 39.85±5.46 ppm was found, with the lowest iodine content being 6.30 ppm and the highest 82.50 ppm, which was analyzed by a titrimetric and spectrometric methods performed on 15 salt samples from India (20). The large difference between the lowest amount of iodine in salts and the highest amount of iodine indicates that there may be a production error. The researchers urge the Ministry of Health authority in the countries of this study to reassess iodized salt quality as an urgent public health imperative. In the iodine analysis performed on 1803 (n=1,533 iodized salt, n=270 crystal salt) salt samples brought from home by primary school children from 7 different districts in Nepal; the mean iodine content in iodized and crystalline salts was 40.8±12.35 ppm and 18.43±11.49 ppm, respectively (21). There was a significant difference between the use of iodized and crystalline salts and the salt iodine content of iodized and crystalline salts between different districts, and it was revealed that only 169 samples (9.4%) of the total samples had an iodine content of <15 ppm, and that most Nepalese households had access to iodized salt. The iodization of salt is the world's most widely used method for fortifying foods with iodine. On the other hand, it is obvious that iodine deficiency is still an important and widespread public health problem. Although salt iodization programs have been initiated by the International Council for Control of Iodine Deficiency Disorders (ICCIDD) in some countries such as the Philippines, Indonesia, New Zealand, Papua New Guinea, Srilanka and Vietnam, successful results have not been achieved, but it has been reported the targeted results have not yet been achieved (5).

Conclusion

In this study, the amount of iodine in the salts stated to be iodized on the labels, 50% of the samples in terms of potassium iodate were found to be in compliance with the Turkish Food Codex Table Salt Communiqué, and 50% (27% high and 23% low) were not found to be in accordance with the aforementioned codex. In this case, it is seen that the salt iodization is not done as it should be in accordance with the target. Considering that high iodine content can cause hyperthyroidism and low iodine content can cause iodine deficiency disease, it is imperative that the Ministry of Health and the Ministry of Agriculture and Forestry should carry out regular, widespread and target-oriented food checks in this area, and that they should also issue necessary warnings to producers with codex violations. In addition, periodic studies in this area will lead to the solution of public health problems such as hyperthyroidism and iodine deficiency in our country.

Ethics

Ethics Committee Approval: Ethics committee approval of the study was obtained from Bezmialem Vakif University Non-interventional Research Ethics Committee with the decision dated 04.09.2018 and numbered 16/197.

Peer-review: Externally peer reviewed.

Authorship Contributions

Concept: M.G.B., Design: M.G.B., A.G.B., Data Collection or Processing: M.G.B., A.G.B., B.Ö., Analysis or Interpretation: M.G.B., A.G.B., B.Ö., Literature Search: M.G.B., A.G.B., B.Ö., Writing: M.G.B., A.G.B., B.Ö.

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