Iodized Salt Between Myth and Reality: Assessment of Iodine Content in Table Salt Commercially Available in Romania

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About 1/3 of the world population lives in areas where iodine is scarce. The easiest solution to provide an organism with adequate iodine doses is the iodization of table salt, a process implemented in about 120 countries. Romanian laws require the iodization of salt used for human consumption. The purpose of our study is to assess the iodine concentration of various table salt brands commercially available in Romania, from different countries – Ukraine, Belarus, Greece, Italy, Turkey, Austria, to see if they comply with accepted standards and compare them with those in our country. An iodometric titration method was used for analyzing the iodine content of the salt samples. The analysis of the samples indicate that a great proportion do not meet accepted standards regarding iodine concentration.

Keywords: Iodized salt, biochemical indicator, health, Romania

Iodine is the essential element in the synthesis of the thyroid hormones by the thyroid gland. The role of these hormones is very important in the organism, as they are directly involved in growth and development. Iodine is brought in the organism through food whose iodine concentration depends on the concentration of this element in the soil. A low iodine concentration in the soil means a low concentration of this element in the plants and thus also in the animals' organisms[1]. In the human body iodine is brought easiest through sodium chloride- table salt [2].

In the whole world 1/3 of the population lives in areas where iodine is scarce and they need a supplement of this element. The easiest solution to provide an organism with iodine is the iodization of table salt, a process implemented in about 120 countries [3]. Another source of iodine is dairy products as long as the animals' fodder comes from soils rich in iodine. Also, sea fish and some algae have a high iodine concentration, as well as chicken or pork provided their food is rich enough in iodine.

The lack of iodine affects human health in many ways. Low iodine input in the organism means a drop in thyroid hormones synthesis which affects brain development, favors goiter, congenital anomalies and endemic cretinism [4,5].

The recommended daily dose of iodine for the organism is differentiated according to age groups: 90μg/day for children under 6, 120 μg/day for children between 6-12 and 150 μg/day for teenagers over 13. The recommended dose for pregnant women is 250 μg/day [4].

The categories of people susceptible for iodine deficit are: pregnant women or women who have just given birth, and implicitly breastfed babies when their only source of iodine is mother's milk [1].

An ideal biochemical indicator for the control of iodine concentration in the organism is the measuring of urinary excretion over a period of 24 h (UIE = urinary iodine excretion) but because of the difficulty of pursuing this investigation it is possible to measure only the concentration of iodine in spontaneous urine (UIC = urinary iodine concentration [6]. Usually an average of urinary iodine >100 μg/L for UIC is useful in identifying the population with a sufficient supply of iodine [7], but especially in children as this sample is easy to take [1]. The concentration of thyroid hormones is an expensive and sensitive investigation [4]. Measuring the thyroglobulin in school children can be useful for measuring the function of the thyroid after iodine input [4]. After acknowledging the importance of diseases caused by the deficit of iodine (IDD) OMS recommended in 1993 the universal iodization of the salt [8]. The legislation which regards the universal iodization of salt was enacted in Romania in 2002, and it stipulates the iodization of salt used for human consumption by 34±8.5mg KI/Kg salt (40-50mg KIO3/Kg salt), applied compulsorily in the food industry for iodization of bread from the year 2004. In endemic zones it is necessary to provide iodine supplements to pregnant women and during the lactation period. Monitoring IDD also implies the quality of iodized salt, i.e. determining the percentage of iodine in the salt from the producer to the distributor.

Experimental part

Metodology

In the Diagnostics and Public Health Investigation Laboratory – The Healthy Chemical Dose in Foods section, assessed and accredited as per ISO/IEC 17025 and bearing the certificate number LI 663, tests are being conducted to determine the amount of potassium iodate and total iodine in iodised salt using volumetric analysis (titration) with sodium thiosulphate.

Principle

In the sample solution, after removing insoluble residue by filtering, iodate content is determined by titration of potassium iodate.

The following reactions take place:

$$KIO_3 + 5KI + 6\ HCl = 3\ I_2 + 6\ KCl + 3\ H_2O$$

$$I_2 + 2\ Na_2S_2O_3 = 2\ NaI + Na_2\ S_4O_6$$

The standards and reference documents used in these activities are:

-SR 8934-9/1997 - Sodium chloride. 10-PS-LCST - specific procedure to determine the content of potassium iodate.

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# All authors had equal contribution.

-SR ESPA/CN-E/109 - Sodium chloride. Titration with sodium thiosulfate for the determination of total iodine.

Tests are conducted conforming to SR 8934-9/1996.

Related materials used:

-User's manual for technical balance PG 2002 - Mettler Toledo.

-User's manual for bi-distiller with deionizer Sanyo-Fistreem Cyclon.

Volumetric analysis is a method for determining the amount of analyzed constituent by measuring the volume of the reagent solution of the known concentration (standard solution) which is consumed for quantitative reaction.

In the tests conducted, the content of potassium iodate was determined using titration after insoluble residue was removed by filtration.

If salt is preserved for longer, the iodate is partially reduced in potassium iodide and thus the total iodine is determined after prior oxidation of the potassium iodides.

The study group included 102 salt samples from Ukraine, Belarus, Greece, Italy, Turkey, Austria, analyzed for iodine content to see if they comply with accepted standards and compare them with those in our country. The NaCl content in the salt used for iodization must not be lower than 97%. In order to provide 150μg/day of iodine via iodized salt, iodine concentration in salt should be 30 mg iodine/kg of salt, respectively 50.6 mg potassium iodate/kg of salt or 39.2 mg potassium iodide/kg of salt. It is admitted as the minimum limit a content of 25mg iodine/kg of salt, respectively 42 mg potassium iodate/kg of salt or 32.5 mg potassium iodide/kg of salt, and as the maximum limit a content of 40 mg iodine/kg of salt, respectively 67.2 mg of potassium iodate/kg of salt or 52 mg potassium iodide/kg of salt.

The analyzed samples come only from European countries. An extremely interesting element is represented by the identification of countries who sell salt with iodine content and who respect or not the laws in force in Romania.

The production processes - purification, recrystallization, iodation -, packaging and labeling, as well as the transportation activities, storage and marketing of salt must deploy under the strict adherence to the hygiene norms in force for food safety, avoiding any risk of contamination.

The norms regarding food safety are applied also to imported iodized salt. The authorities / institutions with control attribution in the field of food safety have the obligation to identify or determine the presence of iodine or the concentration of iodine in iodized salt.

Results and discussions

From our study group 69% samples have adequate iodine content according to law of Romania and 31 % have inadequate iodine content (fig. 1).

The results for the lot of samples conformable to the laws in force were the following:

- samples originating predominantly from Romania- 43%

- in decreasing sequence: Ukraine 21%, Belarus 13%, Greece 12%, Italy and Turkey 4% and Austria 3

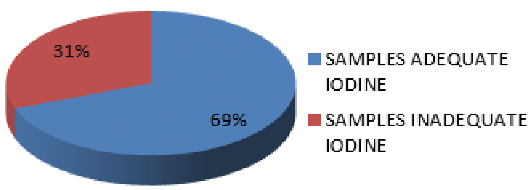

Fig. 1. Repartition of samples in the studied lot

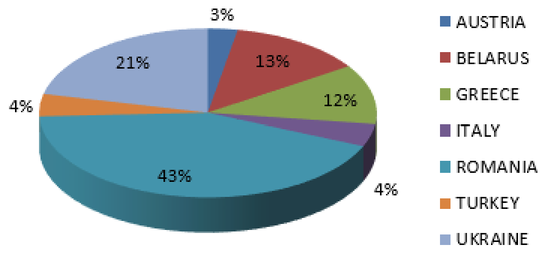

Fig. 2. Repartition of samples conformable according to origin country

The repartition according to countries of origin of unconformable samples was: Ukraine 42%, Romania 29%, Greece 26% and Belarus 3%.

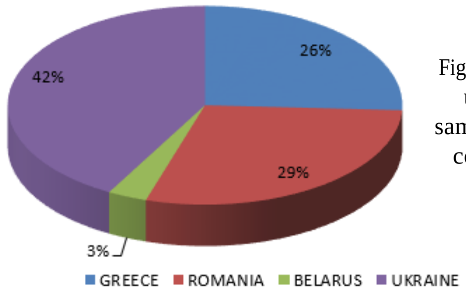

Fig. 3. Repartition of unconformable samples according to country of origin.

In the lot of unconformable samples regarding the iodine concentration there were 3 categories: samples with iodine concentration under the limit admitted by the regulations of the laws in force –below iodine; samples completely lacking iodine - no iodine and samples with a iodine concentration over the admitted maximum limit - supra iodine.

The representation of these 3 subcategories was as follows : below iodine samples -71%; no iodine samples - 16% and supra-iodine samples - 13%

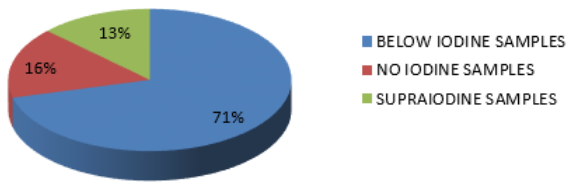

Fig. 4. Repartition of unconformable samples

The below iodine samples were allotted according to the country of origin as follows: 59% from Ukraine, 23% from Romania, 14% from Greece and 4% from Belarus.

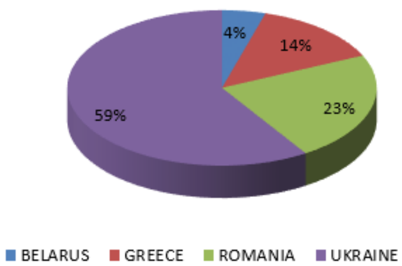

Fig. 5. Repartition according to countries of origin of below iodine samples

The supra-iodine samples come predominantly from Greece -75% and Romania- 25%.

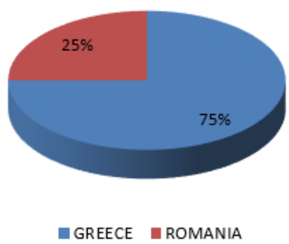

Fig. 6. Repartition according to countries of origin of supra-iodine samples

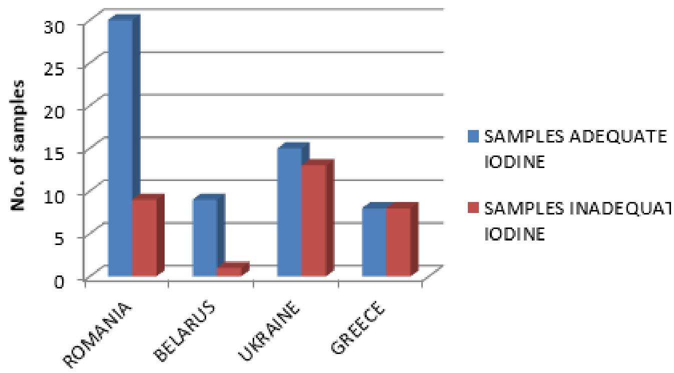

Fig. 7. Repartition of conformable and unconformable samples according to countries of origin

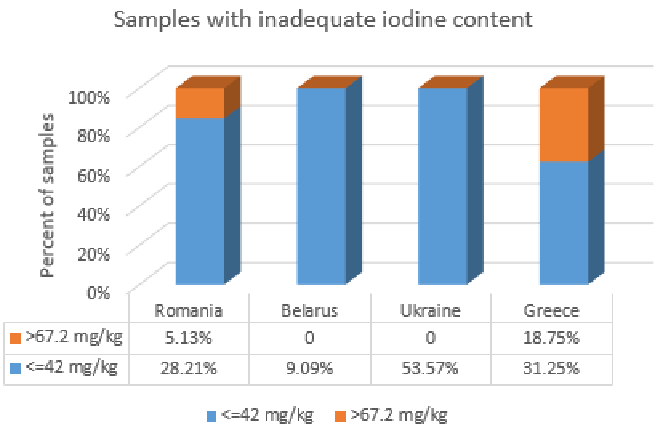

Fig. 8. Percent of samples with inadequate iodine content, below or above legally admitted values, according to country of origin

Table 1

NUMBER OF SAMPLES WITH INADEQUATE IODINE CONTENT, BELOW OR ABOVE LEGALLY ADMITTED VALUES, ACCORDING TO COUNTRY OF ORIGIN

Iodine content	Austria	Belarus	Greece	Italy	Romania	Turkey	Ukraine
<=42mg/kg	0	1	5	0	11	0	15
>=67.2mg/kg	0	0	3	0	2	0	0
Total no. samples (incl. conformable)	2	11	16	3	39	3	28

The 5 no iodine samples (16% of all the unconformable samples) come from Romania and Greece.

Taking into account the countries of origin of the studied samples, we notice the existence of conformable and unconformable products from certain countries: Romania, Ukraine, Greece and Belarus. A particular aspect is represented by the analysis of the conformable and unconformable samples originating from Romania and Belarus, where we can observe the predominance of conformable samples over the unconformable ones. In opposition we find the samples originating from Ukraine and Greece where the number of conformable samples is equal to the unconformable ones.

Most of the total unconformable samples exhibited lower iodine content than legally admitted values. Five countries (Belarus and Ukraine, shown in figure 8, as well as Italy, Turkey, Austria) did not provide any sample with iodine content above the 67.2 mg/kg of salt limit (table 1). All samples showed a fairly normal distribution in terms of iodine content, with an average of 45.78 mg potassium iodate/kg of salt (fig. 9, fig. 10). According to the median value, fifty percent of samples contained over 48.4 mg/kg of salt (table 2).

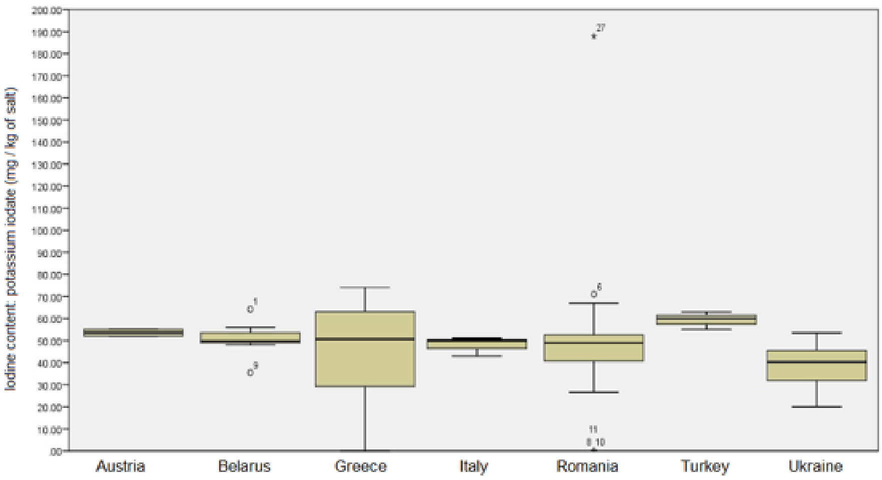

Fig. 9. Distribution of iodine content among samples of salt according to the country of origin

Table 2

AVERAGE IODINE CONTENT OF SAMPLES ACCORDING TO COUNTRY OF ORIGIN

	Austria	Belarus	Greece	Italy	Romania	Turkey	Ukraine	Total
Count*	2	11	16	3	39	3	28	102
Mean	53.55	50.68	45.03	47.97	48.12	59.33	38.86	45.78
Median	53.55	49.80	50.65	49.90	49.00	60.00	40.35	48.40
SD**	2.19	6.92	23.06	4.34	28.13	4.04	9.15	20.73
Min	52.00	35.50	0.00	43.00	0.00	55.00	20.00	0.00
Max	55.10	64.20	74.10	51.00	187.90	63.00	53.50	187.90

*No. of samples; **SD=standard deviation

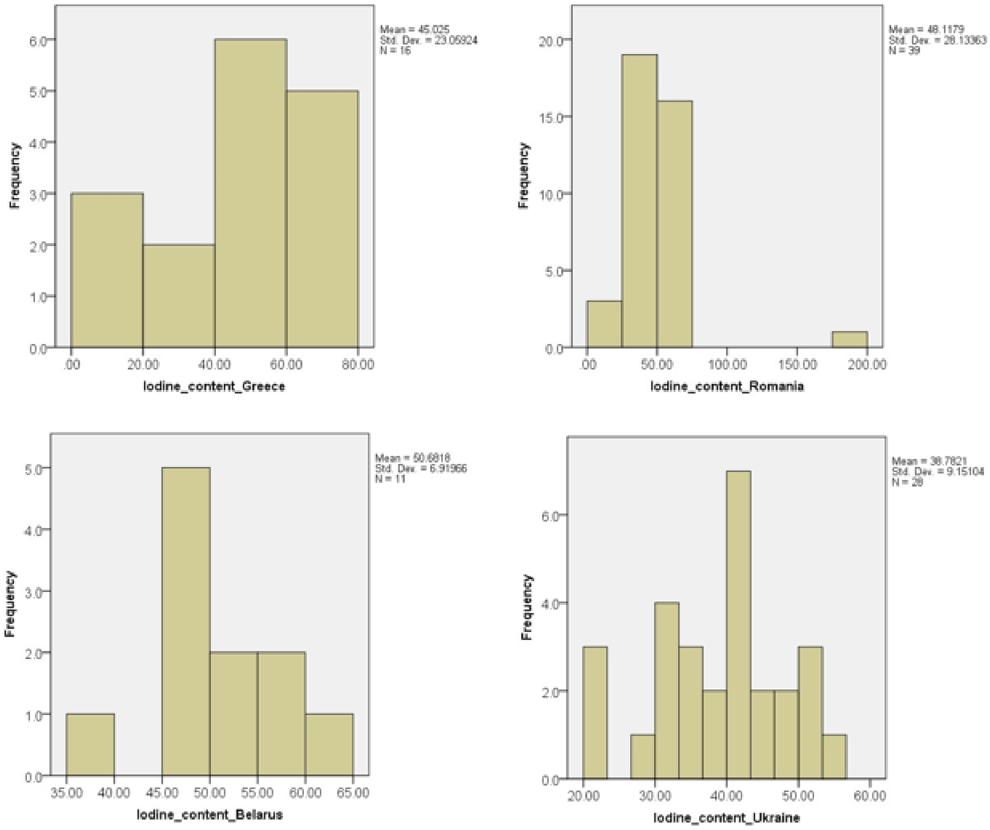

Fig. 10. Iodine content distribution among samples from Greece, Romania, Belarus and Ukraine

Table 3

DIFFERENCES BETWEEN THE RATIO OF CONFORMABLE/UNCONFORMABLE SAMPLES IN ROMANIA VERSUS OTHER COUNTRIES

	Samples conformable	Samples nonconformable	Pearson Chi-Square (value)*	Significance (p)	Odds Ratio*	95% Confidence Interval	
						Lower	Upper
Romania	26	13	-	-	-	-	-
Ukraine	13	15	2.744	**0.098**	2.308	0.851	6.257
Greece	8	8	1.335	**0.248**	2.000	0.612	6.540
Belarus	10	1	2.501	**0.114**	0.200	0.023	1.736

*Computed in comparison to values observed in Romania

No statistically significant differences between the ratio of conformable/unconformable samples in Romania versus other countries was observed ($p>0.05$). The 95% CI of the Odds Ratio obtained confirm the lack of association between country of origin and conformity of samples (table 3).

Most non-compliant samples are from Ukraine and Romania, which draws attention to the fact that there is inadequate control regarding consumer salt. The difference in comparison with the other countries arises from the fact that in Romania the salt is imported mostly from Ukraine and much less from other European countries. This does not exempt the food control authorities authorized to admit importation of products not complying with international standards on food safety and health.

The labeling of iodized salt is made according to the laws in force. The name under which the product is sold is Iodized Salt. On the territory of Romania the retail commercialization of non-iodized salt, be it for personal use or its use in public and collective alimentation, is strictly forbidden [9].

Along with these norms of food safety, the education of the population plays a very important part. It is absolutely necessary that the public should understand the importance of the use of salt and iodized food products, especially in the areas with a traditional iodine deficit. This is important especially in remote areas where nourishment is based especially on vegetal products or animals from one's own farm [10, 11].

Conclusions

From the samples of salt analyzed a great proportion of 30% do not meet accepted standards regarding iodine concentration. The analysis of the samples indicate that these products originate from Romania but also from other countries, which means that these products are incompletely controlled even from the producer to the importer and distributor.

This places stringent monitoring measures of more intense processes of enriching with iodine consumer salt coming from Romania as to achieve the appropriate concentrations legally stipulated as necessary for the human body.

It requires a rigorous control for salt coming from Ukraine by authorized institutions, so as not to allow entry into Romania of products which do not comply with international requirements and standards

Non-standard concentration of iodine in salt can have severe consequences on the health of the population. Thus, a deficit of iodine in nourishment may cause severe illnesses, the extreme form of the lack of this element being endemic cretinism.

So there is the possibility of failure prevention programs for iodine deficiency disorders(IDD).

The implementation of the use of iodized salt in processed foods needs public awareness of the risks of iodine deficiency in order to be successful and sustainable, as well as an adequate legislation which should be in line with the country's dietary customs. Also, regular monitoring of iodine nutrition status is needed, along with the cooperative role of the salt industry and food processors.

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