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Iodine Concentration in Iranian Dairy Milk Products and Its Contribution to the Consumer's Iodine Intake

Mohammad Reza Rezaei Ahvanooei[1], Mohammad Ali Norouzian[1*], Mehdi Hedayati[2]

[1] *Department of Animal and Poultry Sciences, College of Abouraihan, University of Tehran, Tehran, Iran*

[2] *Cellular and Molecular Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

Abstract

BACKGROUND: Due to the large proportion of iodine present in milk and dairy products, they have been one of the important sources of nutritional iodine in several countries. Information about variation in milk iodine concentration in Iran is limited.

OBJECTIVES: The present study was conducted to determine the iodine concentration in Iranian milk and dairy milk products.

METHODS: In the first step, 10 commercial dairy farms (five located in tropical and other located in cold region) were included in the study. In the second step, the iodine concentration of six samples of different milk products from the retail market was determined by Sandell-Kolthoff (acid-digestion) reaction.

RESULTS: The average iodine concentration of milk samples from cold region was significantly lower (50.7 ± 24.3 %) than the iodine concentration of milk samples from the tropical region ($P<0.05$). Sterilized milk (282.0 ± 111.0 µg/l) had higher and raw milk (224.3 ± 116.9 µg/l) had lower iodine concentration ($P<0.05$). There was no effect of milk fat class (whole and semi-skimmed) on milk iodine concentration ($P>0.05$).

CONCLUSIONS: Based on Iranian dairy product intake, raw, pasteurized and sterilized milk provides on average, 74.6, 84.6, 96.0 µg of iodine, approximately 29.8, 33.8, 37.6 % of the adult recommended dietary allowance for this nutrient, respectively.

KEYWORDS: Dairy cow, Human need, Iodine, Milk, Processing

Correspondence

Mohammad Ali Norouzian, Department of Animal and Poultry Sciences, College of Abouraihan, University of Tehran, Iran Tel: +98 (21) 36040907, Fax: +98 (21) 33130662, Email: manorouzian@ut.ac.ir

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Introduction

Iodine is an essential mineral for normal growth, required for thyroid hormones syntheses that have multiple functions as regulators of cell activity (Nazeri et al., 2017). Iodine deficiency can exert a decisive influence on the health status of a population, particularly children at all stages of their development (Norouzian 2011).

In many countries, the provision of iodized salt was incredibly effective at eliminating the iodine deficiency, but there is currently a major global effort to reduce daily salt consumption to reduce the risk of health problems that resulted in an increased percentage of subjects with insufficient iodine status. For this reason, considering the other sources of dietary iodine is essential (Nazeri et al., 2017).

Due to the large proportion of iodine present in dairy products, they have been one of the most important sources of nutritional iodine in several countries. For the UK adult population, dairy products typically contribute 35% to daily iodine intake (Bates et al., 2016). Also, milk and dairy products are a significant source (about 50%) of food-related iodine intake in Switzerland (Walther et al., 2018).

Analysis of iodine concentrations in dairy products in many countries has shown that the iodine content of dairy products clearly has implications for human iodine intake but there is no comprehensive analysis of the iodine concentrations in Iranian milk and dairy product and the factors that affect it. Therefore, our research aims were to quantify the iodine concentrations in Iran retail milk, and estimate the contribution of milk to iodine intakes at the current Iran population milk intakes.

Materials and methods

In the first step, 10 commercial dairy farms (with 100 or more dairy cows; five located in semi-arid area with an average annual rainfall of 120 ± 42 mm and average annual temperature of 33 ± 6.5; tropical region, and five located in a semi-cold area with average annual rainfall of 315 ± 35 mm and an average annual temperature of 26 ± 5.5; cold region of the central area of Iran) were included in the study. During the period of study, the median herd size was 235 cows and the median milk yield was 9200 kg/cow per year. Cows were milked three times a day. Nine raw milk samples were taken from each dairy farm bulk tank within a week. Samples were taken at all times of milking and 3 subsamples were pooled according to milk production of the sampling time. A total of 90 samples were collected for analysis and after every collection, a 40 ml aliquot of each milk sample was taken and stored at –20 ºC in the same freezer until iodine content analysis.

In the second step, six different milk product types (different fat classes milk: pasteurized whole milk and pasteurized semi-skimmed milk; different processed milk: raw, sterilized and pasteurized milk) were purchased from five leading supermarkets in the Tehran province, giving a total of 389 samples. In the present study milk was pasteurized by typically high- temperature short time (HTST; 72 ºC for 15 s) method and sterilization was typically done at 140 ºC for 3–5 s. All milk samples were stored at -20 ºC pending iodine analysis. The iodine concentration in milk samples was analyzed using the Sandell-Kolthoff (acid-digestion) reaction (Hedayati et al., 2007) and results were expressed as micrograms of iodine per liter of milk. Milk samples were carefully homogenized before the alkaline washing procedure.

Data were analyzed using the GLM procedure of SAS version 8 (SAS Institute, Cary, NC). In the case of two groups, Student's t test for independent samples was used. The significance threshold was set at P-value≤0.05.

Results and Discussion

The results of study 1 showed that the region of milk sampling had a significant influence ($P \leq 0.05$) on the iodine concentrations in raw milk (Table 1). The average iodine concentration of milk samples from the cold region was significantly lower (50.7 ± 24.3 %) than the iodine concentration of milk samples from the tropical region. There is limited data on the effect of region sampling on the iodine content of milk. National survey studies on the iodine concentration in milk showed considerable differences between countries, seasons, and production systems, such as conventional and organic farming (Payling et al., 2015; Crnkić et al., 2015). Plant species and variety, soil of the region, and iodine content of intake water were reported to influence milk iodine content in these regions. In another study, Dahl et al. (2003) reported higher milk iodine content in the South and East regions of Norway. These authors demonstrated that this variation may have been due to the longer period of pasture feeding and differences in the access of dairy cows to iodine-fortified fodder. Another possibility for lower milk iodine content in cold-mountainous regions can be high precipitation in these regions. All iodine compounds are readily soluble in water and high precipitation results in the release of much of their iodine content into groundwater, which reduces plant access to this trace element. Therefore, plants and animal feed grown in this area will contain lower iodine concentration compared to another region with low participation (Watts and Mitchell 2009). No information on the iodine concentrations of the diets was supplied in this study. Further investigations are required to determine the factors affecting the iodine concentration of milk.

Table 1. the effect of sampling region (cold versus tropical) on raw milk iodine content (µg/l)

	Tropical region (n= 45)	Cold region (n = 45)	P-value
Mean	306.6	150.1	<0.05
SD	102.75	56.6	
Min	194.0	76.0	
Max	439.3	220.1	

The effect of heat processing (pasteurization and sterilization) on milk iodine concentrations are shown in Table 2. Milk iodine concentration was significantly ($P<0.05$) influenced by heating processing. Sterilized milk (282.0 ± 111.0 µg/l) had higher and raw milk (224.3 ± 116.9 µg/l) had lower iodine concentration. Overall, the iodine concentration of raw milk was 20.5 ± 4.3 % and 11.8 ± 1.7 % lower than sterilized and pasteurized milk, respectively. Also, the iodine content of pasteurized milk was 9.9 ± 2.6 % lower than sterilized milk. Processing steps in the milk industry, such as heat treatment and skimming, are considered potential causes of iodine loss, but current data are limited and equivocal (Reijden et al., 2017). The iodine losses during pasteurization could also be one reason for the differences in the iodine concentrations of raw milk, in bulk milk or in milk samples from the food retail sector (Flachowsky et al., 2014). Norouzian et al. (2009, 2011) reported a 27-34% decrease in milk iodine concentration after HTST processing. In agreement with our results, Nazeri et al. (2015) showed higher iodine concentration in sterilized milk as compared to raw and pasteurized milk. This increase of milk iodine after heating processing is probably due to condensation and reduction in the volume of milk after the high temperature during sterilization (140 ºC) and pasteurization (72 ºC; Nazeri et al., 2015). Similarly, this effect was reported during the production of whey cheese whereby the whey is boiled in order to remove water, resulted in increases in the concentration of iodine in the remaining product and explains the higher iodine concentration in whey cheese (Dahl et al., 2003). On the other hand, another possible reason for lower raw milk iodine concentration may be due to the variation of milk iodine concentration in the different dairy farms. Thus, any high iodine concentrations in raw milk from one farm will be diluted by lower concentrations in milk from other farms resulting in lower iodine concentration of bulk raw milk (Soriguer et al., 2011; Bath et al., 2012).

Table 2. the effect of heat processing on milk iodine concentration (µg/l)

	Raw (n=90)	Pasteurized (n = 72)	Sterilized (n = 54)	P value
Mean	224.3	254.0	282.0	<0.05
SD	116.9	114.5	111.0	
Min	76.0	66.9	90.6	
Max	439.3	444.8	590.6	

The effect of milk fat class (whole and semi-skimmed milk) on iodine concentration is shown in Table 3. There was no effect of milk fat type on milk iodine concentration (P>0.05). Small (Soriguer et al., 2011) or no (Payling et al., 2015) variations in milk iodine concentration have been reported for different milk classes. In agreement with our findings, Arrizabalaga et al. (2015) reported that iodine concentration between 3 milk varieties: whole, semi-skimmed, and skimmed milk, had no significant differences. In the study of Soriguer et al. (2011) iodine concentration of whole, semi-skimmed and skimmed milk was 251, 254 and 273 µg/l, respectively. No same effect was seen in the present and another study (Payling et al., 2015). Milk iodine variation due to fat content is very small compared with the large variation in iodine concentration seen in most studies (Payling et al., 2015).

The Iranian consumption of dairy products as milk equivalents is 112.5 kg per capita in 2016. In the present study the contribution of raw, pasteurized, and sterilized milk to the actual iodine supply of the Iranian population was estimated (Figures 1-3). The contribution of the different groups of milk products was estimated based on of their per capita consumption in 2016.

The resulting estimation showed that daily intake of one and a half cup of raw, pasteurized and sterilized milk provides on average, 74.6, 84.6, 96.0 µg of iodine, approximately 29.8, 33.8, 37.6 % of the adult recommended dietary allowance (WHO 2007) for this nutrient, respectively. Based on calculations of Reijden et al. (2017), milk and dairy contribute 13-64% of the recommended daily iodine intake in industrialized countries.

In conclusion, the present study demonstrated that this concentration of iodine in milk does not pose a public health threat concerning element; however, milk and dairy products possibly play an important role as iodine sources in the Iranian population.

Table 3. the effect of milk fat class on milk iodine concentration (µg/l)

	Full fat (n=81)	Semi-skimmed (n = 72)	P-value
Mean	259.7	260.3	<0.05
SD	120.9	146.3	
Min	66.9	90.9	
Max	422.4	590.6	

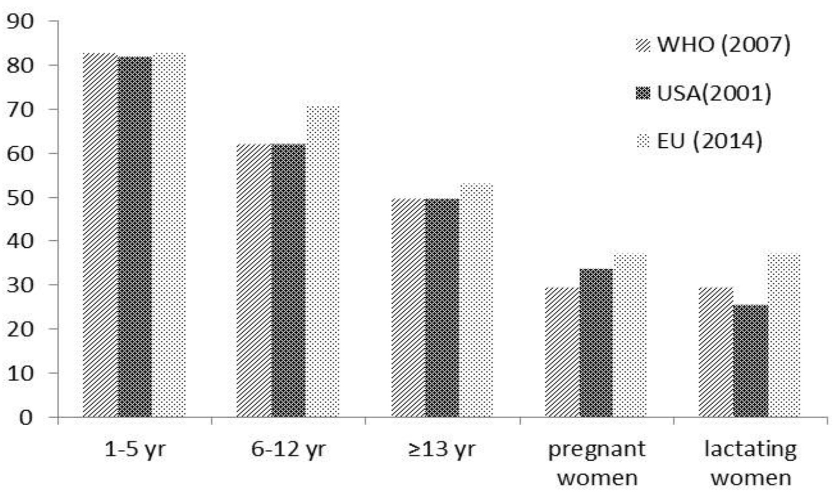

Figure 1. Contribution of raw milk to the different groups recommended daily iodine intake (% of need)

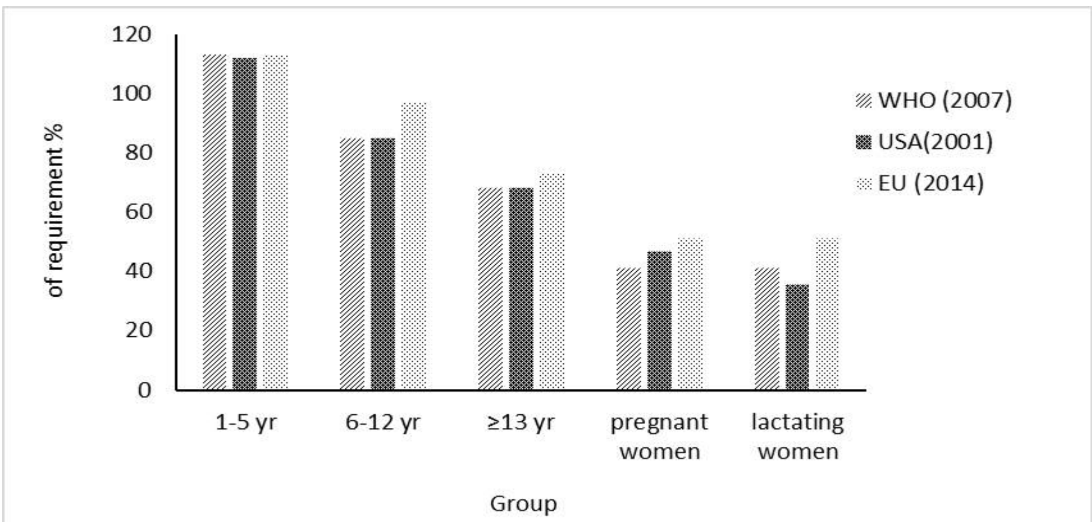

Figure 2. Contribution of pasteurized milk to the different groups recommended daily iodine intake (% of need)

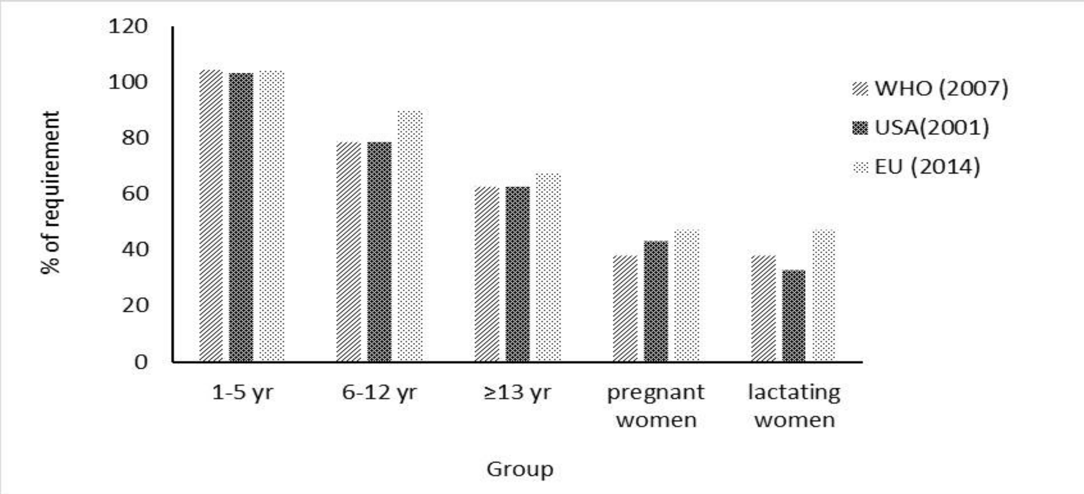

Figure 3. Contribution of sterilized milk to the different groups recommended daily iodine intake (% of need)

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Conflicts of Interest

The authors declared that there are no conflicts of interest.

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مجله طب دامی ایران، ۱۳۹۹، دوره ۱۴، شماره ۲، ۱۶۶-۱۵۹

بررسی غلظت ید محصولات لبنی ایران و سهم آن در تامین نیاز مصرف‌کنندگان

محمدرضا رضائی آهوانوئی[۱]، محمدعلی نوروزیان*[۱]، مهدی هدایتی[۲]

[۱]گروه علوم دام و طیور، پردیس ابوریحان، دانشگاه تهران، تهران، ایران
[۲]پژوهشکده علوم غدد درون ریز و متابولیسم، دانشگاه شهید بهشتی، تهران، ایران

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چکیده

زمینه مطالعه: امروزه شیر به‌عنوان منبع مهمی برای تأمین نیاز ید روزانه گروه‌های مختلف سنی در برخی کشورها مطرح است اما در ایران اطلاعات زیادی در مورد غلظت ید شیر مصرفی موجود در بازار وجود ندارد.

هدف: هدف از این مطالعه تعیین غلظت ید شیر مصرفی موجود در بازار و بررسی میزان سهم آن در تامین نیاز گروه های مختلف سنی افراد جامعه است.

روش کار: در مرحله اول این مطالعه، از تانک حجمی شیر ۱۰ گاوداری صنعتی (در دو منطقه گرمسیر و سردسیر استان تهران) نمونه برداری شد. در مرحله دوم نیز شش برند شیر پرمصرف بازار انتخاب و غلظت ید نمونه‌های بدست آمده به روش سندل کالتوف اندازه‌گیری شد.

نتایج: شیر خام گاوداری‌های مناطق سردسیر ۲۴/۳ ± ۵۰/۷ درصد ید کمتری نسبت به نمونه‌های شیر خام گاوداری‌های مناطق گرمسیر داشتند (P<۰/۰۵). شیر استریلیزه (۱۱۱/۰ ± ۲۸۲/۰ میکروگرم در هر لیتر) ید بیشتری نسبت به شیر خام (۱۱۶/۹ ± ۲۲۴/۳ میکروگرم در هر لیتر) داشت (P <۰/۰۵). محتوای چربی نمونه‌های آزمایشی (شیرپرچرب یا کم چرب) اثری بر غلظت ید نداشت (P>۰/۰۵).

نتیجه گیری نهایی: نتیجه گیری نهایی: بر اساس میانگین مصرف شیر جامعه ایرانی، شیرهای خام، پاستوریزه و استریلیزه بطور میانگین به ترتیب ۷۴/۶، ۸۴/۶ و ۹۶/۰ میکروگرم و یا به ترتیب ۲۹/۸، ۳۳/۸ و ۳۷/۶ درصد نیاز ید روزانه افراد بزرگسال را تأمین می کنند.

واژه‌های کلیدی:

شیر، فرآوری، ید، نیاز انسان، گاو شیری.

نویسندهٔ مسئول: محمدعلی نوروزیان، گروه علوم دام و طیور، پردیس ابوریحان، دانشگاه تهران، تهران، ایرا. ایمیل: manorouzian@ut.ac.ir