Journal of Trace Elements in Medicine and Biology 46 (2018) 138–143

Contents lists available at ScienceDirect

Journal of Trace Elements in Medicine and Biology

journal homepage: www.elsevier.com/locate/jtemb

Food chain

Iodine in Swiss milk depending on production (conventional versus organic) and on processing (raw versus UHT) and the contribution of milk to the human iodine supply

Barbara Walther[a,*], Daniel Wechsler[a], Patrick Schlegel[b], Max Haldimann[c]

[a] Agroscope, Schwarzenburgstrasse 161, CH-3003 Bern, Switzerland
[b] Agroscope, Tioleyre 4, 1725 Posieux, Switzerland
[c] Federal Food Safety and Veterinary Office FSVO, 3003 Bern, Switzerland

ARTICLE INFO

Keywords:
Iodine
Swiss milk
Conventional milk
Organic milk
Seasonal variation

ABSTRACT

The iodine content in milk depends on various factors, including the season, production system, and location of milk production. The aim of this study was 1) to obtain data on the iodine concentration of conventional and organically produced milk and according to seasons; 2) to compare these actual data with previous measurement data; 3) to study the influence of UHT treatment on the iodine content and 4) to estimate the contribution of organic and conventional milk to the consumer's iodine intake.

A total of 110 samples of conventional and organic ultra-heat treated (UHT) whole milk were collected in the period between 1 May 2013 and 30 April 2014 from two large-scale companies, processing milk from two regions in Switzerland. The iodine concentration in organic milk (average 71 ± 25 µg/l) was significantly lower than in conventional milk (average 111 ± 26 µg/l) and varied between suppliers. Milk iodine concentration varied according to the month of collection in organic and conventionally produced milk, with lowest values between August and October (organic milk 42 µg/l; conventional milk 75 µg/l) and highest values in January (organic milk 99 µg/l; conventional milk 145 µg/l). Heat treatment did not influence iodine concentration. Since milk and dairy products are significant source of food-related iodine intake in Switzerland, consumers who prefer organic milk and dairy products are likely to have an inferior iodine status.

1. Introduction

Iodine is an essential element for thyroid hormone production. A too low dietary iodine offer may create a thyroid hormone deficit with deficiency symptoms including cretinism, brain damage, irreversible mental retardation, deaf-mutism, and goitre. Iodine deficiency, with its various mental and physical consequences is part of the history of most European countries, especially in alpine regions of Austria, France, Italy, and Switzerland [1]. These regions are characterized by iodine deficient soils, where iodine has been washed away by glaciation [2].

In the 19th century, the high prevalence of goitre and cretinism in Swiss alpine regions was recognized, and the relationship between scarce iodine and goitre was established. Initial studies with iodised salt in the valley of Zermatt by a general practitioner could successfully reduce iodine deficiency and its consequences [3]. In 1922, the Swiss Goitre Commission recommended that salt should be iodised at a level of 3.75 mg iodine per kg salt. Since then, the iodisation concentration has been continuously raised as a result of the regular monitoring of Swiss children and pregnant women [4] to actually 25 mg per kg [5].

Depending on country and organization, the recommended daily intake (RDI) for iodine may vary considerably. The Swiss RDI for iodine are based on the WHO recommendations (children < 5 years 90 µg/day, children 5–12 years 120 µg/day, children > 12 years and adults 150 µg/day, pregnant or breastfeeding women 250 µg/day) [6]. In Switzerland, approximately 50% of iodine intake is covered by iodised salt as possible part of processed food or food prepared at home [7]. The other 50% of the intake comes from food – mainly milk and dairy products [8]. The regular monitoring of urinary iodine excretion of Swiss population groups revealed a decrease in the iodine supply in children and pregnant women between 2004 and 2009 [9]. The changes in the iodine supply of the Swiss population are thought to be the results of different causes. The proportion of iodised salt in industrial food production was reduced in the past few years to avoid export problems (for example, the use of iodised salt in processed food is not allowed in France [10]). Considering the association of a high salt consumption with increased risk for hypertension and a higher

* Corresponding author.
E-mail address: barbara.walther@agroscope.admin.ch (B. Walther).

https://doi.org/10.1016/j.jtemb.2017.12.004
Received 10 April 2017; Received in revised form 19 December 2017; Accepted 21 December 2017

prevalence of coronary heart diseases, the Swiss Federal Food Safety and Veterinary Office called for action to reduce salt intake as recommended by the WHO [11]. The decreasing consumption of iodised salt simultaneously led to a reduction in iodine intake, and as a consequence, the iodine content in iodised salt had to be increased [10],4].

National survey studies on the iodine concentration in milk showed considerable differences between countries, seasons, and production systems, such as conventional and organic farming [12–22]. The aim of the present study was therefore to obtain data on the iodine content in conventionally and organically produced consumer milk of Swiss origin and its seasonal variation. A comparison with data collected in Switzerland in a similar way about 25 years ago was made to show the evolution of iodine concentration in Swiss raw milk. Moreover, an attempt was made to investigate the influence of processing (UHT treatment) on iodine content, and to estimate the contribution of conventionally and organically produced milk and milk products to the actual iodine supply of the Swiss population. For simplification, the terms organic and conventional milk and milk products are used in the following text.

2. Material and methods

2.1. Sampling

A total of 110 samples of conventional and organic UHT whole milk (min. 3.5% fat) were collected in the period between 1 May 2013 and 30 April 2014. The samples were collected from two large-scale companies, one located in the middle of the country (company A) and the other in the western part of Switzerland (company B). Together they cover more than 50% of the Swiss market for UHT milk. From company A, 27 conventional and 27 organic milks were sampled at intervals of 2 weeks. At company B, 28 conventional and 28 organic milk samples were collected in the same way. After sampling, the commercial milks (0.25 l, 0.5 l or 1 l) were frozen at −20 °C and transferred to the laboratory of the Swiss Federal Food Safety and Veterinary Office (FFSV) for the determination of the iodine content.

In addition, before and after the UHT treatment at both plants, milk samples were taken from 4 batches of conventional and 4 batches of organic milk to investigate the influence of heat treatment on the iodine content of the processed milk.

2.2. Sample preparation and analysis

Milk samples (1.5 g) were weighed into graduated 50 ml tubes and extracted with 0.5 ml tetramethylammonium hydroxide 25% (Fluka Sigma-Aldrich, Buchs, Switzerland) for a duration of 3 h at 90 °C in a heat cabinet. The tubes were filled up to the 50 ml mark with deionised water. They were then closed, shaken, and left over night for sedimentation at ambient temperature to separate solid particles in the suspension. Aliquots of 10 ml were pipetted from the middle of the tubes in order to avoid taking up any sediment from the bottom or parts of the fat fraction on top of the solution. The aliquots were then spiked with 25 µl of a solution containing 33.5 ng of ^{129}I (NIST SRM 4949C, Gaithersburg, MD, USA) and mixed for the final ICP-MS measurement.

The ^{129}I/^{127}I ratios in the sample solutions were measured using an Element2 sector-field ICP-MS (Thermo Scientific, Bremen, Germany) at a low resolution setting of $m/\Delta m = 300$. The ICP-MS was equipped with a special high-solids nebuliser and a small cyclonic spray chamber. The amount of iodine was calculated from the change of the isotope ratio induced by the addition of the long-lived radio isotope ^{129}I, which is chemically identical [23]. Thus, the susceptibility to errors is the same for both isotopes and the ratio remains unchanged. Iodine determination in biological materials by ICP-MS does not exhibit a bias against spectrophotometric measurement of Sandell–Kolthoff reduction reaction catalysed by iodine ([4,24]), a method that was used in previous milk studies [21]. Hence, comparability of the results has been ensured.

The whole milk powder reference material RM 8435 from NIST (Gaithersburg, MD, USA) and the skimmed milk powder reference material ERM® – BD151(European Commission, Institute for Reference Materials and Measurements (IRMM) Geel, Belgium) were included in each run (n = 12). The measured iodine concentrations of 2.6 ± 0.73 mg/kg and 1.6 ± 0.05 mg/kg dry matter (DM) agreed well with the reference concentrations of 2.3 ± 0.40 mg/kg and 1.7 ± 0.05 mg/kg, respectively, at the 95% confidence interval (CI).The available milk reference materials were either in the offset range or at the upper end of the measured sample concentrations; however, the concentration of the ^{129}I spike was set that the resulting ^{129}I/^{127}I ratios yield the best possible precision and accuracy also for lower concentrations [25].

2.3. Statistics

Data processing and statistical analyses were carried out by using SYSTAT 13 (Systat Software Inc., San Jose, CA, USA). Following descriptive analysis, iodine responses in milk were evaluated using a full factorial analysis of variance (ANOVA) model that included month of collection (May 2013 until April 2014), regionally different producers (A, B) and production system (organic, conventional) as independent variables. After fitting the ANOVA model, a Bonferroni multiple comparison test was performed to compare the means of the iodine values for grouping variables of interest. A paired *t*-test was used to estimate a UHT milk treatment effect.

3. Results and discussion

3.1. Influence of conventional and organic farming on milk iodine content with consideration of season and region

The production system had a significant influence ($p < 0.0001$) on the iodine concentrations in conventional and organic UHT milk (Table 1). Organic UHT milk contained on average 36% less iodine than

Table 1
Iodine content of organic and conventional UHT-milk (µg/l) sampled in 2013/14.

	UHT-milk Company A (2013/14)		UHT-milk Company B (2013/14)		UHT-milk Mean (2013/14)	
	conventional (*N = 28*)	organic (*N = 28*)	conventional (*N = 27*)	organic (*N = 27*)	conventional (*N = 55*)	organic (*N = 55*)
Mean[a]	107	62	116	81	111	71
SD	26	18	25	28	26	25
Min	62	35	74	42	62	35
Max	148	99	151	135	151	135

[a] According to the Bonferroni multiple comparison test, significance of the differences in the iodine content between conventional and organic and Company A vs. Company B were $p < 0.05$ and $p < 0.0001$, respectively.