Food Chemistry 178 (2015) 327–330

Contents lists available at ScienceDirect

Food Chemistry

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

Effect of milk type and processing on iodine concentration of organic and conventional winter milk at retail: Implications for nutrition

Laura M. Payling, Darren T. Juniper, Chris Drake, Caroline Rymer, D. Ian Givens *

Food Production and Quality Division, Faculty of Life Sciences, University of Reading, Reading RG6 6AR, UK

ARTICLE INFO

Article history:
Received 11 August 2014
Received in revised form 1 December 2014
Accepted 19 January 2015
Available online 24 January 2015

Keywords:
Iodine
Milk
Organic
UHT
Fat class

ABSTRACT

Milk is the largest source of iodine in UK diets and an earlier study showed that organic summer milk had significantly lower iodine concentration than conventional milk. There are no comparable studies with winter milk or the effect of milk fat class or heat processing method. Two retail studies with winter milk are reported. Study 1 showed no effect of fat class but organic milk was 32.2% lower in iodine than conventional milk (404 vs. 595 μg/L; $P < 0.001$). Study 2 found no difference between conventional and Channel Island milk but organic milk contained 35.5% less iodine than conventional milk (474 vs. 306 μg/L; $P < 0.001$). UHT and branded organic milk also had lower iodine concentrations than conventional milk (331 μg/L; $P < 0.001$ and 268 μg/L: $P < 0.0001$ respectively). The results indicate that replacement of conventional milk by organic or UHT milk will increase the risk of sub-optimal iodine status especially for pregnant/lactating women.

1. Introduction

Iodine is a key component of the hormones produced by the thyroid gland which are particularly important during pregnancy for foetal brain development (Zimmermann, 2009). The UK Reference Nutrient Intakes (RNI) for iodine are 130 and 140 μg/d for children aged 11–14 years and adults respectively with no increase during pregnancy or lactation (Department of Health, 1991), compared with 150 μg iodine/d for adults by the US Institute of Medicine (IOM) and the World Health Organisation (WHO). IOM also proposes an increase of 47% and 93% during pregnancy and lactation respectively whereas WHO advises an increase of 67% for both (Zimmermann, 2009). In many countries provision of iodised salt has reduced the incidences of iodine deficiency, but in countries such as the UK widespread interventions have not been enforced (Phillips, 1997). This has led to a sustained level of mild iodine deficiency in many populations, notably about 44% of children and adults in Europe (Zimmermann & Andersson, 2011).

For some time the UK population has been assumed to be of adequate iodine status (Wenlock, Buss, Moxon, & Bunton, 1982). However, a study in UK schoolgirls recorded mild iodine deficiency in 51% of the participants based on urinary iodine concentrations (Vanderpump et al., 2011) and the recently published UK National Diet and Nutrition Survey (Bates et al., 2014) reports that on average, young females aged 11–18 years consume only 81% of the RNI for iodine and that 22% of young females have iodine intakes below the Lower RNI (70 μg iodine/d). In addition, mild-to-moderate iodine deficiency has been demonstrated in a large UK cohort of pregnant women (Bath, Walter, Taylor, Wright, & Rayman, 2014) together with evidence of an association between low maternal iodine status in early pregnancy and poorer verbal IQ, reading accuracy and reading comprehension in the children (Bath, Rayman, Steer, Golding, & Emmett, 2013).

In the UK, milk and dairy foods are the largest dietary source of iodine providing 40% and 39% of the daily intake of iodine for 11–18 year old males and females respectively (Bates et al., 2014). Both genders obtain the majority (∼43%) of the dairy food contribution from semi-skimmed milk (Bates et al., 2014). Survey studies on milk iodine concentrations carried out in the last 14 years (Food Standards Agency, 2008; Ministry of Agriculture, Fisheries & Food, 2000) are not suggestive of any overall reduction in UK milk iodine concentration but they do show that iodine concentration is highly variable and that milk produced in the summer has on average, a 50% lower iodine concentration than winter milk. Moreover, the studies of The Food Standards Agency (2008) and Bath, Button, and Rayman (2012) both showed that summer milk from organic dairy systems had significantly lower (∼−40%) iodine concentrations than from conventional systems. These findings clearly have implications for human iodine intake and status but there is little evidence on conventional vs. organic milk produced in winter, the effect of milk fat class (whole, semi-skimmed, skimmed) or

* Corresponding author. Tel.: +44 118 378 8491.
E-mail address: d.i.givens@reading.ac.uk (D.I. Givens).

http://dx.doi.org/10.1016/j.foodchem.2015.01.091
0308-8146/© 2015 Published by Elsevier Ltd.

the effect of milk processing method. Accordingly, two UK retail studies were therefore undertaken with the objectives of comparing the iodine content of (1) organic and conventional winter milk, (2) whole, semi-skimmed and skimmed milk and (3) pasteurised and ultra-high temperature (UHT) treated milk.

2. Materials and methods

2.1. Milk samples

In Study 1, the intention was to purchase two samples of pasteurised conventionally and organically produced whole (full fat), semi-skimmed and skimmed milk from two leading supermarkets in the Reading area in late January 2014. However, Supermarket 1 did not stock organic skimmed milk when visited, leading to a total of 22 samples. In Study 2, five different milk product types (conventional semi-skimmed, organic semi-skimmed, branded organic semi-skimmed, UHT semi-skimmed and conventional whole milk from Channel Island breeds of cow) were purchased from four leading supermarkets in the Reading area in each of three consecutive weeks, beginning in the first week of February 2014 giving a total of 60 samples. Except for the UHT milk, all other types were pasteurised. In both studies all milks were supermarket own brand except for the branded organic milk in Study 2. All milk samples were stored at −20 °C pending analysis.

2.2. Sample analysis

Milk samples were allowed to defrost overnight and thoroughly mixed by vortexing before analysis. Samples from Study 1 had fat, protein and lactose concentrations measured by methods of International Organisation for Standardisation (2008), Davis and Macdonald (1953) and Sanchez-Manzanarea, Fernandez-Villacaas, Marin-Iniesta, and Laencina (1993) respectively. Iodine concentration was measured in all samples by alkali extraction followed by inductively coupled plasma mass spectrometry (ICP-MS) based on the method of Fecher, Goldmann, and Nagengast (1998). In brief 100 μl of milk were diluted to 10 ml with 2% tetramethyl ammonium hydroxide in ultra-pure water and containing 5 μg/L of rhodium as an internal standard. Analysis was then undertaken by ICP-MS (iCAP Q, Thermo Scientific Scientific Inc. Waltham, MA, USA). Certified standard solutions (Romil Ltd, Cambridge, UK) based on ammonium iodide were treated as for milk samples leading to final concentrations of 0, 2, 4, 6, 8 and 10 μg/L iodine.

2.3. Statistical analysis

The effect of milk product type (conventional production, Channel Island, organic production, UHT, branded organic), milk fat class (whole, semi-skimmed, skimmed) and supermarket of origin were determined as appropriate to each study, by fixed effect analysis of variance using a general linear model (Mintab version 16; Minitab Inc., State College, PA, USA). Tukey's pairwise multiple comparison test was then used to identify which treatments were significantly different from each other when the significance was $P < 0.05$.

3. Results

3.1. Study 1

There was no significant effect of conventional vs. organic production system on fat, protein or lactose contents of the milks. Fat content was significantly ($P < 0.001$) affected by milk fat class with mean values of 3.55, 1.42 and 0.01 g/100 g for whole, semi-skimmed and skimmed milk respectively. The iodine concentrations of the milks are shown in Table 1. There was no effect of milk fat class and overall, no fat class × production system interaction although such an interaction was seen for milk from Supermarket 2 which was related to some small fat class effects ($P < 0.05$) in conventional but not organic milk. Overall, there was a significant ($P < 0.001$) effect of production system with organic milk having consistently lower iodine concentrations than conventional. Mean iodine concentration in organic milk was 32.2% lower than of conventional.

3.2. Study 2

The iodine concentrations of the milk types are shown in Table 2. Overall, milk iodine concentration was not affected by supermarket but was significantly ($P < 0.001$) influenced by milk production system with organic and branded organic milk having lower iodine concentrations than conventional. Branded organic milk had the lowest mean iodine concentration and this had a tendency to be lower than own-brand organic ($P < 0.059$). Overall, the iodine concentration of organic (including branded organic) milk was 35.5% lower than conventional. A production system x supermarket interaction ($P < 0.05$) was seen due to Supermarket 2 having unusually high iodine concentrations in its milk labelled as organic. If data from this supermarket are excluded the iodine concentration of organic (including branded organic) milk was 43.9% lower than conventional. Interestingly, conventionally produced UHT milk had a lower ($P < 0.05$) iodine concentration than conventional pasteurised milk with a mean value not significantly different to organic milk. Iodine in Channel Island milk was not significantly different to conventional milk.

4. Discussion

To our knowledge, this is the first balanced comparison of the iodine concentration of conventional and organic UK retail milk produced in the winter. The Food Standards Agency (2008)

Table 1
Study 1: least square mean (±SE) iodine concentrations of retail milk as influenced by milk fat class (FC), production system (conventional vs. organic; PS) and supermarket (SM).

Supermarket	Mean iodine concentration (μg/L)										
	Conventional			Organic			P-Value for				
	Whole $n = 4$	Semi-skimmed $n = 4$	Skimmed $n = 4$	Whole $n = 4$	Semi-skimmed $n = 4$	Skimmed $n = 2$	SED	FC	PS	FC × PS	SM × PS
1	486.0 ± 7.0	560.0 ± 20.0	502.5 ± 3.5	482.5 ± 7.0	454.0 ± 8.0	nd	nd	NS	NS	nd	–
2	669.5 ± 3.5[ab]	585.5 ± 21.5[b]	768.5 ± 24.5[a]	316.0 ± 21.0[c]	419.0 ± 41.0[c]	325.5 ± 12.5[c]	33.43	NS	<0.001	0.003	–
Overall	577.8 ± 53.1[a]	572.8 ± 14.1[a]	635.5 ± 77.4[a]	399.2 ± 48.9[b]	436.5 ± 19.8[b]	325.5 ± 12.5[b]	40.67	NS	<0.001	NS	<0.001

NS, not significant ($P > 0.05$).
nd, no or insufficient data due to missing samples.
SED, standard error of the difference.
[a,b,c] Means within a row with no superscripts or those with a common superscript are not significantly different ($P > 0.05$).