



## Nutrition

## Nutritional status/supply status

# Defining sources, variability and bioavailability of iodine in milk and dairy products to ensure adequate iodine nutrition in the Swiss population

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### Key words

Milk, iodine, bioavailability, conventional farming, organic farming, dose-response

### Aim of the study

The overall aim of this project was to provide the scientific basis for recommendations on how to better control variability in milk and dairy iodine concentration optimal for human iodine intakes in Switzerland, thus avoiding both iodine deficiency and iodine excess. To achieve this, the following specific aims were defined:

- 1) To quantify the main sources influencing iodine content of cow's milk in Swiss dairy farming
- 2) To investigate the dose-response relationship between feed iodine and milk iodine under Swiss farming conditions
- 3) To quantify iodine losses in dairy production
- 4) To quantify iodine absorption from milk and compare it to absorption from added inorganic iodine

### Material and methods

In part 1, bulk milk samples over all four seasons, feed samples as well as information on farming and feeding practices were collected from 32 farms throughout Switzerland and from the Aosta Valley. Using feed iodine content as well as the data collected from the farmers, the main influencing factors on milk iodine content were determined. Parts 2 and 3 included two experiments investigating the iodine distribution and accumulation during milk production and processing: 1) a dose-response experiment on iodine in milk at iodine supplementation levels in feed of 0, 0.5, 0.7, 1, and 2 mg iodine/kg dry matter, and 2) a dose-response experiment on iodine in dairy products (cheese and yoghurt) using milk with increasing iodine concentration. In part 4, we conducted a cross-over balance study in 11 male and female adults to determine iodine bioavailability and its dependence on milk matrix and iodine source.

### Results and significance

On Swiss farms we found a median (min-max) milk iodine concentration of 87 (5-371) µg/L with farm type (organic versus conventional), season and teat disinfection with an iodine-containing disinfectant as significant predictors of milk iodine. In our study on iodine concentrations in milk and dairy products, we demonstrated a linear relationship between feed and milk iodine ( $R_2=0.96$ ), reaching a near-steady state after about 3 weeks of feeding. Further, we found that most of the iodine ( $\approx 80\%$ ) was lost in whey at curd separation in milk processing. Nevertheless, dairy iodine increased linearly with milk iodine ( $R_2>0.95$ ) and cellar ripening did not influence the iodine concentration of the semi-hard cheeses. Iodine speciation showed iodide as the only detectable iodine fraction in both raw and heat treated milk and heat treatment had no effect on milk iodide fraction or on total iodine. In our cross-over balance study, we were finally able to show that urinary iodine excretion increased linearly with iodine intake and neither the form of iodine (intrinsic versus extrinsic) nor the milk matrix affected urinary iodine excretion. We further showed, that fractional iodine absorption was reduced with higher ( $\sim 350$ - $450$  µg/d) compared to lower ( $\sim 100$ - $200$  µg/d) iodine intakes ( $p<0.001$ ).

At present, considering the large variation of iodine in milk found, milk is an unreliable iodine source in human nutrition. However, by standardizing iodine supplementation in dairy cow feeding, e.g. adding a defined amount of iodine to only one of the feed components, and by replacing iodine containing disinfectants with other products, it should be possible to reach a more standardized milk iodine concentration. A supplementation level of

1-2 mg iodine/kg dry matter feed on a daily basis would further yield milk with an iodine concentration of 150-300 µg/l, thus providing 25-50% of the adult recommended daily allowance for iodine at current Swiss intake levels.

#### **Publications, posters and presentations**

Publication:

- O.L. van der Reijden, M.B. Zimmermann, V. Galetti (2017) Iodine in dairy milk: Sources, concentrations and importance to human health. *Best Practice & Research in Clinical Endocrinology & Metabolism*, 31, 4, 385.
- O.L. van der Reijden, V. Galetti, M. Hulmann, A. Krzystek, M. Haldimann, P. Schlegel, E. Manzocchi, J. Bérard, M. Kreuzer, M.B. Zimmermann, I. Herter-Aeberli (2018) The main determinants of iodine in cow's milk in Switzerland are farm type, season and teat dipping. *British Journal of Nutrition*, 119, 5, 559.
- O.L. van der Reijden, V. Galetti, I. Herter-Aeberli, M.B. Zimmermann, C. Zeder, A. Krzystek, M. Haldimann, A. Bamaz, M. Kreuzer, J. Bérard, P. Schlegel (submitted) Effects of feed iodine concentrations and milk processing on iodine concentrations of cow's milk and dairy products, and potential impact on iodine intake in Swiss adults. Submitted to *British Journal of Nutrition* (2018).
- O.L. van der Reijden, V. Galetti, S. Bürkli, C. Zeder, A. Krzystek, M. Haldimann, J. Bérard, M.B. Zimmermann, I. Herter-Aeberli (submitted) Iodine bioavailability from cow's milk: a randomized, crossover balance study in healthy iodine-replete adults. Submitted to *American Journal of Nutrition* (2019).

#### **Oral presentations related to this project were presented at the following conferences:**

EXPO, 2015, Milan, Italy  
11<sup>th</sup> eco.naturkongress, 2016, Basel, Switzerland  
21<sup>st</sup> International Congress of Nutrition, 2017, Buenos Aires, Argentina  
87<sup>th</sup> Annual Meeting of the American Thyroid Association, 2017, Victoria, United States  
Nutrition 2018, Boston, United States  
Bioavailability, 2018, Norwich, United Kingdom  
World Food System Center Research Symposium 2018, ETH Zurich, Switzerland  
41<sup>st</sup> Annual Meeting of the ETA, 2018, Newcastle, United Kingdom

#### **Posters related to this project were presented at the following conferences/events**

World Food System Center Research Symposium 2016, ETH Zurich, Switzerland  
Frühjahrstagung 2017, ETH Zurich, Switzerland  
World Food System Center Research Symposium 2017, ETH Zurich, Switzerland

#### **Project 5.15.01**

**Project duration:** 15.03.2015 bis 14.03.2019