



Preliminary communication

Assessment of acrylamide intake by duplicate diet study

Summary

A *duplicate diet study* was performed to get a more accurate image of the acrylamide intake in the Swiss diet. 27 participants (13 women and 14 men, aged 16-57) delivered during two days a mirror image (duplicate) of their diet to the laboratory. The acrylamide concentration was analysed in the solid food; the beverages were not sampled but noted in records. The contribution of beverages was estimated by calculation from the recorded consumption and the acrylamide content separately analysed in the different beverages. The mean daily intake was measured at 0.28 µg/kg bw. The contribution of the different meals and beverages to the intake was as follows: breakfast 8%, lunch 21%, dinner 22%, snacks 13% and coffee 36%. Even if the consumption of baked, roasted, fried and deep fried potatoes is considered to be below Swiss average in this study, the survey leads to the conclusion that coffee is a significant source of acrylamide in a typical Swiss diet.

Introduction

In April 2002, the Swedish National Food Administration (NFA) and researchers from Stockholm University announced their findings that acrylamide, a toxic chemical, potentially carcinogenic to human beings, was formed in many types of food during cooking at high temperatures. The NFA informed international authorities and organizations about their findings in order to initiate international collaboration as a priority. The Food Science Division of the Swiss Federal Office of Public Health (SFOPH) started immediately the development of a detection method and analysed a broad range of different foodstuffs. It was verified that acrylamide formation occurred primarily in cooking processes like frying, deep-frying, baking and roasting. The real intake of acrylamide is difficult to estimate because exact data on processing procedures, especially for homemade meals, are sparse. It appeared essential to assess the intake by analysing the "total diet" of individuals and it was decided to start a duplicate diet study in summer 2002. The aim of this investigation was also to detect possible new important contributors for acrylamide in the diet.

Experimental

Design of study

27 individuals (13 women and 14 men) participated in the duplicate diet study and were divided into nine groups. Each group was given two specific collection days in order to obtain an equal number of the days of the week. The collection was carried out during September. Participants were not informed on the purpose of the study. For each sampling day, they were instructed to deliver the following:

- A duplicate serving of the solid food consumed within 24 hours. The food was collected in four, separated portions: breakfast, lunch, dinner and snacks (food eaten between the principal meals).
- A protocol listing the composition and preparation details of supplied meals.
- A list of consumed beverages, including quantities.

The next day the collected portions were brought to the laboratory by each individual of the group. They were weighed and controlled in order to check accordance with the delivered protocol. Non edible parts such as peels, bones and stones were removed. The meals of the three participants in a group were pooled together, resulting in four pooled samples per day, i.e. pooled breakfast, lunch, dinner and snacks. This procedure resulted in 72 samples of meals (9 groups X 4 meals X 2 days) to be analysed.



Analysis

The pooled samples were weighed, homogenised and lyophilised before analysis. The samples were analysed following the method published on the Web-site of the SFOPH (http://www.bag.admin.ch/verbrau/aktuell/d/AA_methode.pdf). All samples were analysed with two independent detection methods (GC-HRMS and LC-MS/MS).

Results and discussion

The mean daily intake of acrylamide in this study was determined at 0.277 µg/kg bw. The relative contribution of the different meals and of beverages is shown in table 1. The intake variation between the different groups is depicted in figures 1 and 2.

Meal category	Intake [µg/kg bw]	Exposure [%]
Breakfast	0.022	8
Lunch	0.057	21
Dinner	0.061	22
Snacks	0.037	13
Coffee	0.100	36
Total	0.277	100

Table 1: Contribution of the different meals to the daily intake of acrylamide

For the estimation of the contribution of drinks, samples of all different beverages reported in the study were analysed. According to the individual records, water (including mineral water) coffee, black tea, wine, fruit juices, lemonades were the principal beverages. Acrylamide was not detectable in teas. In wine, fruit juices and lemonades, detection of traces of acrylamide was not unequivocal (clearly all <2 µg/L). In hot chocolate and malted breakfast beverages amounts of 2-4 µg/L were measured, but consumption of these beverages was too low (0.14 servings per capita and day) to play an important role in the acrylamide intake. Conversely, coffee was shown to be an important contributor of acrylamide in the diet. Although the mean content was only 20 µg/L (from 22 samples, range: 8-40µg/L), the relatively high consumption (2.4 servings per capita and per day) coffee contributed to circa one third of the daily intake. The consumption in the present study matches the estimated mean consumption of coffee in Switzerland.

It seems that the consumption of fried, deep fried, baked and roasted potatoes was below average in this study. From inland production and import/export data, it was attempted to calculate the possible additional contribution by this type of meals. 16 servings should have been recorded for this type of food. Six were actually reported. The consumption of potato crisps may also have been a bit below average. Three servings would have been needed to agree with the average, but only two were recorded.

To correct this underestimation of acrylamide intake, 10 servings of fried, deep fried, baked or roasted potatoes have to be added to the records. Assuming a serving size of 150 g and a mean acrylamide content of 400 µg/kg, this would add 0.16 µg/kg bw (600 µg, 54 person-days, 70.1kg mean bw). For potato crisps (serving = 50 g, mean content = 1400 µg/kg) this would increase the intake by 0.018 µg/kg bw. The corrected, higher daily intake would rise to 0.46 µg/kg bw. However, the coffee would still contribute to 22% of the daily intake, indicating unquestionably the importance of this beverage in the average diet.



Remarks

The picture of the acrylamide intake in the Swiss diet was refined and the significance of coffee for the mean intake was demonstrated. This study also showed that foodstuffs containing a low amount of acrylamide could be of importance if their consumption rate is high enough. It is likely that other such foodstuffs have not yet been identified in the diet. The acrylamide issue is complex: today it should not be reduced to coffee and/or fried potatoes intake.

*K. Brunner, V. Dudler, H. Reinhard, P. Rhy, H. Rupp, F. Sager, M. Streule, H. Zimmermann and O. Zoller**

Section Food Chemistry
Division of Food Science

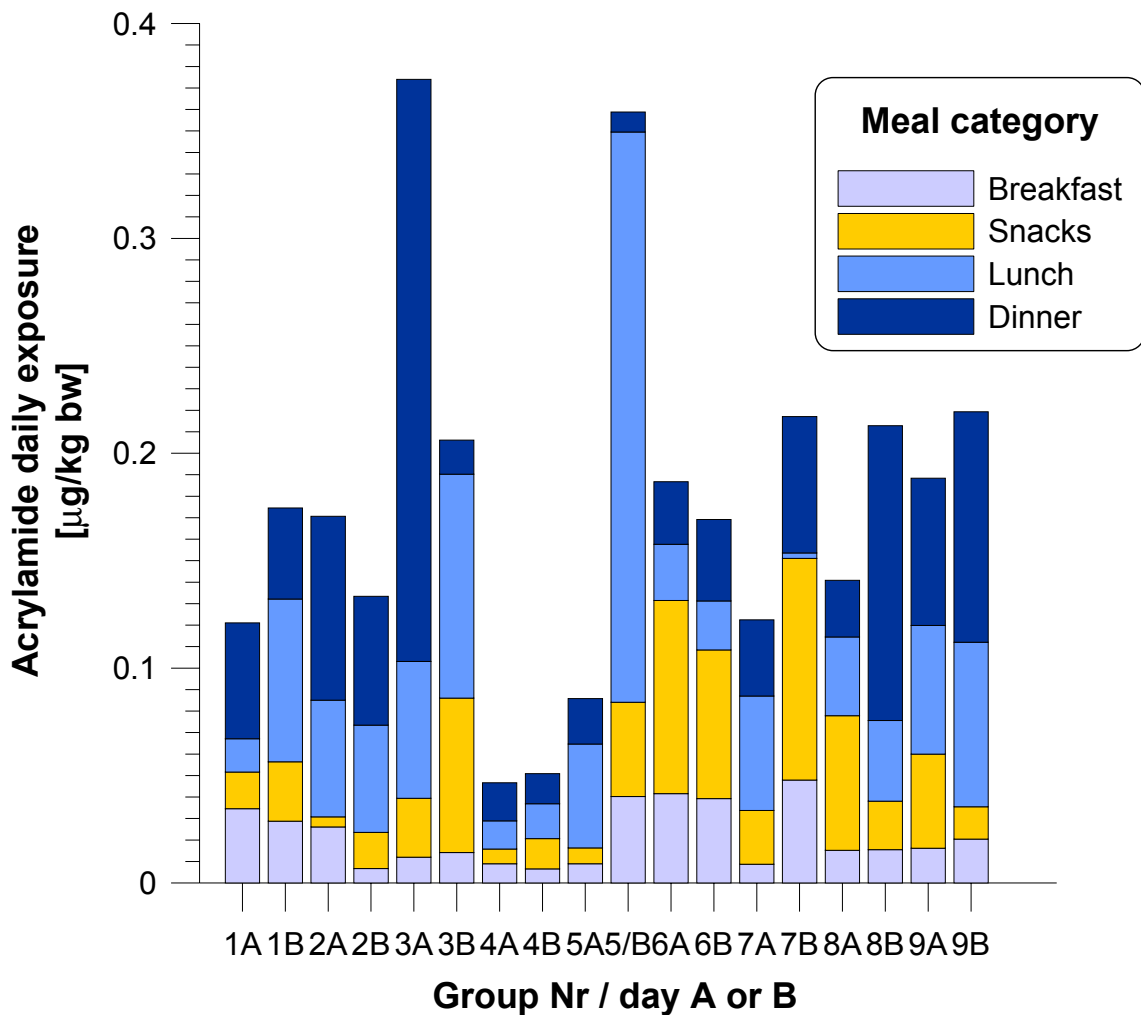


Figure 1: Contribution of all meal categories in the acrylamide intake for each group of participants. A and B denotes the first and second sampling day.

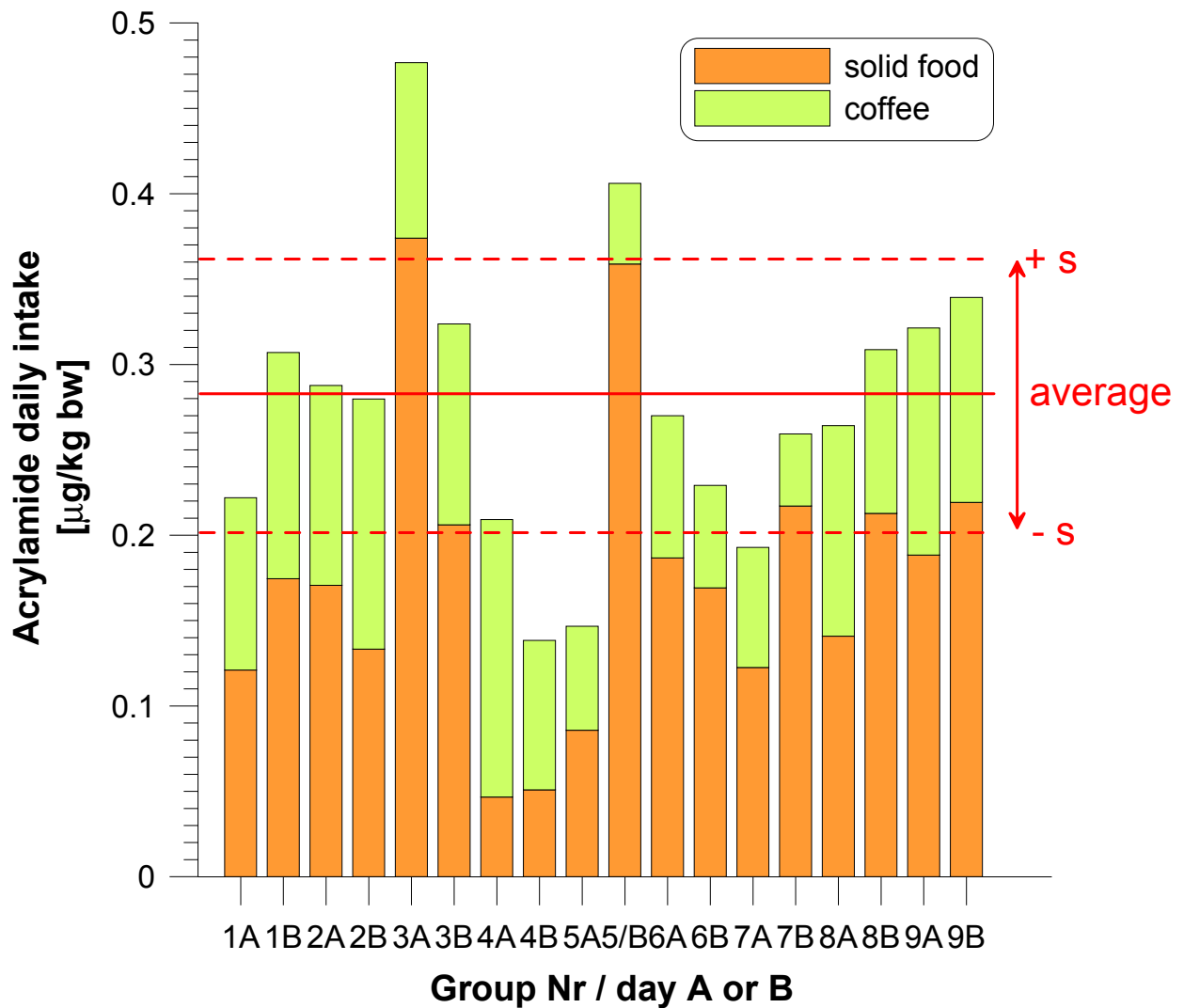


Figure 2: Distribution of acrylamide intake between solid food and coffee for the different groups. A and B denotes the first and second sampling day; s is the standard deviation from average.