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Research Article

Importance of a canteen lunch on the dietary intake of acrylamide

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A food and drink intake survey was carried out among university students and staff members. Consumption data were collected on days when the participants took hot lunch in a university canteen. The dietary acrylamide exposure was calculated through a probabilistic approach and revealed a median intake of 0.40 μg/kg bw/day [90% confidence interval: 0.36–0.44], which is in accordance with previous exposure calculations. Biscuits (35.4%), French fries (29.9%), bread (23.5%), and chocolate (11.2%) were identified to be the main sources of dietary acrylamide. Foodstuffs consumed in between the three main meals of the day (so called snack type foods) contributed the most to the intake (42.2%). The exposure was lower in an intervention group which received free portions of fruit and vegetables, indicating that a nutritionally balanced diet may contribute to a decreased acrylamide intake. French fries had a significant impact on the acrylamide intake, due to the frequent consumption in the canteen. This demonstrates the important responsibility of caterers and canteen kitchens in the mitigation of acrylamide exposure through reduction of acrylamide in their prepared products, in particular in French fries.

Keywords: Acrylamide / Balanced diet / Canteen food / Dietary intake

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1 Introduction

In April 2002, acrylamide was identified as a heat-induced process contaminant, present in fried, baked, grilled, or toasted carbohydrate-rich foodstuffs [1]. Based on previous acrylamide intake studies and current toxicological data, the genotoxic and carcinogenic risks of dietary acrylamide might not be negligible for humans [2]. Till now, no single study could however provide conclusive evidence on the human health effects [3]. Consequently, it was recommended to reduce acrylamide concentrations in foodstuffs as much as possible [2].

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Abbreviations: bw, body weight; **CI,** confidence interval; **IRMM,** Institute for Reference Materials and Measurements; **P 50,** 50th percentile (=median)

On the other hand, acrylamide-containing foodstuffs contribute significantly to the total micro- and macronutrient composition of the diet, as well as to the total daily energy intake [4]. Given its ubiquity in the diet, totally removing the dietary exposure of acrylamide is thus impossible. Therefore, it is interesting to know which food categories contribute the most to the daily intake in order to consider practical measures to reduce the acrylamide content in these products.

Furthermore, out of home eating has considerably increased the last decennia and has gained an important place in the habitual diet [5]. Consequently, the catering sector has become a strategic partner to promote a balanced diet in Europe [6]. However, public health nutrition and toxicological issues regarding this sector have so far received little attention in nutrition research.

The main purpose of this investigation was to determine the importance of canteen food on the dietary acrylamide exposure. More specifically, this study has four objectives: (i) to assess acrylamide exposure in the habitual diet of young professionals and students through a probabilistic approach, (ii) to identify the food groups that contribute most to acrylamide intake, (iii) to investigate the relative contribution of a canteen meal on acrylamide intake, and (iv) to document the effect of an increased accessibility to fruit and vegetables on acrylamide exposure. This trial was part of a larger intervention study that investigated the effect of a lunch with increased accessibility to fruits and vegetables on the daily food intake pattern.

2 Materials and methods

2.1 Study area

A food intake study was carried out in the canteen of the Faculty of Bioscience Engineering at Ghent University (Belgium). This restaurant is representative to other canteens of the university in the sense that the same suppliers cater for all kitchens. Preparation methods and menus are standardized and the meals offered are largely the same in all canteens. The faculty canteen serves about 250 hot meals *per* day. The meals contain a protein component (meat, fish, or vegetarian), with a choice of vegetables and a carbohydrate source (rice, French fries, mashed, or boiled potato).

2.2 Study design

Food intake data were obtained from a three-day record of food and drinks. Participants were asked to record all food and drinks on days during which they took a hot lunch in the canteen. Those days could be chosen freely in the first two weeks of December 2005. Portion sizes of the canteen meals were measured from purchased samples, while other foodstuffs were quantified using a standardized reference manual for Belgian food products [Bellemans, M., De Maeyer, M, *Manual for a standardised quantification of foodstuffs, revision January 2005*, https://portal.health.fgov.be]. Information on cooking practices was also recorded to differentiate between boiled and deep-fried potato products. Weight, height, date of birth, and gender were self-reported.

A convenience sample of 160 university students and faculty staff (60 men and 100 women) aged between 18 and 35 years provided valid data. Since this survey was part of a larger study, investigating the effect of an improved lunch on the daily food intake pattern, the participants were randomly assigned into an intervention and a control group. After drop-outs and excluding nonresidents, 85 persons in the intervention group and 75 persons in the control group were retained for analysis. In this way, 480 daily consumption patterns were obtained.

The intervention group was offered two portions of fruit, with one portion being one pear, one apple, or two mandarins. One prepacked fresh salad was offered as vegetable portion. Salads offered were tomato (200 g portion), cucumber (150 g), or seasonal salad (150 g) containing a mix of cabbage, cucumber lettuce, and carrots. The portions of fruit and vegetables were offered free of charge. The control group received no extra food. At the end, all volunteers were rewarded with two cinema tickets.

2.3 Acrylamide contamination data

The acrylamide levels used for the exposure calculations were obtained from several sources. The Institute for Reference Materials and Measurements [IRMM, The EU monitoring database of acrylamide levels in food: status June 2006, http://www.irmm.jrc.be/html/activities/acrylamide/database.htm] composed a European Monitoring Database containing more than 7000 validated acrylamide levels originating from different European Member States and from the European food industry. Samples were analyzed between July 2002 and June 2006. Before publication on the IRMM website, the levels were evaluated for reliability based on laboratory and method performance/quality criteria, such as *e.g.*, proficiency testing results, LODs and LOQs [7]. In addition to these IRMM data, about 500 acrylamide concentration levels were used, originating from food products on the Belgian market and provided by the Belgian Federal Agency for the Safety of the Food Chain. The majority of these data were not yet included into the European Monitoring Database at the time of study. Finally, also the acrylamide levels of ten ready-to-eat French fry portions, sampled in the canteen during the food intake survey, were determined in our laboratory using a previously described and accredited LC-MS/MS analysis method [8]. For the intake estimation, the left censored data, being the data below LOD or LOQ, were respectively replaced by the corresponding LOD divided by 2 or LOQ divided by 2 [9, 10].

2.4 Grouping of food items

The food items were classified into 14 different food categories. The food groups contributing the most to the acrylamide exposure are mentioned in Table 1. The classification was based on the divergent acrylamide levels between the categorized foodstuffs and was in agreement with the categorization in previous acrylamide exposure assessments [11–14]. Food groups such as onion bread and food for diabetics, included in the IRMM database, were not consumed and consequently not included as a food group. For the food group "coffee drink", data for liquid coffee and data originating from (roasted and ground) powder were used. The latter were recalculated to the drink using a conversion factor of 0.046 proposed by Dooren *et al.* [15].

2.5 Probabilistic exposure assessment

The exposure assessment was focused on the acrylamide containing foodstuffs. Acrylamide intake was modeled multiplying consumption data with contamination levels through a probabilistic approach. The exposure was expressed as μg acrylamide *per* kg body weight (bw) *per* day. The variability of the consumption and contamination levels was characterized by a nonparametric, discrete, uniform distribution. In this approach, the collected data points themselves are considered to form a discrete uniform distribution, meaning that all collected data points have the same probability of occurrence [16].

In addition, the characterization of uncertainty was performed using nonparametric Bootstrap. The Bootstrap theory assumes that the true distribution F (of *e.g.*, acrylamide concentration levels in French fries) can be reasonably approximated by the distribution F′ of *N* observed values. Obviously, this is a more reasonable assumption when more data are collected. For a sufficiently large number of times, *N* random samples (with replacement) are taken from the distribution F′. Each time, a statistic of interest is calculated from that sample. In such a way, a distribution of uncertainty about a parameter is obtained [16].

Propagation of variability and uncertainty was performed by second order Monte Carlo simulation using @RISK (@RISK 4.5 risk analysis software for Excel, Palisade, UK), randomly combining the consumption distribution with the contamination distribution. This simulation technique consists of two Monte Carlo loops, the one nested inside the other. The inner loop deals with the variability, while the outer loop deals with the uncertainty of the input variables. Latin Hypercube sampling was used [29]. The variability was described performing one thousand iterations. One thousand Bootstrap simulations were executed to estimate the confidence intervals (CI).

The exposure distributions were calculated for each food group separately, and for all food groups together. In addition, the exposure distributions were calculated independently for the three main meals of the day (breakfast, lunch, and dinner) and for the food and drinks consumed in between (defined as snack type food). Breakfast was arbitrarily defined as the first meal of the day, between getting up and 10.00 am. Lunch was consumed between 11.30 am and 2.00 pm in the university canteen. Dinner was defined as the meal consumed roughly between 6.00 and 8.00 pm. Because of this separate calculation, the total intake at a certain percentile is each time different from the sum of the different food items (or meals) at that percentile [14]. Since the acrylamide content of French fries consumed inside the canteen was measured, a distinction could be made between the contamination level of French fries, served in the university canteen and French fries consumed elsewhere. It was assumed that French fries, consumed outside the canteen, had contamination levels comparable to the values of the Belgian and European databases. With this distinction, it was moreover possible to evaluate the impact of the canteen French fries on the total acrylamide exposure.

3 Results

3.1 Evaluation of consumption and contamination levels

Food consumption and acrylamide contamination levels of the most important food groups are presented in Table 1. The acrylamide levels vary considerably between single food items within food groups, as reported previously [3, 12]. From Table 1, it is clear that bread is consumed the most on median daily basis, followed by canteen French fries, biscuits, and chocolate. Men have a higher intake of food *per* kg bodyweight, compared to women.

Table 1. Descriptive statistics of acrylamide contamination (μg/kg) and food consumption (mg/kg bw/day) for the most important food groups.

	Contamination (μg/kg foodstuff)*			Consumption (mg/kg bw/day) – P 50 – P 95** (Mean)		
	N	Mean	P 50 (P 0 – P 100)	Total (*N* = 160)	Male (*N* = 60)	Female (*N* = 100)
Biscuits	1130	276	142 (<5–6798)	404–1727 (589)	375–1801 (576)	483–1658 (598)
Bread	119	27	15 (<7–150)	1639–3708 (1768)	1868–4083 (2063)	1589–3168 (1592)
Breakfast cereals	380	125	70 (<5–1649)	0–1294 (291)	0–1313 (267)	0–1204 (305)
Chocolate	43	190	130 (<8–826)	142–618 (215)	88–618 (196)	163–624 (226)
Coffee drink	262	14	12 (<0.5–59)	0–6362 (1381)	0–4768 (1107)	0–6632 (1546)
Crisp bread	557	329	182 (<5–2838)	0–523 (88)	0–312 (46)	0–576 (113)
French fries (outside canteen)	538	377	220 (<5–3300)	0–1127 (125)	0–1134 (123)	0–1113 (126)
French fries (canteen data)	10	58	50 (32–116)	814–2349 (813)	892–2362 (980)	629–2286 (713)
Potato crisps	925	707	522 (<5–4215)	0–547 (98)	0–599 (137)	0–521 (75)
Gingerbread	1025	556	308 (<5–7834)	0–206 (24)	0–217 (35)	0–5 (17)
Sweet spiced biscuit	47	353	277 (<15–1234)	0–399 (75)	0–406 (76)	0–295 (74)

* For values below the LOD and LOQ, LOD/2 and LOQ/2 were respectively used.
** 50th and 95th percentile.
N, number of observed values.

Table 2. Variability and uncertainty of the dietary acrylamide intake (μg/kg bw/day) (best estimation [90% confidence interval])

Percentile	Acrylamide exposure
5	0.103 [0.087–0.118]
10	0.140 [0.124–0.160]
25	0.232 [0.207–2.260]
50	0.398 [0.359–0.442]
75	0.681 [0.615–0.755]
90	1.105 [0.997–1.227]
95	1.481 [1.315–1.663]
99	2.591 [2.170–3.112]
99.9	4.521 [3.265–7.370]
Mean	0.537 [0.457–0.699]

3.2 Acrylamide intake estimation

Table 2 shows the characteristics of the dietary acrylamide intake. The median intake is estimated to be 0.398 μg/kg bw/day, with a 90% CI between 0.359 and 0.442. The 5th percentile of intake is 0.103 μg/kg bw/day while the 95th percentile is 1.481 μg/kg bw/day. All percentiles are higher for men compared to women (results not shown). More specific, the median intake for respectively women and men is 0.393 and 0.408 μg/kg bw/day. This difference is not significant.

3.3 Importance of each food group

The importance to the acrylamide intake of each food group is presented in Table 3. These results show that the median daily acrylamide intake (P 50) can be attributed to biscuits (35.4%), canteen French fries (29.9%), bread (23.5%), and chocolate (11.2%). These are also the most frequently consumed foodstuffs, as shown in Table 1. Bread is the most important contributor to dietary acrylamide for the lower percentiles (upto the 40th percentile). For percentiles higher than 40, biscuits represent the main source of acrylamide. Above the 95th percentile, biscuits, French fries, potato crisps, breakfast cereals, chocolate, bread, crisp bread, sweet spiced biscuit, coffee drink, and gingerbread are (in decreasing order of importance) the predominant sources of acrylamide. Other food categories such as baby's biscuits, choco-spread, coffee substitutes drink, and popcorn contribute little to the total acrylamide intake and are therefore not mentioned in Table 3.

3.4 Importance of each meal

The distribution of acrylamide intake over the different meals and snacks of the day is presented in Table 4, in terms of percentage for the 50th and 95th percentile. Within each meal, the most important contributing food categories are calculated, also in terms of percentage on the meal. From Table 4, it is clear that the snacks contribute the most to the acrylamide intake, both at the median and at higher percentiles. Biscuits are the main source of intake in between the three meals of the day. At higher percentiles, the contribution of potato crisps, chocolate, sweet spiced biscuit, and coffee becomes more important. The overall share of the dinner is more distinct for the upper percentiles, coinciding with an increasing contribution of French fries. The canteen French fries are by far the most important source of acrylamide intake during lunch time, while bread is the major acrylamide source during breakfast and dinner, at the 50th percentile. For the higher percentiles, other food categories contribute to the acrylamide intake, which were not contributing at the median intake level, as already observed in Table 3.

Table 3. Contribution of the most important food groups to the estimated intake (μg/kg bw/day) of acrylamide (best estimation [% on total exposure])

Percentile	5	10	25	50	75	90	95	99	99.9	Mean
Biscuits	0 [0]	0 [0]	0.004 [18.6]	0.042 [35.4]	0.160 [36.3]	0.416 [31.8]	0.693 [27.7]	1.598 [24.7]	3.533 [24.8]	0.161 [29.4]
Bread	0.003 [100]	0.007 [100]	0.015 [77.3]	0.028 [23.5]	0.056 [12.6]	0.110 [8.4]	0.162 [6.5]	0.312 [4.8]	0.521 [3.7]	0.048 [8.8]
Breakfast cereals	0 [0]	0 [0]	0 [0]	0 [0]	0.023 [5.3]	0.100 [7.7]	0.189 [7.5]	0.492 [7.6]	1.089 [7.6]	0.037 [6.7]
Chocolate	0 [0]	0 [0]	0.001 [4.1]	0.013 [11.2]	0.046 [10.5]	0.106 [8.1]	0.165 [6.6]	0.367 [5.7]	0.677 [4.7]	0.040 [7.3]
Coffee drink	0 [0]	0 [0]	0 [0]	0 [0]	0.024 [5.5]	0.059 [4.5]	0.088 [3.5]	0.165 [2.5]	0.297 [2.1]	0.019 [3.5]
Crisp bread	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0.054 [4.1]	0.158 [6.3]	0.560 [8.7]	1.300 [9.1]	0.029 [5.2]
French fries (outside canteen)	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0.026 [2.0]	0.267 [10.7]	0.996 [15.4]	2.510 [17.6]	0.046 [8.5]
French fries (canteen)	0 [0]	0 [0]	0 [0]	0.036 [29.9]	0.072 [16.3]	0.116 [8.8]	0.145 [5.8]	0.226 [3.5]	0.344 [2.4]	0.047 [8.5]
Potato crisps	0 [0]	0 [0]	0 [0]	0 [0]	0.031 [7.0]	0.219 [16.7]	0.404 [16.1]	0.907 [14.0]	1.667 [11.7]	0.068 [12.5]
Gingerbread	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0.034 [1.4]	0.316 [4.9]	1.045 [7.3]	0.012 [2.3]
Sweet spiced biscuit	0 [0]	0 [0]	0 [0]	0 [0]	0.020 [4.6]	0.068 [5.2]	0.135 [5.4]	0.355 [5.5]	0.760 [5.3]	0.026 [4.8]

Table 4. Distribution of acrylamide intake over the different meals and most important foodstuffs within each meal, in terms of percentage

	50th percentile				95th percentile			
	Breakfast	Snack	Lunch	Dinner	Breakfast	Snack	Lunch	Dinner
Total	23.2	42.2	15.5	19.1	20.6	39.7	8.7	31.0
Biscuits	–	96.3	–	–	24.6	42.1	–	–
Bread	100	–	–	100	12.1	0.5	6.1	14.3
Breakfast cereals	–	–	–	–	32.1	–	–	–
Chocolate	–	3.7	–	–	8.9	9.4	–	7.0
Coffee drink	–	–	–	–	7.4	4.9	–	1.0
Crisp bread	–	–	–	–	1.6	–	–	11.2
French fries (outside canteen)	–	–	–	–	–	–	–	37.4
French fries (canteen data)	–	–	100	–	–	–	93.9	–
Potato crisps	–	–	–	–	–	35.5	–	–
Sweet spiced biscuit	–	–	–	–	7.1	5.7	–	5.3

Table 5. Median acrylamide intake (μg/kg bw/day) in the intervention and the control group (best estimation [90% confidence interval])

		50th percentile	% Difference with respect to the control group
Control group (nonvegetable & fruit group)	Total	0.422 [0.368–0.473]	
	Breakfast	0.057 [0.046–0.072]	
	Snack	0.116 [0.093–0.142]	
	Lunch	0.044 [0.030–0.057]	
	Dinner	0.059 [0.046–0.079]	
Intervention group (vegetable & fruit group)	Total	0.379 [0.335–0.427]	−10.2
	Breakfast	0.065 [0.053–0.079]	+14.0
	Snack	0.103 [0.081–0.129]	−11.2
	Lunch	0.038 [0.028–0.053]	−13.6
	Dinner	0.042 [0.031–0.054]	−28.8

3.5 Impact of extra fruit and vegetables

A comparison of the acrylamide intake between the control group and the intervention group, receiving free of charge fruit and vegetables during lunch, is shown in Table 5. It can be observed that the acrylamide intake levels are lower in the intervention group, with a reduction of 10.2% at the 50th percentile, compared to the control group. However, this difference is not significant. A decreased intake can be observed for lunch, dinner, and snacks, but not for breakfast.

4 Discussion

4.1 Acrylamide intake assessment

A solid probabilistic exposure assessment was carried out combining the food intake data with a large amount of European and Belgian acrylamide contamination levels. The acrylamide intake, mentioned in Table 2, corresponds well with the range of previous calculations performed in Belgium and in other European countries [11–14, 17]. In addition, the estimation is in agreement with the long-term dietary acrylamide exposure in developed countries, as calculated by the FAO/WHO, which is between 0.3 and 0.8 μg/kg bw/day [18]. The joint FAO/WHO expert committee on food additives recently estimated the average intake in the general population between 0.3 and 2.0 μg/kg bw/day. However, for high percentile consumers (90th–97.5th) the estimates ranged from 0.6 to 3.5 μg/kg bw/day [2]. In the present study, the 95th percentiles are also almost four times higher than the median intake levels. It is thus clear that a significant part of the population is subject to a much higher acrylamide exposure.

The higher acrylamide intake of men compared to women can be explained by the fact that men have a higher intake of food than women [14, 19]. From Table 1, it is also clear that men consumed more French fries than women.

Apart from the canteen French fries and the data obtained from the Belgian federal food agency, the majority of the acrylamide contamination data used for the above mentioned calculations originated from the European Monitoring Database, containing mostly German data. To quantify whether the origin of the contamination data significantly affected the outcome, the acrylamide exposure was calculated using only the Belgian data, and only the European data, revealing however no significant difference between the calculations (results not shown).

4.2 Importance of food group and meal to the acrylamide intake

In agreement with our findings (Table 3 and 4), other studies [4, 14, 17, 19] confirm that bread considerably contributes to the acrylamide intake, mainly because it is consumed in a relatively large amount (Table 1). The substantial contribution of snack type products, such as biscuits and potato crisps was specifically attributed to this age category (18–35 years) [11, 14, 17]. On the other hand, the contribution of French fries in this study is lower compared to previous simulations [11, 14]. The relatively low contamination levels, measured in the university canteen and used for the exposure calculation, are probably the reason for this, as discussed further on. It is plausible that the consumption of chocolate and sweet spiced biscuit is to some extent overestimated due to St. Nicholas day (6th of December), a local saint's day traditionally accompanied by an increased consumption of these food products. This bias towards a higher consumption of specialty food during a specific period of time (*e.g.*, PreChristmas or Eastern) has previously already been demonstrated [12]. However, it should be stated that this possible bias in this study is only restricted to food groups which appear to be less important to the overall acrylamide intake, as compared to *e.g.*, bread and French fries. Consequently, this will not have a major impact on the findings of this study.

Different dietary patterns can also be observed between the median and 95th percentile of the distribution (Tables 3 and 4). Indeed, some food categories are consumed at the higher percentiles, which are not consumed at lower percentiles [12, 14]. These figures may represent different dietary patterns, according to the level of exposure. However, it needs to be mentioned that the dietary patterns observed at the highest percentiles may not concern the long-term high consumers, but only participants who reported having consumed these foodstuffs on the recalled days [12]. Consequently, the number of individuals participating in this survey may be too small in order to attribute this "tail" phenomenon to consumers who occasionally have a day with high exposures *versus* consumers who may always be at the high end of exposure (due to the consumption of certain foods that contain high levels of acrylamide).

4.3 Scenario study addressing the effect of canteen food on the total acrylamide intake

As shown in Table 4, the acrylamide exposure during lunch can mainly be attributed to the consumption of canteen French fries. It was also observed that the share of French fries in the total acrylamide intake was rather low compared to previous acrylamide exposure assessments, due to the low degree of acrylamide contamination in the analyzed canteen French fries. Therefore, the total acrylamide intake was recalculated applying the European contamination data for the French fries, consumed during lunch, instead of the acrylamide data of the French fries sampled in the university canteen. A median acrylamide intake of 0.573 [90% CI: 0.516–0.631] μg/kg bw/day was obtained accordingly. The share of French fries increased from 29.9 (Table 3) to 47.9%, which is more in agreement with previous studies [11, 14, 17]. The lunch meal also became more important with respect to the other meals. This shows the important responsibility of the caterers and canteen kitchens in the mitigation of acrylamide exposure through the reduction of acrylamide in their prepared products, in particular in French fries. Because of their particularly high consumption during the canteen lunch, French fries can have a significant contribution to the acrylamide intake, especially if not sufficient care is taken in order to reduce the acrylamide formation during frying. From previous research [20–24], it is known that the reducing sugar content of potatoes plays a key role in the mitigation of acrylamide in French fries, as well as the calibre size and seasonal factors. Consequently, caterers should pay specific attention to the selection of raw material in order to mitigate as much as possible the formation of acrylamide in the prepared French fries.

From the low acrylamide contents, measured in the canteen French fries, it can moreover be concluded that the acrylamide formation is well under control in the canteen kitchen. This can be ascribed to an optimized deep frying process, during which the temperature is not allowed to exceed 170°C. Moreover, the frying time is fully standardized, meaning that the fried product is automatically removed from the oil bath after a fixed period of time.

4.4 Impact of extra fruit and vegetables

Many epidemiological studies have shown health benefits resulting from eating sufficient fruit and vegetables [25]. Intervention studies where fruit and vegetables were made highly accessible have mainly looked at the consumption of fruit and vegetables, but less to the secondary effects on other foods. The present results show that, besides the health promoting effect of fruit and vegetables, an increased availability of these foodstuffs to canteen customers might also have an impact on the acrylamide intake. As shown in Table 5, the acrylamide intake on total basis is lower in the intervention group, which received extra fruit and vegetables during lunch, however not significantly lower. It is however remarkable that a decrease can also be observed for the lunch, dinner, and snacks, but not for the breakfast. This different trend can however be explained by the fact that the vegetable and fruit portions were only distributed during lunch. The results presented here may be a first indication that increased availability of fruit and vegetables, containing no acrylamide, may indeed lead to a decreased intake of acrylamide containing foodstuffs. This would be an extra health benefit besides the known health promoting effects of some constituents in fruits and vegetables [25].

4.5 Conclusions

Snack type products contributed the most to the acrylamide intake. However, the acrylamide intake during lunch could become more important when the degree of French fries contamination increases. Therefore, caterers should pay specific attention to the selection of raw material, more specifically potato tubers low in reducing sugars, in order to mitigate as much as possible the formation of acrylamide in the prepared French fries. Too long heating times and too high frying temperatures should also be avoided since this also increases the acrylamide level in the final product. In combination with a nutritionally balanced meal, composed of foods from many sources and rich in fruits and vegetables, a significant reduction in acrylamide exposure to a large population of out of home eating consumers can be achieved. In addition, a moderate consumption of fried and fatty foods should be encouraged [26]. Previous research has proven that worksite canteens are an ideal working space to promote a genuine healthy diet [27, 28]. This exemplary role may be specifically attributed to (school) canteens which prepare foodstuffs for younger children and adolescents, a population group which can still easily pick up good eating habits and which is considered to be more exposed to acrylamide compared to older age groups [12].

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