Stability of Acrylamide in Food during Storage

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In April 2002 the Swedish National Food Administration reported the finding of alarmingly high levels of acrylamide in heat-treated potato products and other baked goods [1]. Many researchers have confirmed the presence of acrylamide in different processed foods and it was shown that its concentration might reach levels as high as several mg per kg depending on the composition and the way of processing [2–6]. However, only a few articles were concerned with the stability of acrylamide in the food [7–9].

Acrylamide is a rather reactive component, as known from the fact that it reacts at body temperature with haemoglobin in the living organism. Therefore, it could be expected that it also reacts rather rapidly with food components. The stability of acrylamide in food might be of great interest since a minimising concept controlled by the food surveillance authority was initiated in Germany. However, as long as it cannot be excluded that acrylamide is not stable in the finished product (and therefore lower acrylamide levels in some products were only a result of a longer storage period of the respective sample) this proceeding might not be justifiable without considering the production date.

In our study the stability of acrylamide was determined in carbohydrate-rich food as well as in coffee and cacao. For this, a variety of different storable acrylamide-containing carbohydrate-rich foods (cookies, crisp bread, cornflakes, potato chips, peanuts, raw sugar, and liquorice confect) were analysed in January 2004 and re-analysed in April 2004. The samples were divided into two parts and one part was homogenised and analysed directly while the other part was stored in a closed package at 10 to 12°C in the dark. For most samples the recovery of acrylamide after storage was between 90 and 120% and was within the measurement uncertainty. However, a slight decrease was determined for dietary biscuits (from 530 to 470 ± 12 μg/kg and from 2400 to 2000 ± 20 μg/kg, respectively), and for liquorice confect (from 550 to 450 ± 6 μg/kg). The coefficient of variation (CV) for biscuits was 2.7%, i.e. the rate of decrease was higher than the analytical variability. However, it can not be excluded that the lower acrylamide contents analysed after storage were due to the inhomogeneity of the sample within the package because the sample was not homogenised before analysis but rather two different parts of the original sample were analysed before and after storage.

Coffee is known to contain acrylamide but also various other reaction products, responsible among others for the coffee aroma. In order to examine the stability of acrylamide in vacuum-packaged ground coffee and in roasted coffee beans several original 250 g vacuum packs of ground coffee and 500 g original packages of coffee beans were stored at 10–12°C. All packages derived from 1 production batch, i.e. had the same date of expiry. To assure homogeneity of acrylamide in all individual packages, 10 randomly selected packs were first analysed in duplicate before storage. The average acrylamide concentration was 305 ± 21 μg/kg for ground coffee and 285 ± 12 μg/kg for coffee beans. Ten unopened vacuum-packs were then stored for 3 month and analysed again. Significantly lower amounts were found for all packs. The average acrylamide concentration was 210 ± 13 μg/kg for ground coffee and 200 ± 8 μg/kg for coffee beans, indicating a significant and uniform decrease of acrylamide over time even when vacuum-packaged. On the contrary, acrylamide was shown to be stable both in soluble coffee (spray dried coffee extracts) and in coffee substitutes (spray dried extracts) over 3-month storage. For coffee substitutes no significant decrease of acrylamide occurred even after one-year storage. These results suggest that acrylamide losses occur over time

probably as a result of reactions with coffee-typical constituents present in the coffee bean or powder, respectively.

In cacao acrylamide is formed among numberless other Maillard products during the roasting process of the cacao beans similar to coffee. In order to analyse the stability of acrylamide in cacao the powder was stored in closed glass jars at 10–12°C for 6 month. During this time acrylamide concentrations significantly drop down from 265 ± 25 μg/kg to 180 ± 13 μg/kg. This finding confirms the assumption that special substances (possibly formed during the roasting process) present in coffee and cacao, e.g. SH group-containing substances, are responsible for a decrease of acrylamide over time.

In conclusion, the observations gave reasons to suggest that acrylamide concentrations in some foods can vary depending on the storage time since the levels can be affected by special food constituents and/or reaction products.

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