



Risk Assessment of Dietary Exposure to Acrylamide in the Norwegian Population

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Authors' contributions

This work was carried out in collaboration between all authors. The opinion has been assessed and approved by the Panel on Contaminants of VKM. All authors read and approved the final manuscript.

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Grey Literature

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ABSTRACT

Request from the Norwegian Food Safety Authority

The Norwegian Food Safety Authority (NFSA) requested the Norwegian Scientific Committee for Food Safety (VKM) to assess whether Norwegians in general or subgroups in the population could be expected to have different dietary exposure to acrylamide than reported for other European population groups, and if found to be different to calculate their exposure. Furthermore, VKM was asked to identify food categories with a high potential to increase acrylamide exposure; both for the

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whole population and for specific groups. Finally, VKM was asked to characterise the risk of acrylamide exposure to the Norwegian population compared to the rest of the European population. The Norwegian Food Safety Authority intends to use this risk assessment as a basis for the Norwegian contribution to the ongoing legislative work in the EU and to consider the necessity to adjust the existing national dietary advices or to issue new ones.

How VKM has addressed the request

VKM appointed a working group consisting of members of the Panel on Contaminants to answer the request. The Panel on Contaminants has reviewed and revised the draft prepared by the working group and finally approved the risk assessment on dietary acrylamide exposure in the Norwegian population.

What acrylamide is and its toxicity to humans

Acrylamide is a water-soluble organic chemical formed in carbohydrate-rich foods from naturally present carbohydrates and amino acids during cooking or other heat processing at temperatures above 120°C. Acrylamide is a widely used industrial chemical and is also formed in tobacco smoke.

Acrylamide is known to be neurotoxic in humans and is classified as a probable human carcinogen. Concerns about exposure to acrylamide in the general population arose in 2002 when it was discovered in heat-treated foods.

Dietary acrylamide exposure in Europe and Norway

Dietary acrylamide exposure has been assessed by combining food consumption data and acrylamide concentration data and by biological markers of exposure both in Norway and different European countries. In the EFSA 2015 Scientific Opinion on acrylamide in food, chronic dietary exposure was calculated for 61,338 individuals from 28 surveys and 17 different European countries covering the following age groups: infants (<1 year old), toddlers (≥1 year to <3 years old), other children (≥3 years to <10 years old), adolescents (≥10 years to <18 years old), adults (≥18 years to <65 years old), elderly (≥65 years to <75 years old) and very elderly (≥75 years old). The estimation of human exposure to acrylamide revealed that infants, toddlers and other children were the most exposed groups, but EFSA concluded that dietary acrylamide represents a health concern for all age groups.

In previous Norwegian studies reporting dietary acrylamide exposure, the mean and median exposure in adolescents and adults were in the range of 0.3-0.5 µg/kg bw per day. These estimates are in the same range as the mean daily exposures estimated by EFSA for adolescents (0.4-0.9 µg/kg bw) and adults (0.4-0.5 µg/kg bw). Taking into consideration the results from previous exposure estimates and knowledge about food consumption patterns in recent consumption surveys in Norway, VKM concludes that Norwegian adults, adolescents and children older than three years of age are not likely to have a different exposure to acrylamide than corresponding age groups in other European countries. VKM therefore decided not to perform a new exposure assessment in these age groups.

No previous studies in Norway have assessed acrylamide exposure in infants and children less than three years of age. Information from national and European dietary surveys shows that Norwegian 1-year-olds, but not 2-year-olds, have higher consumption of infant porridge than other European toddlers. VKM therefore decided to conduct a full exposure estimate in 1-year-old toddlers.

The comparison of data on acrylamide occurrence in food reported by EFSA (2015) and in foods sampled in Norway showed that acrylamide concentrations in the main food categories do not differ essentially, with the exception of three categories. The category "Potato crisps and snacks" has higher acrylamide concentrations in Norwegian samples than in those reported by EFSA, while

the categories “Baby foods, other than cereal-based” and “Processed cereal-based baby food” (i.e. infant porridge) have lower concentrations in Norwegian samples than in those reported by EFSA. VKM considered that Norwegian analytical values were sufficient for exposure calculations if the concentrations were analysed in 16 samples or more. Infant porridge had 52 analysed samples and VKM considered that the brands sampled are representative for infant porridge on the Norwegian market.

VKM calculated acrylamide exposure based on food consumption in Norwegian 1-year-olds by two approaches: one using EFSA concentration data only; and the other using Norwegian concentration data for food categories including 16 samples or more, and EFSA data for the remaining categories. Both approaches resulted in acrylamide exposures within the exposure range for toddlers reported by EFSA (2015). When using EFSA concentration data only the calculated daily exposure (mean: 1.6 µg/kg bw and P95: 3.2 µg/kg bw) is in the upper range calculated by EFSA for toddlers (mean range: 0.9-1.9 µg/kg bw, P95 range: 1.2-3.4 µg/kg bw). When using Norwegian concentration data for food categories including 16 Norwegian samples or more and EFSA data for the remaining categories, the calculated daily exposure (mean: 0.9 µg/kg bw, P95: 1.6 µg/kg bw) is in the lower range of what EFSA has calculated for toddlers.

The dietary exposure for acrylamide in Norwegian 1-year-olds is within the same range as reported by EFSA for European toddlers. Although the acrylamide-concentration was lower in infant porridge (i.e. “Processed cereal-based baby food”) sampled in Norway than in those reported by EFSA, Norwegian 1-year-olds have higher consumption of infant porridge than European toddlers. In addition to infant porridge, soft bread is a major source of acrylamide in Norwegian 1-year-olds.

Food categories with high potential to increase acrylamide exposure

Baby food and soft bread contributed most to acrylamide exposure in the 1-year-olds, while food items contributing the most to acrylamide exposure in adults are fried potato products, coffee, biscuits, crackers and crisp breads, and soft bread.

Previous Norwegian studies and EFSA (2015) showed that in all populations groups except toddlers, ‘fried potato products’ is a food group with high potential to increase acrylamide exposure. Acrylamide is also contributed by food items commonly consumed such as coffee and bread, and this is of concern in Norway as well as in the rest of Europe.

The EFSA risk assessment included exposure scenarios addressing the potential impact of home-cooking habits, locations of consumption, and preferences for particular food products. These scenarios showed that food preparation, and particularly conditions of potato frying, resulted in large variations and a possible increase of acrylamide exposure by as much as 80%. VKM considers that these scenarios carried out by EFSA are equally relevant for the Norwegian population. The temperature and browning of fried potato products will have a considerable impact on the exposure to acrylamide.

VKM calculated three simplified scenarios to illustrate the influence of consumption of particular food items on acrylamide exposure. These scenarios confirmed that potato crisps, French Fries and coffee are food items with high potential to increase acrylamide exposure.

Risk characterisation of dietary acrylamide exposure in Norway

VKM used the same reference points as EFSA (2015), and calculated Margin of Exposures (MOEs) for assessing health risk. MOE is the ratio between a reference value and the estimated dietary exposure. The MOE approach provides an indication of the level of safety but it does not quantify the risk as such.

For non-neoplastic effects, EFSA used a BMDL10 value of 0.43 mg/kg bw/day as the reference point based on animal studies of neurotoxicity, and considered a substance-specific MOE of 125 or above as a sufficient safety margin for no health concern.

For neoplastic effects, EFSA used a BMDL10 value of 0.17 mg/kg bw/day as the reference point based on animal studies, and taking into account overall uncertainties in the interpretation, EFSA concluded that a MOE of 10 000 or higher would be of low concern for public health.

The EFSA risk assessment concluded that the MOEs for non-neoplastic effects were above 125 for all age groups indicating no health concern, whereas the MOEs for non-neoplastic effects were substantially lower than 10 000, indicating a health concern for all age groups.

The dietary acrylamide exposure in Norwegian adolescent and adults reported in previous studies were within the range calculated by EFSA for these age groups. VKM therefore concludes that the resulting MOEs for non-neoplastic and neoplastic effects of acrylamide for adolescent and adults will be similar to those calculated by EFSA.

VKM calculated acrylamide exposure based on food consumption in Norwegian 1-year-olds by two approaches: one using EFSA concentration data only; and the other using Norwegian concentration data for food categories including 16 samples or more, and EFSA data for the remaining categories. Both approaches resulted in comparable MOEs.

For both non-neoplastic and neoplastic effects, MOEs for 1-year-olds were similar to those reported in EFSA 2015.

For non-neoplastic effects of dietary acrylamide exposure, VKM reached the same conclusion as EFSA, which is that the MOEs across all age groups indicate no health concern.

For neoplastic effects of dietary acrylamide exposure, VKM reached the same conclusion as EFSA, which is that the MOEs across all age groups were substantially lower than 10 000, indicating a health concern.

VKM is of the opinion that the conclusion reached by EFSA's risk assessment of acrylamide, which states that acrylamide in food potentially increases the risk of developing cancer for consumers in all age groups, also applies to Norwegians.

Uncertainties and data gaps

There is uncertainty in the calculation of dietary acrylamide exposure. One of the reasons is that none of the existing dietary methods are able to capture the "true" long-term food consumption in individuals. Another reason is that the large variation in acrylamide concentrations in food items, even within the same food category. Acrylamide concentrations in food depend on how food is being processed and cooking practises both at home and in restaurants. Cooking practices and preferences, in especially the degree of browning, represent particular uncertainties when estimating dietary acrylamide exposure. More knowledge about this is needed in order to provide a better basis for up-to-date exposure estimates in Norway.

Keywords: Acrylamide; dietary exposure; fried potato products; health concern; margin of exposure; Norwegian Scientific Committee for Food Safety; risk assessment; toddlers; VKM

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NOTE:

This work was carried out in collaboration between all authors. The opinion has been assessed and approved by the Panel on Contaminants of VKM. All authors read and approved the final manuscript. Competence of VKM experts: Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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