federal public service
HEALTH, FOOD CHAIN SAFETY
AND ENVIRONMENT

Acrylamide levels in less investigated foodstuffs

Acrylamide (AA) is a carcinogenic substance that is formed in foodstuffs during certain high-temperature processing operations. Regulation (EU) 2017/2158 provides *benchmark levels* in AA for certain foodstuffs and also gives an overview of the existing mitigation measures. Due to the potential risk of the presence of AA in food categories not (yet) listed in Regulation (EU) 2017/2158, the European Commission has published Recommendation (EU) 2019/1888 on the monitoring of the presence of AA in certain other foodstuffs. At the same time, on 25 October 2019, the EFSA also issued a call for data to be collected at European level on AA levels in foods based on chia seeds.
Sciensano, at the request of the FPS Public Health, set up a project to collect missing data on AA levels in other new food categories available on the Belgian market, as envisaged by Recommendation (EU) 2019/1888 and the EFSA call. A second objective, specific to potato products, was to determine the impact of the cooking method used on the formation of AA : deep-frying versus baking at the time-and-temperature conditions indicated by the manufacturer. Furthermore, the impact of the domestic cooking practices of the Belgian population on the AA levels in those products was investigated. The AA concentration data obtained were combined with data from the most recent Belgian Food Consumption Survey (FCS2014) to estimate the exposure of the Belgian population to AA. Hence, the associated health risk was assessed.

Acrylamide concentration in foodstuffs

Low levels of AA (sometimes below the limit of detection of 10 µg/kg) were found for some food categories like the **"bread"** (e.g. milk rolls, hamburger roll, tortilla, etc.) and **"pastries"** ones (e.g. viennoiseries, donuts, churros, pancakes) as well as for **dried fruit**, **nougat** and **caramel.** In the **foods containing chia seeds** in various proportions (biscuits and bread), AA was detected in less than 50% of the samples. When AA was present, the concentrations found varied in the same order of magnitude as similar samples without chia seeds, suggesting that there is no evidence that the presence of chia seeds could be associated to higher concentrations of AA. Large variations in AA content ranging from undetected to more than 4000 µg kg^{-1} were observed in **coffee substitutes** based on fruit, plants and/or nuts (concentrations were measured in the dry product and not in the prepared drink). No AA was detected in the fruit-based coffee substitutes while concentrations comparable to those in regular coffee were detected (29 - 184 µg kg^{-1}) in the nut- and/or plant-based substitutes. The highest AA concentration (4389 µg kg^{-1}) was detected in a sample consisting of 60% roasted Jerusalem artichoke root and 37% roasted dandelion root. **Rice and maize waffles (*i.e.* puffed rice cakes)** contained AA ranging from undetected to 259 µg kg^{-1} whereas in **extruded wheat and maize products** a maximum concentration of 337 µg kg^{-1} was found. The same applies to the category of **nuts and oilseeds**, where concentrations ranging from non-detected to 155 µg kg^{-1} were determined, and also to **cocoa beverage-preparation powder**, where concentrations ranged from below the quantification limit (of 20 µg/kg) to 141 µg kg^{-1}. Samples with different amounts of cocoa (13-100%) were purchased but no correlation could be made between the cocoa content and the amount of AA detected. The concentration of AA in black olives seems to be related to the manufacturing process: canned California-style **black olives** showed higher values than the Greek-

style ones (431 and 575 µg kg^{-1} vs 102 µg kg^{-1}, respectively). High levels of AA were found in **root and vegetable based crisps** (sweet potato, parsnip, carrot, beetroot, cassava): in some of the samples analysed, the values were higher than 750 µg kg^{-1}, the current value specified in the Regulation (EU) 2017/2158 for potato chips. The last food category examined was **potato products**. Thirteen samples (röstis, pomme duchesse and potato balls) were prepared by deep-frying and in the oven following the manufacturer instructions closely to assess the impact of the cooking method on AA levels. AA levels found ranged from undetected to 1503 µg kg^{-1} when following the time indicated on the packaging. Subsequently, fourteen participants were selected and asked to complete a questionnaire on their cooking habits and also to prepare croquettes, sweet potato fries and hamburger buns at their homes (using their kitchen appliances) to investigate the role of these habits on AA formation. Interestingly, all the AA levels in the food prepared by the participants were lower than in the reference food prepared in the laboratory : more than half of the participants did not follow the cooking instructions on the packaging and stopped the cooking process once the food showed a golden yellow colour. This golden yellow colour criterion is also recommended in Regulation (EU) 2017/2158 to keep low AA levels in potato products : the darker the prepared potato product, the higher the level of AA.

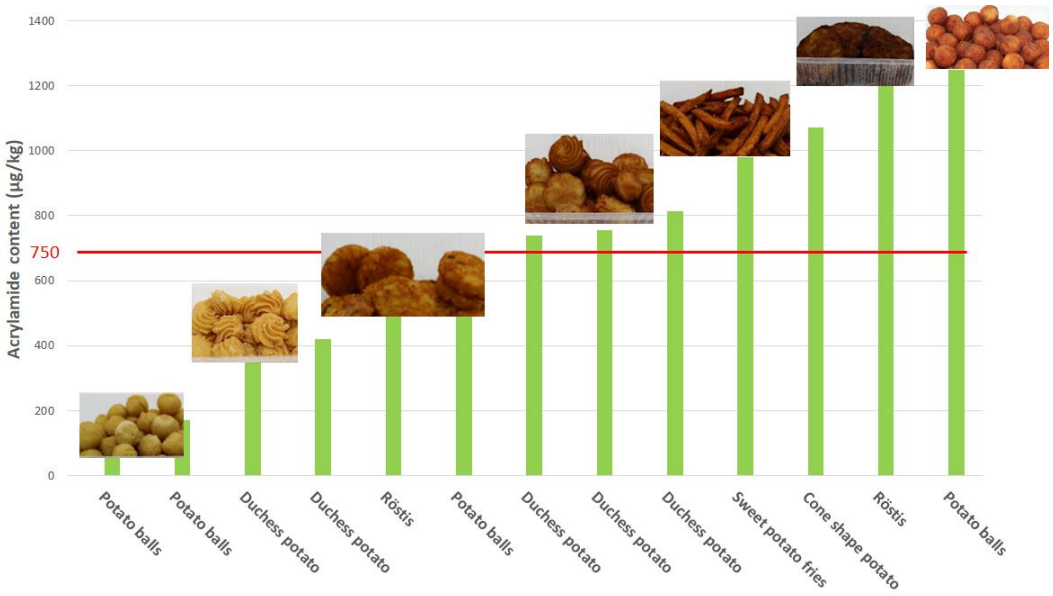

Figure 1. Acrylamide level for some food products depending the cooking mode used and resulting coloration

<u>Exposure assessment and Risk associated to AA dietary exposure in Belgian consumers</u>

The AA analytical results were taken into account to evaluate the exposure to AA of Belgian population. The presence of AA in food is also monitored in the yearly control program of FASFC: results of the monitoring program from the period 2016-2020 were also considered for the dietary exposure assessment. Each food product of the dataset was then manually linked to a corresponding food item of the FCS2014. Two chronic exposure scenarios were estimated: Maximum analytical concentrations scenario (MAC) and mean analytical concentrations scenario (MeAC). Children (3 – 9 years) resulted to be the most exposed group, followed by the adolescents (10 – 17 years) while the adults are the least

exposed (18 – 64 years) in both scenarios. **The main contributors for the AA exposure are potato fries, potato chips, bread (white, brown and special), cacao and bakery ware for all age classes**. All other product categories each contribute less than 5% to the total AA exposure (Figure 2).

Risk characterization of AA was performed using the Margin of Exposure approach (MOE). Exposure values for the three different age groups were compared to the $BMDL_{10}$ (benchmark dose lower bound associated with a 10% change in response relative to background response) used as the reference point for neoplastic effects, *i.e.* 0.17 mg kg^{-1} bw day^{-1}. It was found that, for neoplastic effects, almost all MOEs were substantially lower than 10 000 indicating a potential health concern.

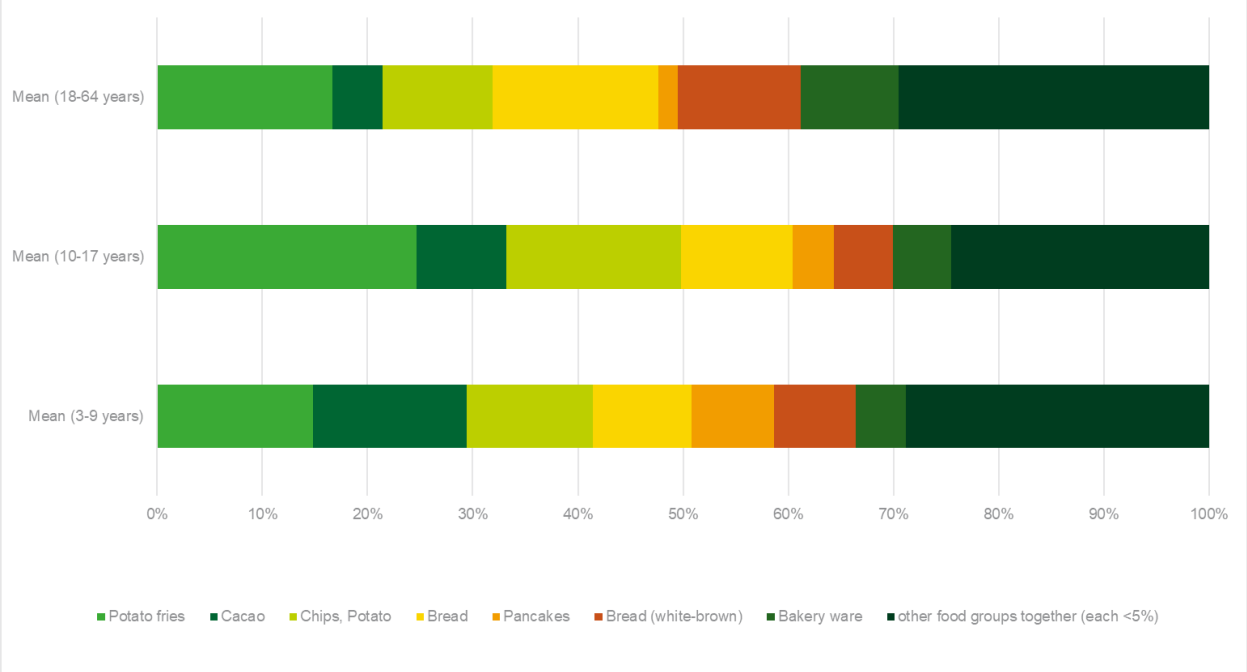

Figure 2. Relative contribution of the main food groups to the daily intake of AA expressed for three age classes and based on MeAC

Policy-making

This project aiming at evaluation of the presence of AA in foodstuffs not listed in Regulation (EU) 2017/2158 has indeed identified new sources of AA and assessed the main contributors to AA exposure. Particular emphasis has been placed on the study of potato products, other than fries and crisps which are already known sources of AA. Based on this results, we conclude that the recommendation to fry until golden yellow (not brown) should also be more widely applied to these potato products. Furthermore, this study has also shown the relevance of root and vegetable based crisps/fries for AA policy corroborating the results on potato crisps/fries. The results also raise questions about California-style black ripe olives. These data will be used, together with data from other European countries, to develop a European policy aiming at including additional benchmark levels and mitigation measures in the European legislation, in order to protect the consumer.