AUTHOR COMMENTARIES - 2009

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Richard Stadler

Featured Paper Interview

According to Essential Science Indicators℠ *from Thomson Reuters, the paper "Acrylamide from Maillard reaction products," (Stadler RH,* et al., Nature *419[6906]: 449-50, 3 October 2002) is currently ranked at #5 among Highly Cited Papers in Agricultural Sciences, with 379 citations up to June 30th of this year.*

In the interview below, lead author Dr. Richard Stadler of the Nestlé Product Technology Center in Orbe, Switzerland, talks with ScienceWatch.com *about the paper and its impact on the food industry.*

SW: What factors prompted you and your co-authors to undertake this study?

Acrylamide was first discovered in food in April 2002 by the Swedish National Food Authority that reported the presence of acrylamide in certain types of food cooked at high temperatures. The food industry was of course very concerned at this discovery and took this finding very seriously. Thus, all our efforts were focused on very quickly developing appropriate analytical methods in the different food matrices, and then trying to explain how acrylamide is formed in foods, i.e., elucidate the mechanistic pathway.

SW: How was it conducted, and what were your findings?

We were fortunate to have at our disposal the appropriate equipment (tandem mass spectrometers) and scientists with many years of experience in trace analysis, complemented by an in-depth knowledge of food and natural products chemistry. It took us approximately two to three weeks to develop an analytical method by isotope dilution mass spectrometry and confirm the reported results.

In parallel, we employed model systems and heated different amino acids either alone or together with reducing sugars to determine the precursor(s) of acrylamide. From a structural point of view, asparagine and glutamine were good candidates, and indeed, we were the first laboratory able to demonstrate that asparagine forms the acrylamide backbone via the Maillard reaction by using stable isotope-labeled asparagine (published in our *Nature* paper).

Figure 1 [+]enlarge

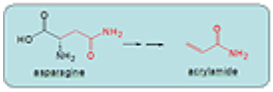
SW: How was the paper received by the community?

The paper was widely cited and had very good media coverage, together, I must add, with a paper on the same subject and published by Prof. Don Mottram and co-workers (Mottram DS, Wedzicha BL, Dodson AT, "Acrylamide is formed in the Maillard reaction," *Nature*

419[6906]: 448-9, 3 October 2002). Both papers showed essentially the same route of formation of acrylamide and both are today considered the source of reference with regard to acrylamide formation in foods.

The Acrylamide Toolbox.

Figure 2 [+]enlarge



A diagram showing asparagine as a precursor of acrylamide.

SW: Where have you taken your acrylamide research since this paper's publication?

The early work on the mechanisms of formation opened several opportunities to mitigate acrylamide. Today, we are leading the European Food & Drink Industry initiatives on identifying approaches for the reduction of acrylamide in the concerned foods, and the output of these activities are reflected in the Confederation of the Food and Drink Industries of the EU (CIAA) *Acrylamide Toolbox*.

The *Acrylamide Toolbox* brings together those methods of acrylamide reduction that are known to work in the production process and reviews other proposed methods that are at either the pilot plant or laboratory scale stage. The objective of the *Toolbox* is to provide practical tools that food manufacturers can use to reduce acrylamide according to their particular situation. Using a selection of these tools, food manufacturers have been able to reduce acrylamide levels in some foods by around 40%. The *Toolbox* is a dynamic concept and is regularly updated as new methods of mitigation are introduced. In fact, the *Toolbox* is recommended for use on the European Commission website.

A further achievement was the issuance of the *Acrylamide Pamphlets*. These are meant to assist the small-medium enterprises in the implementation of the *Toolbox*, and were developed jointly by the CIAA and the European Commission, Directorate General Health and Consumer Protection (DG-SANCO), in collaboration with national authorities for five key sectors: Biscuits, Crackers & Crispbreads, Bread Products, Breakfast Cereals, and Fried Potato Products, such as Potato Crisps and French Fries. Individual operators can use the tools outlined in the pamphlets to adapt their unique production systems.

The pamphlets are available in > 20 languages on the website.

In fact, the way in which the acrylamide issue was addressed is an excellent example of how public authorities, industry, and academia can closely work together and come to a tangible result like the *Acrylamide Toolbox* and *Acrylamide Pamphlets* to ensure that the foods we consume are safe.

SW: What would you say to the general public about acrylamide?

Acrylamide is formed naturally during the cooking process irrespective of whether the food is prepared in a food factory, a restaurant, or in a domestic kitchen, and has probably been part of our diet for thousands of years.

There is strong consensus that a balanced and varied diet, which includes plenty of fruit and vegetables, and avoiding overcooking of food, will contribute to further reducing acrylamide levels. Trying to avoid eating food that may contain acrylamide would compromise efforts to eat a balanced diet. According to estimates from the US Food and Drug Administration, more than 40% of our daily energy intake is from foods that contain some acrylamide.

The food and drink industry will continue its constructive approach and apply the appropriate techniques outlined in the *Acrylamide Toolbox*. There is no simple solution to remove acrylamide from the human diet, and industry will continue to work closely with the scientific community and relevant authorities to update best practice in mitigation. In addition, society must also address acrylamide formation in home cooking through better public education and information campaigns.

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Richard Stadler's current most-cited paper in *Essential Science Indicators*, with 379 cites:

Stadler RH, *et al.*, "Acrylamide from Maillard reaction products," *Nature* 419(6906): 449-50, 3 October 2002. Source: *Essential Science Indicators* from Thomson Reuters.

KEYWORDS: ACRYLAMIDE, MAILLARD REACTION PRODUCTS, FOOD, COOKING TEMPERATURES, ANALYTICAL METHODS, TANDEM MASS SPECTROMETERS, ISOTOPE DILUTION MASS

SPECTROMETRY, PRECURSORS, ASPARAGINE, ACRYLAMIDE TOOLBOX, ACRYLAMIDE REDUCTION, ACRYLAMIDE PAMPHLETS.

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