A range of compounds formed during household and industrial heat treatment, the presence of neo-formed contaminants in staple foods, has caused real concern. **Inès Birlouez-Aragon** of ICARE, explains how her project's quantification methods allow SMEs to reduce the level of NFCs in their products

Reducing neo-formed contaminants in food

Household and industrial heat treatment performs a number of important functions in food preparation; improving its digestibility, ensuring microbiolocal safety and developing flavour and taste to name just three. While these kinds of processes are an integral part of food production, recent research on neo-formed contaminants (NFCs), a range of compounds produced during heat treatment, paints a worrying picture of their wider health effects. High levels of acrylamide – an NFC present in staple foods like potatoes, breakfast cereals and even infant formulas – have been linked to a potential increased risk of cancer, while research into Heterocyclic Amines suggests that high doses may have a carcinogenic impact. These compounds are not external to the process but are formed naturally during thermal processing of foods through the complex set of chemical reactions taking place. While these findings are yet to be precisely quantified in humans, a growing weight of scientific evidence suggests some NFCs may have a negative effect on health, making understanding the mechanisms behind their formation in heat-treated food a real research priority, one to which the ICARE project has responded. "We are gathering evidence on processed foods – including both industrially and home-processed foods. We are addressing the question of whether ingesting processed foods, especially those processed under high temperatures, could induce some visible, quantifiable in vivo data," says Inès Birlouez-Aragon, ICARE's overall coordinator.

With a large proportion of the population exposed to NFCs since they are widely distributed in our diet, this is work with broad relevance, as reflected by the overall composition of the project. ICARE brings together national food industry associations, SMEs and research centres from across Europe,

The Sensor Fluoralys is composed of a light sources unit, a sample cuvette holder to be filled with the crushed or liquid food and a spectrometer to analyse the emitted signal. The software allows the translation of the signal into NFC concentration

and indeed was established in direct response to the wider concern surrounding food safety issues, the scale and potential impact of which Birlouez-Aragon says demand thorough investigation. "It is very important for us to gather evidence on the effects of NFCs, because since 2002, when concerns about acrylamide were first made public, food processing companies – particularly SMEs – have become increasingly aware of food safety issues," she explains. "As such it is very important for us to check if acrylamide and heat-processed foods, represent a safety problem. For that reason we have held two clinical trials in which we compared a diet without heat processed foods and a diet which included them in order to quantify in vivo effects. After a month we saw visible changes in some metabolites which are known risk factors in the development of degenerative diseases. We want to help SMEs anticipate new potential European Community regulations, and hence help them improve their production process and its control, and in turn control the contaminants in their food and consequently on the dietary exposure to population."

The Maillard reaction

Although these compounds are relatively well-known due to their effects on the colour and taste of foods, it is recent discoveries which have brought the potential food safety implications of industrial and domestic heat treatment into sharper focus. The Maillard reaction, a chemical reaction between an amino acid and reducing sugar which is a central part of the food production and presentation process, was discovered by Louis-Camille Maillard in 1911. However, it was only in 2002 that acrylamide was discovered in starchy foods like bread and potato chips, a finding which prompted scientists to look

again at the effects of heat treatment. "Acrylamide has long been known as a toxicant – a carcinogenic compound. Discovering this same molecule in foods made us aware that heat treatment processing could give rise to new toxic molecules," outlines Birlouez-Aragon, who is keen to stress that while acrylamide is among the most prominent of the NFCs, it is far from being the only contaminant formed during the Maillard reaction, the process of which varies according to the product itself. "The Maillard Reaction requires heat treatment, but the nature of that heat treatment can vary" she continues. "This could mean either high temperatures over a short period, or low temperatures over a long period. It depends on the molecules; for some molecules high temperatures are a prerequisite for their formation – that is the case for acrylamide for example – but other compounds, such as furan or carboxymethyllysine, can be formed during storage, which happens at low temperatures but over a long period."

NFC quantification

The presence of NFCs in infant formulas further reinforce the need to clarify and quantify the possible long-term implications of daily ingestion of NFC from the early infancy. However, while acknowledging the scale of the problem, Birlouez-Aragon is confident that her project can achieve real improvements. "The varying levels of acrylamide concentration in similar products demonstrate that it is possible to reduce contaminant levels," she stresses. However, the analysis this requires is prohibitively expensive, hence ICARE's focus on developing NFC quantification methods for SMEs. "Currently the costs of analysis are quite prohibitive (around €200), and companies willing to analyse enough samples to fully understand the connection between their production process and the level of NFCs are spending a prohibitive amount of money," says Birlouez-Aragon. "We aim to develop low-cost analytical methods to allow SMEs to analyse NFCs. We want the food industry to be able to not only analyse samples, but also to use this analysis to better understand how the process affects the quality of the final product. This is crucial to understanding how changes in process parameters will affect the final level of NFCs in the product, which in turn will help us optimise the process. The project has already developed an at-line sensor, which signifies that the industry must take samples from the process line and analyse them. We also want to develop an on-line sensor, which could be put directly on the process to directly control it. In future we hope to implement the sensor on-line, in order to allow SMEs to control the process and continuously monitor the concentration of the different contaminants, thereby ensuring that a given level will not be exceeded." More over the European Commission has written pamphlets to list all the existing knowledge on NFC formation and free training has been developed for SMEs to help them find ways to better control their process and lower NFC formation. ★

Acrylamide or furan analysis in one product costs approximately €200. The number of samples to analyse in order to fully understand the real impact of processing on the food quality parameters, including NFC concentration is high

Such processes are an integral part of food production and when home-cooked at high temperature, in large part encouraged by wider societal trends. Modern lifestyles leave many people with little time to cook, while supermarkets shelves are stacked with goods imported from all over the world, and Birlouez says the result is significant changes in consumption patterns. "My hypothesis is that today we are using many more ready-to-eat and long shelf life products than we once did. During the production of long-life products many different heat treatments are applied, and NFCs will accumulate during the different steps in this industrial process," she explains, outlining issues her project is working to address. "The objective of the project is not to identify new NFCs, but rather to analyse levels of variability between European commercial products," continues Birlouez-Aragon. "We have found great variability in NFC concentration between products from the same family. For example, in potato chips the concentration of acrylamide varies between 1 and 50, while in infant formulas the concentration of carboxymethyllysine shows a similar variation."

Spectralys Innovation was selected as prize-winner of the national competition on innovative SMEs organised by OSEO (Ministry of Research and Finance).

At a glance

Full Project Title
Impeding neo-formed Contaminants Accumulation to Reduce their health Effects (ICARE)
ACTIA - Coordinator of project.
National Association for Food Industry (IAGs) - Owners of Icare results and dissemination.

Project Funding
EU: €3,000,000

Project Partners
National associations: ANIA (France) • FEDERAMILENTARE (Italy) • FIAB (Spain) • FIPA (Portugal) • FFDI (Czech Republic) / SMEs: 12 SMEs / Technical centres: ACTIA / Public research institutes: AgroParisTech (FR) • Institut LaSalle Beauvais (FR) • Instituto del Frio (SP) • Universita'degli studi di Napoli Federico II (IT) • Deutsche Forschungsantalt für Lebensmittelchemie (D) • Institute of Preventive and Clinical Medicine (SL)

Contact Details
Coordinator, Inès Birlouez-Aragon
T: +33 141 506 770
E: ines.birlouez@spectralys.fr

Inès Birlouez-Aragon

Scientific Coordinator

Inès Birlouez-Aragon is a senior scientist and Professor in Food chemistry and Nutrition at AgroParisTech, the French leading institute for education and research in Life Science, Agronomy, Food technology and environment. She obtained her PhD in biochemistry in 1982 and occupied the position of Professor assistant in Human Nutrition for 8 years, and the position of Professor in Food chemistry up to now. In October 2008, she created her own enterprise, SPECTRALYS Innovation, to valorise the results obtained in the ICARE project that she developed and coordinated for the scientific and technical aspects.