

Acrylamide mitigation strategies

Identification

Key words	acrylamide, mitigation, neo-formed contaminant, asparaginase, asparagine, high pressure processing, potato, coffee, bread, bakery products, reducing sugar, acrylamide toolbox
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How does it work?

Primary objective	Acrylamide mitigation strategies are applied to reduce the content of the heat-induced contaminant and possible carcinogen acrylamide. In April 2002, it was shown that many heated foods contain significant levels of this contaminant.
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Working principle

Acrylamide in foods is predominantly formed as a result of the **Maillard reaction** between asparagine (an amino acid) and a reducing sugar (or reactive carbonyl compounds) at elevated temperature, although also other pathways not involving asparagines are known (acrolein or acrylic acid). It has been detected in French fries, bread, ... (i.e. food products that are cooked by methods that result in (partial) drying of the surface, forming a crust). The Maillard reaction is the predominant chemical process that is responsible for the colour, flavour and texture of cooked foods.

Acrylamide mitigation strategies intervene in the formation of this compound by affecting the Maillard reaction, at four different levels in the product life cycle:

1. Agronomy
2. Recipe
3. Processing
4. Final preparation.

The CIAA offers a “acrylamide toolbox” to assist individual manufacturers to assess and evaluate which of the intervention steps identified so far may be helpful to reduce acrylamide formation in their specific manufacturing processes and products.

It needs to be emphasised that there is in most cases no single solution to reduce acrylamide in foods, even in a given product category. Furthermore, interventions in the Maillard reaction are likely to result in different or even unwanted product characteristics.

Some mitigation strategies include (CIAA):

1. Agronomy
 - Selection of potato cultivars of low level of reducing sugars
 - Control of storage temperature (above 8-10°C) to minimize the low temperature
2. Recipe
 - Replacing ammonium bicarbonate with sodium bicarbonate as a raising agent (1). However, this increases the sodium consumption, which might possibly lead to and increase in cardiovascular diseases (2).
 - Reducing the ratio of potato flour in extruded snacks and adding calcium chloride reduces acrylamide formation (3)
3. Processing
 - Soaking in water to extract the water soluble reducing sugars, however, this will also lead to loss of vitamins and minerals
 - Use of asparaginase for removal of asparagines. Although this technology is highly effective in the laboratory, a study on this mitigation strategy in an industrial scale French fries production setting only showed significant reduction in acrylamide when the enzyme was added to non-par fried fries, so that there was a long enough contact time (4). The enzyme is also effective (at laboratory scale, at least) to minimize the formation of acrylamide in biscuits (5,6) and potato chips in combination with blanching (7).
 - Dipping in acids (e.g. citric acid) to reduce the pH leading to a slower Maillard reaction
 - Use of enzymes that affect the reducing sugars, for instance glucose oxidase. (8)
 - Novel processing technologies can also intervene in the Maillard reaction (9). For instance, in high pressure, high temperature processing, the Maillard reaction is slowed down, as is also the formation of acrylamide (10).
4. Final preparation
 - Frying and toasting only to a yellow brown colour (both at factory level, for instance for crisps and at catering/consumer level, for instance for fries and toast). The temperature and time combination applied play a crucial role in the formation of acrylamide (10). Therefore, kinetic information on the formation and elimination of acrylamide is crucial (11).

Images

Additional effects

Acrylamide mitigation strategies can affect the organoleptic quality of the food product or even increase the prevalence of other processing induced contaminants.

Important process parameters

temperature, time (therefore, kinetic data on formation and elimination are indispensable to evaluate the mitigation strategies) (11,12)

Important product parameters water activity, pH, asparagine content, reducing sugars content

What can it be used for?

Products French fries, bread, cookies, coffee, (low-moisture foods containing asparagine and reducing sugars)
Operations Baking, roasting, frying
Solutions for short comings Producing safe foods

What can it NOT be used for?

Products Not relevant for high-moist food products, as acrylamide is not formed in these.
Operations In processes occurring at low temperature, no acrylamide is formed, hence, mitigation strategies are not required.
Other limitations Acrylamide mitigation strategies can affect the organoleptic quality of the food product or even increase the prevalence of other processing induced contaminants.
Risks or hazards Acrylamide mitigation strategies can increase the prevalence of other processing induced contaminants (e.g. 3-monochloropropanediol in bread when prolonging yeast fermentation) (13).

Implementation

Maturity The effect of the application of these mitigation strategies on the dietary exposure to acrylamide has not been shown yet.(5,8)
Many strategies work well at lab scale, but are not or less effective under industrial settings.
Modularity /Implementation Mitigation strategies can be implemented at different levels in the process chain. For some strategies, extra steps need to be foreseen (f.e. soaking, enzymatic treatment,.....).
Consumer aspects Consumers will be open to strategies that prevent the formation of a potential carcinogen in popular foods such as bread and chips. Of course, they will require the quality of these products to be comparable to the conventional products. The consumer needs to be better informed on the various possibilities for keeping the AA content of meals as low as possible, as an important share of the AA intake is due to prepared meals. For instance, frying French fries or toasting bread only to a golden yellow color is a relatively easily achievable mitigation strategy.

Legal aspects

The basic principles of EU legislation on contaminants in food are in Council Regulation 315/93/EEC of 8 February 1993 :

- food containing a contaminant to an amount unacceptable from the public health viewpoint and in particular at a toxicological level, shall not be placed on the market
- contaminant levels shall be kept as low as can reasonably be achieved following recommended good working practices
- maximum levels must be set for certain contaminants in order to protect public health

Member States should report to EFSA findings on acrylamide as specified in Commission Recommendation 2007/196/EC and Commission Recommendation 2007/331/EC.

Any intervention must also be evaluated for its regulatory impact (e.g. additives). Asparaginases have received “generally recognized as safe” (GRAS) status from the US FDA.

Environmental aspects

Facilities that might be interesting for you

Title	Institute/company
Auditorium IRTA	IRTA
Clean room - HistoCell	Noray
Video observation system for market research and product development tasks - Keki	NAIK EKI

Further Information

Institutes SLU, KU Leuven LFT, Wageningen UR - FBR, Ghent University - NutriFOODchem, Lund University, VSCHT, UNINA - DSA, DTU Food

Companies DSM, Novozymes

References

Source:

<http://www.foodtech-portal.eu/index.php?title=Special:PdfPrint&page=Acrylamide+mitigation+strategies>