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GUIDELINES TO AUTHORITIES AND CONSUMER ORGANISATIONS ON HOME COOKING AND CONSUMPTION (DRAFT)

Responsible partner

Livsmedelsverket (Swedish National Food Administration) (P9) and BEUC (P20).

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Aim

To provide basis for targeted advice to consumers on healthy consumption and home cooking of fried foods

HEATOX GUIDELINES TO AUTHORITIES AND CONSUMER ORGANISATIONS ON HOME COOKING AND CONSUMPTION

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1 Aims of this document

These guidelines constitute a brief summary of available knowledge about acrylamide formation and intake together with advice to national authorities and consumer organisations on how they may help consumers on reducing acrylamide when cooking and through consumption advice.

Acrylamide formation and minimisation strategies have been quite extensively studied in the laboratory and in industrial environments where the control of parameters is difficult but more predictable than in home cooking. Data on acrylamide intake from food cooked in the home are limited compared to the data now available on manufactured products. However, due to the probable carcinogenic effect of this compound, it is important to:
- inform consumers about practical ways of reducing acrylamide formation while cooking;
- provide dietary advice on how to reduce acrylamide intake.

This document is aimed at national food authorities and consumer organisations and provides a concise summary of the available information on this issue gathered by HEATOX scientists through original results from the HEATOX project and a literature review.

Information to consumers should be consistent, clear and conveyed in a way that is simple to apply to everyday cooking. Due to the extreme complexity of acrylamide formation and minimisation strategies and to the large uncertainties still associated to the presence of this compound in staple foods, it will be difficult and sometimes impossible to provide home cooking advice to consumers. However, some important and effective messages can be developed based on the most reliable results currently available.

2 Why <u>national</u> advice on home cooking

The HEATOX workshop in Graz 2006 identified significant differences in home cooking methods and availability of raw material within countries and certainly across the different European regions and member states. The HEATOX project has tried to add to available evidence and identify some of the national differences that are responsible for potential variations in acrylamide levels for example traditional varieties of raw ingredients, cooking and preparation methods. It is important that national authorities not only continue to investigate how national differences affect acrylamide formation but also take a proactive role in developing communication strategies that are suitable for consumers.

The national differences in dietary habits and cooking methods, as well as the different availability of raw ingredients, need to be taken into account by national authorities and consumer organisations when developing material like brochures, web pages, and presentations for consumers.

Considerations on rapidly changing dietary habits are also important. For example, in many countries deep fried potato products were unusual 50 years ago, while now they have become more and more popular. The time devoted to home cooking is changing across Europe, due to the increased availability of ready-made foods and changes in lifestyles; the number of meals fully prepared at home is decreasing in favour of increased consumption of pre-prepared food and fast foods. It is important to assess the likely impact that these trends will have on diets in different countries.

3 Risks from cooked food

Food has been cooked for thousands of years, primarily to easier digest, but also to increase taste. A by-effect was better food safety primarily in microbiological terms. There are, to summarise, a number of very good reasons to cook foods.

However, research in the last decades suggests that toxic chemicals can be formed during heat treatment of foods. For some of these chemicals, for example polycyclic aromatic hydrocarbons, advice on smoking and frying over open flames have been issued in many European countries to reduce the contamination of foods. These recommendations do not affect the levels of other toxins, nutrients, taste or palatability.

This illustrates a general problem. Cooking advice, in order to decrease the formation of a given chemical, must not increase the level of other potentially harmful substances, decrease levels of beneficial agents or decrease microbiological safety. Palatability should also be comparable. Such deliberations are very difficult since, in most cases, the data both on risks and on benefits, are not quantitative enough. Generally speaking, risks are more often quantified than benefits.

It is important to bear risk/risk and risk/benefit assessments in mind when issuing cooking advice.

What then, is known about the health impact of acrylamide and other heat induced toxicants.

The conclusions of the HEATOX project can be summarised as follows

- Acrylamide has been classified as a probable human carcinogen by WHO, World Health Organisation. This conclusion is strengthened by the project. There seems to be no risk for other toxic effects after exposure via foods.
- Compared with many regulated food carcinogens, the exposure of acrylamide poses a higher estimated risk to European consumers.
- Risk assessments and recommendations to minimize exposure to acrylamide made by WHO are still valid.
- Other compounds formed during cooking of food, for example HMF, Furan, and a variety of Maillard reactants and lipid oxidation products may also constitute an increased cancer risk for consumers. Approximately 50 substances that would require risk assessment has been identified within the project.
- Current knowledge does not allow for a risk/benefit assessment of cooking with respect to acrylamide or other heat induced toxicants.

Consequently, there are good reasons to reduce the exposure to acrylamide, primarily in food produced outside homes but also in foods prepared domestically. From data obtained within HEATOX it seems reasonable to conclude that an altered consumption profile will have greater impact than altered home cooking conditions.

However, one should not underestimate the potential for reduced acrylamide exposure via better home cooking procedures since extreme exposure can be easily reached with certain cooking habits. This is especially true for consumers who fry a lot of potatoes and do it really dark. There is a limit for extreme intake via bread and coffee.

4. General information on acrylamide formation and intake

4a) Levels in different commodities.

As a simple general rule, acrylamide can be formed in vegetable foods that is heated enough to produce a fairly dry and brown/yellow surface. Thus, acrylamide can be found in many common foods prepared by frying, baking or roasting. The most important acrylamide containing foods are found within three main groups:
(1) potatoes; crisps, french fries and other fried potato dishes
(2) cereals; bread and other bakery products, roasted breakfast cereals, various snacks, etc.
(3) coffee.

Table 1. Acrylamide levels (microgram/kg) in some important groups of commercial food products from the European Commission database

Food type	Median	Quartile range[2]	Maximum
Potato crisps	528	314-938	4215
french fries	186	85-363	4653
Crispbread	244	79-505	2838
Fine bakery ware	145	53-350	3324
Coffee[1]	286	223-373	975

[1] Refers to roasted coffee beans or ground coffee powder. The concentration in normal brewed coffee is roughly 20 times lower, directly depending on the coffee to water proportion used.
(Coffee substitutes based on chicory contains approximately 2-3 times more acrylamide than normal coffee)
[2] Includes the middle 50 % of samples, i.e. 25 % of the samples were below and another 25 % above the interval given.

The table includes general food types consumed in Europe, although a majority of the data was submitted from Germany. National differences between foods from these groups can exist. Differences can for example be due to traditional preferences regarding the roast degree of coffee beans, the type of flour and grains used in breads, etc. In addition, there are several regional products and traditional home cooking dishes.

HEATOX and others have analysed a number of special foods from different countries. A few examples of local foods that are sometimes high or fairly high in acrylamide are the Norwegian Lefse and Lompe (thin soft potato bread), the Swiss Rösti (panfried grated potatoes), the Dutch spiced cake from rye flour, the Turkish Tulumba (syrup soaked fried pastry) and roasted almonds, and the Spanish Neules and Kikos.

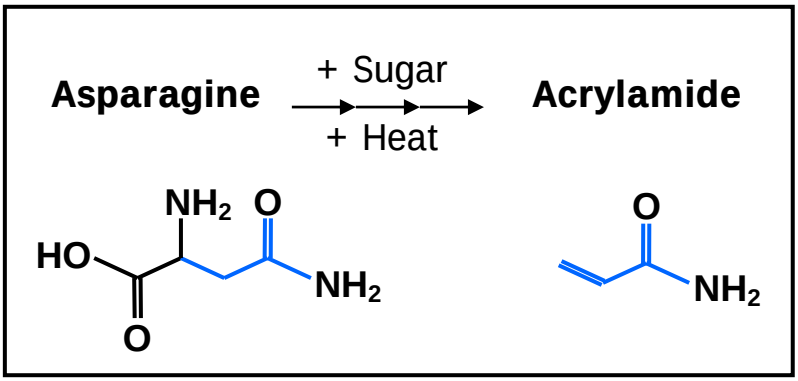
4b) Formation and mitigation

The heat-induced formation of acrylamide is linked to the Maillard reaction, also responsible for the desirable colour and flavour changes that characterize fried foods. The Maillard reaction involves numerous reaction pathways and end products, all starting from amino acids and sugars naturally present in the foods. Acrylamide is formed by reaction between reducing sugars, for example glucose and fructose, and one specific amino acid, namely asparagine (fig 1). Other formation mechanisms have been reported,

for example involving the gluten protein from wheat, but these are believed to be of minor general importance.

The acrylamide level in a specific food is the result of a complex balance between formation and removal/breakdown of acrylamide at the same time, and between acrylamide formation and other reactions competing for the same reactants. One important focus within the HEATOX project has been to study this balance, for example in relation to formation of flavour compounds and reactions involving other amino acids than asparagine.

Fig 1



The most important factors determining the acrylamide amount formed in a specific food can be listed as follows:

- *The raw material*
  - Levels of the precursors (asparagine and sugars), influenced for example by genetic and agronomic factors
- *Pre-treatments and recipe*
  - Size and shape (i.e. surface to volume ratio) of the food item
  - Treatments that reduces the precursor levels, for example blanching and fermentation
  - Ingredients that will enhance or interfere with acrylamide formation, for example glucose and fructose, ammonium bicarbonate, acidifiers, amino acids other than asparagine.
- *The cooking process*
  - Thermal input and heat-transfer (temperature and time)
- *Product characteristics*
  - Moisture level and colour

The raw material

The potential for acrylamide formation of a food commodity is related to how much it contains of free asparagine and reducing sugars that is not protein or starch bound. Sugar is normally the limiting factor in potato, while asparagine is limiting in grains. The levels may vary significantly between different plant varieties and due to the conditions during growth.

In **potatoes**, the sugar levels increase significantly over time during low temperature (<10°C) storage. The lower the temperature is, the faster is the sugar accumulation. On

the other hand, low temperature will also delay sprouting. In practice therefore, storage at 4-8°C is normally applied as a compromise between sugar accumulation and sprouting. Long-term storage at higher temperature may require the use of chemical sprout inhibitors. High sugar content in cold stored potatoes can be reduced to a varying extent by reconditioning at higher temperature (for example 15-20°C).

The levels of both sugar and asparagine vary between different potato varieties, as does their tolerance to cold storage and tendency for sprouting. Higher variation in sugar levels can be expected in consumption potatoes compared to those used by food industries. Control of product colour, by means of controlled sugar contents, have long been practised by the industry through variety selection and demands on storage conditions and agricultural practices.

Coffee beans can be of two types, Robusta or Arabica. Robusta is generally higher in asparagine and therefore more prone to acrylamide formation.

In **cereals**, most of the asparagine is present in the outer parts of the grain (i.e. bran and germ). The acrylamide levels are therefore generally higher in whole meal products compared to those made from white flour. In addition, rye has higher levels than wheat, which in turn is higher than corn and rice.

Pre-treatments and recipe

The levels of precursors in the raw material can be washed out from the surface tissues by water prior to cooking, i.e. soaking or blanching. This has been applied for example in the preparation of french fries and other **potato** products. The effect will vary depending on factors such as treatment time, the water temperature and pH, size and shape of the potato pieces and the cooking process.

Yeast consumes asparagine during fermentation, so using extensive yeast-fermentation would reduce the content of free asparagine in the dough and thereby acrylamide formation in the oven-baked **bread**. Thus, processes not using bakers yeast (for example “cold fermented” crisp bread, scones) will generally result in bread with higher contents of acrylamide. Sour dough fermentation before yeast-fermentation may limit the asparagine reducing effect due to unfavourable conditions for the bakers yeast.

Addition of ammonium hydrogen carbonate (ammonium bicarbonate, hartshorn, powdered baking ammonia) as a leavening agent is known to drastically enhance the acrylamide formation. Replacement by normal baking powder (sodium hydrogen carbonate) has been successfully applied for some **biscuits and cookies**.

A number of other ingredients and additives have been shown to lower the acrylamide formation under some circumstances. Examples are acids, like citric acid, amino acids other than asparagine (for example glycine), and or salts (for example calcium chloride). In general, the use of such additives is restricted by their effect on taste and other product quality aspects. Addition of reducing sugars, esp. fructose, may increase acrylamide formation, while sucrose will sometimes have the opposite effect.

Asparaginase is an enzyme that converts asparagine into aspartic acid. Asparaginase treatment prior to cooking can remove almost all free asparagine, and thereby inhibiting acrylamide formation. In practice, the treatment is most feasible for wet mixtures, like bread dough. In contrast with most other mitigation options, the selective removal of asparagine is predicted to have little effect on the taste, colour and other quality characteristic of the food. However, the use of this new food additive/processing aid might involve legal considerations. New European rules for food enzymes are under preparation.

The cooking process

Acrylamide formation accelerates during the final phases of the cooking process. One reason for this is that it is not until the food surface starts drying out that temperature becomes significantly higher that 100°C. A critical parameter in controlling acrylamide formation is therefore the final water content in, for example potato crisps, crisp breads, etc. The consequence for other foods is that most of the acrylamide is found in the outer part of the food item, i.e. in the crust of bread.

Acrylamide formation increases with increasing thermal input, i.e. the added effect of temperature and time. Roasting of coffee is a special case where the thermal input becomes so high that acrylamide breakdown reaction exceeds formation. This means that higher degree of roasting, i.e. dark roast coffee, results in lower acrylamide levels.

The type and quality of the frying oil has no influence on acrylamide levels.

Product characteristics

High acrylamide levels in many foods, bread and fried potato, is linked to the surface colour, i.e. browning.

4c Intake in different countries

The average intake for adults in some European countries varies between 0,3 and 0,5 micrograms per kg body weight and day and between 0,3 and 1,4 for children and adolescents. In general children have a higher exposure than adults, because the exposure is expressed relative to the bodyweight.

The pie charts in figure 2 show for some countries the contribution of different food groups to the acrylamide exposure.
It is important to know which food groups are significant for the acrylamide exposure in a country. Detailed information on specific groups in the population may help to identify food groups to focus on in order to give consumption advice. In most countries fried potato products, coffee and bread are important acrylamide sources. However adolescents and children have different consumption patterns, for their acrylamide exposure coffee is of less importance, whereas biscuits may form an important source for these groups.

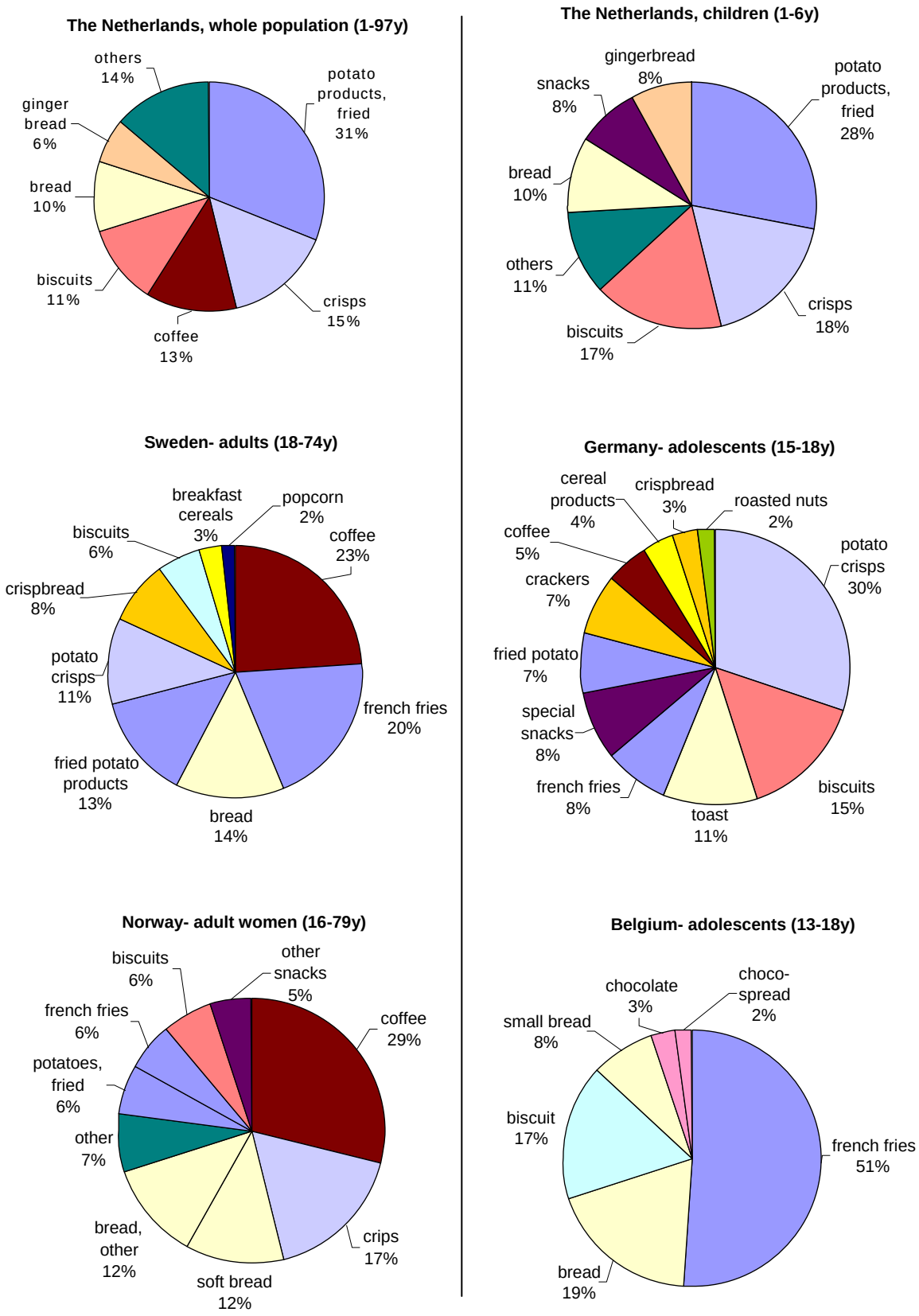


Figure 2 Contribution of food groups to acrylamide exposure in different countries for different age groups (Dybing et al., 2005).

5 Home cooking

5a Results from experiments with specific foods

The available scientific evidence is very limited. HEATOX researchers have conducted a number of experiments, some of which the results are briefly summarised below.

Deep-fried french fries

A series of experiments were done on french fries in order to investigate and optimize the frying conditions with regard to acrylamide content and product quality. Various fryers for domestic or catering use were included. It was concluded that three main aspects related to the frying process must be taken into account:

- the kind of the frying equipment (referring to the heating power),
- the initial oil temperature and frying time,
- the amount of potato immersed in the hot oil (product/oil ratio).

Since these parameters were interrelated, the optimal conditions could not be specified for the parameters independently. Although the acrylamide formation takes place during the final phase of the cooking procedure, the thermal profile during the whole process needs to be considered.

As a general rule of thumb though, the results from HEATOX and other studies suggests that the initial oil temperature should not be above 170-175°C. Depending on the heating power of the fryer, the amount of potato immersed in the oil should be adjusted to give an actual frying temperature starting from about 140°C and ending at about 160°C. A bigger long-lasting temperature drop after addition of the potato will increase the fat uptake, and a higher end temperature will result in excessive acrylamide formation.

Oven-roasted potato wedges

The effect of blanching on acrylamide levels in oven baked potato was studied. Several potato varieties were used for making roasted wedges according to two different recipes from Swedish cookery books; one of the recipes included blanching for 4-5 minutes combined with a shorter roasting time. The acrylamide levels (200-300 µg/kg) were around 20-50 % lower in potato wedges that had been blanched before roasting. In a similar study by another HEATOX partner, an average 10 % decrease was achieved by blanching in boiling water for 4 minutes and a 20 % decrease by soaking in cold water for 2 hours prior to roasting.

In Sweden, a common way of serving potato is to use cold, boiled potato that are diced and then fried for 3-4 minutes in a frying pan. The acrylamide content in fried, boiled potato dices was generally 10 times higher than in roasted potato wedges from the same potato variety. The difference might be explained by the higher surface to volume ratio in the diced potato compared to wedges.

Toasted bread

Ordinary soft yeast-leavened breads of two types were investigated:

- white breads baked from sifted wheat flour (bread A, B)
- darker breads with some rye flour added. (bread C, D)

Loaves were toasted in a toaster for domestic use.

The amounts of acrylamide produced in the different breads by toasting were related to the concentrations before toasting. There was hardly any acrylamide increase in the light toasted breads. The levels for medium toasting increased by a factor of 1.5-5 compared to the levels before toasting. The acrylamide levels and degree of toasting for two of the breads are shown in figure 3.

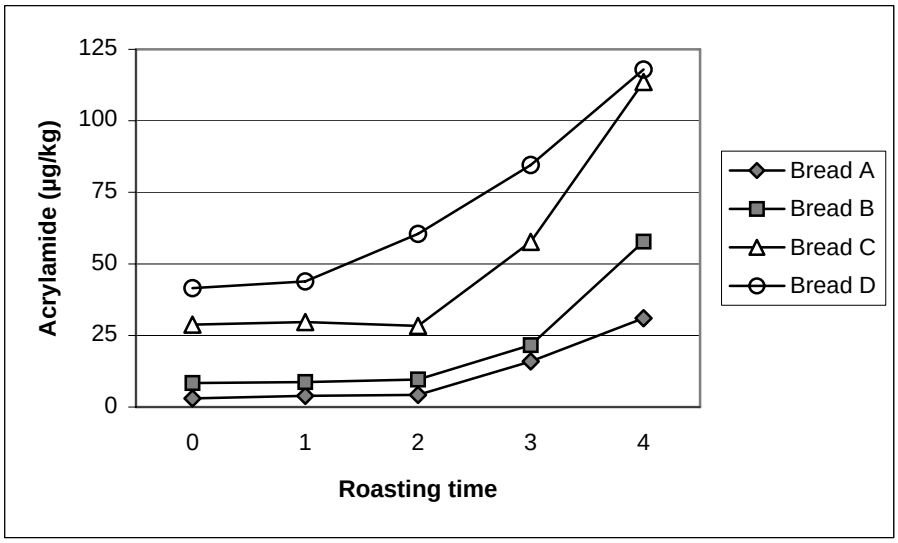
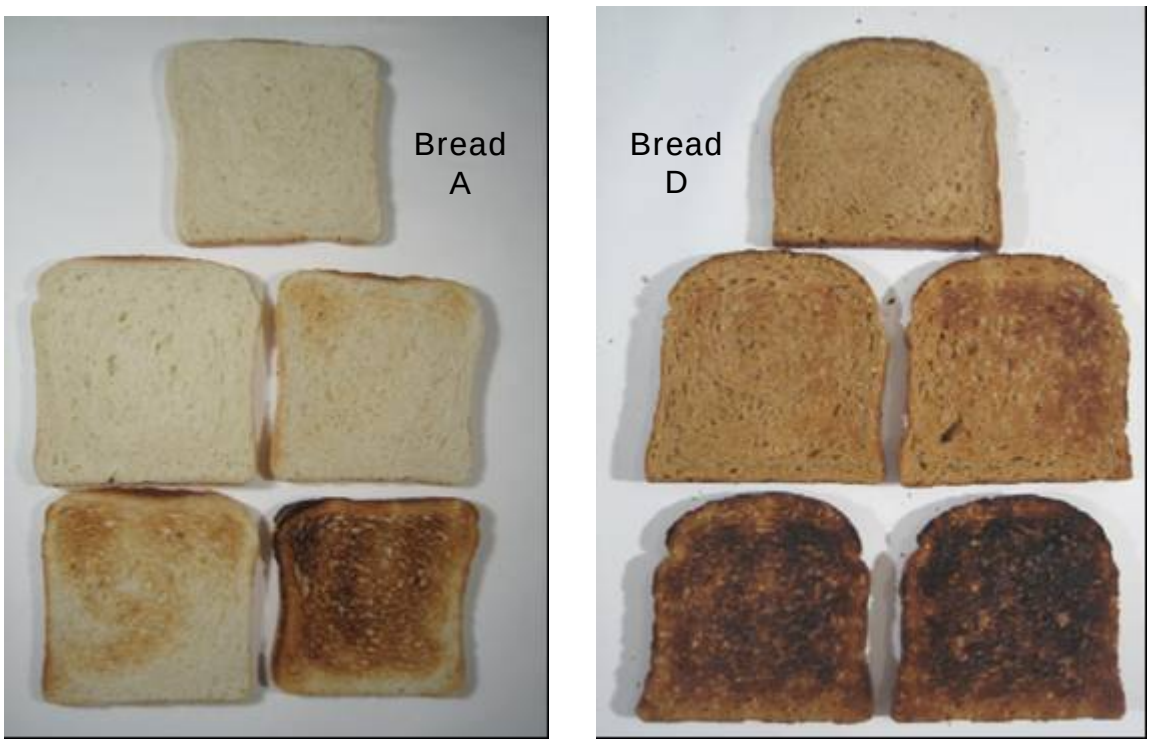


Figure 3: *The acrylamide concentrations have been corrected for weight losses.*



The loaf on top is not toasted, below are toasting times 1, 2, 3 and 4 from left to right.

5b Intake from home cooked foods

The general intake of acrylamide for adults is quite similar across Europe, 0.3-0.5 microgram/kg body weight and day. This may depend on the large proportion of industrially made food. Processes within food industry are controlled, which results in quite consistent acrylamide levels across countries.
The proportion of acrylamide intake from home cooking has not been studied as extensively as from manufactured foods. Due to the fact that a large number of foods contributing to acrylamide intake are industrially produced the contribution from home cooking is probably quite small in the general population. Exposure from home cooking comes primarily from potato products with some addition of toasted and homemade bread.
However, home cooking can generate a very large and almost unpredictable variation even for the same product and for the same cook, which makes it difficult to predict the real intake from home cooked foods. Therefore it is important that consumers follow the advice not to overcook their food and follow the available cooking guidelines. By following the cooking guidelines acrylamide intake from home cooked foods can be kept as low as possible.

Scenario studies on mitigation for home cooking in The Netherlands showed minor influences on the total exposure. Cooking practice regarding baked potatoes and french fries can influence exposure in two directions: “good cooking”, meaning following cooking instructions that include all relevant methods to keep the acrylamide as low as reasonable, lead to lower total exposure, whereas “over-cooking” lead to increased total exposure (table 2).
For toasted bread no scenario was calculated. The Dutch population consumes little toast, thus changes in acrylamide levels in toast have little effect on the overall exposure. However, for countries where more toast is consumed the degree of toasting may influence the exposure. See for example pie-chart on German adolescents in Figure 2.

Table 2 Influence on total exposure by home cooking mitigation, scenarios on Dutch food consumption. Estimates are based on comparisons between “normal” acrylamide levels from the EU database (JRC-irmm) and results from Dutch home cooking experiments within the HEATOX project.

Scenarios	**Change in acrylamide level , %**	**Effect on total acrylamide exposure, %**
Oven baked potato wedges ‘good cooking’	-50	- 4
french fries ‘good cooking’	-60	- 8
french fries fried ‘over-cooking’	+60	+ 8

6 Advice

6a Home cooking practices

General

National differences both regarding cooking practices and dishes are important to the suitability and need for specific advice on home cooking. For example, in Belgium most household kitchens are equipped with built-in fryers, while in other countries it is more common to pan fry or oven bake. Bread machines are common in UK households, but not in Mediterranean kitchens. Examples of other differences are how much home fried potatoes are consumed, the use of raw potatoes in relation to prefabricated product, etc.

Existing advice

Below follows summarized information gathered from websites of national authorities.

Potato products

Three things are usually considered:

- *Storage temperature*
- *Preparation*
- *Temperature and colour*

General rules of thumb
Prefer larger pieces.
Golden colour, avoid dark-coloured.
Follow advice on package or from appliances provider.
Soak, wash or blanch potatoes.
Potato varieties low in sugar contribute less.

Deep frying:
Temperature not exceeding 175 degrees

Pan frying:
Don't fry too hard – too brown. Using margarine rather than oil might help.
Use boiled potatoes, not raw.
Wash or soak raw potatoes for an hour.

Oven baking:
Not over 200 degrees.
Not over 180 degrees in hot air oven.

Cereal products:
Toast to the lightest colour acceptable.
Don't make bread, pizza and cookies too brown.

HEATOX advice

General advice

National authorities should:

- Concentrate on advice on home cooking concerned with potato products.
- Stimulate industry to further reduce the levels in ready to eat and prefabricated foods.
- Don't forget the industry producing cooking equipment.

Potato products

- *Potatoes low in sugar*

The most efficient way to limit acrylamide levels in home cooking from fresh potatoes is to give consumers access to potatoes low in sugar.

The selection of varieties, especially consumer potatoes, is very country specific. Information on sugar levels in different varieties, and advice to consumers on suitable potato varieties, ought to be obtained and given on a national basis. Special labelling on consumer potatoes indicating suitability for frying, could be considered in countries where home cooked potato is known to be an important source of acrylamide intake. Also, recommendations to producers on sugar levels in prefabricated potato products for domestic frying could be considered.

Consumers could store potatoes intended for frying at higher temp (10-20 °C) for up to a few weeks. Temperatures below 6 °C should be avoided at all times. This advice is likely to be of limited importance if the potato supplied to consumers are already high in sugars due to improper handling earlier in the supply chain. National authorities could influence suppliers' storage conditions to avoid unnecessarily low temperatures during whole supply chain.

> *Note: Potato sprouts contain large amounts of the natural toxicants solanine and chaconine and should be removed before cooking.*

- *Blanch or soak*

Potatoes high in sugar could be blanched by putting the potato pieces for a few minutes in hot water, or soak in cold water for at 30 minutes or longer, prior to frying. Blanched potatoes can be fried for shorter time that fresh.

- *Best frying temperature*

For deep frying in oil, the *actual* frying temperature should be in the range 145 to 170°C. Lower temperature will increase fat uptake, while higher give excessive acrylamide formation. Note that this is not identical to the starting temperature of the oil or in the oven, since there is always a temperature drop when the potato is inserted. The temperature profile depends on (1) the starting temperature, (2) the amount of potato in relation to the oil or oven volume and (3) the heating capacity of the cooker/oven.

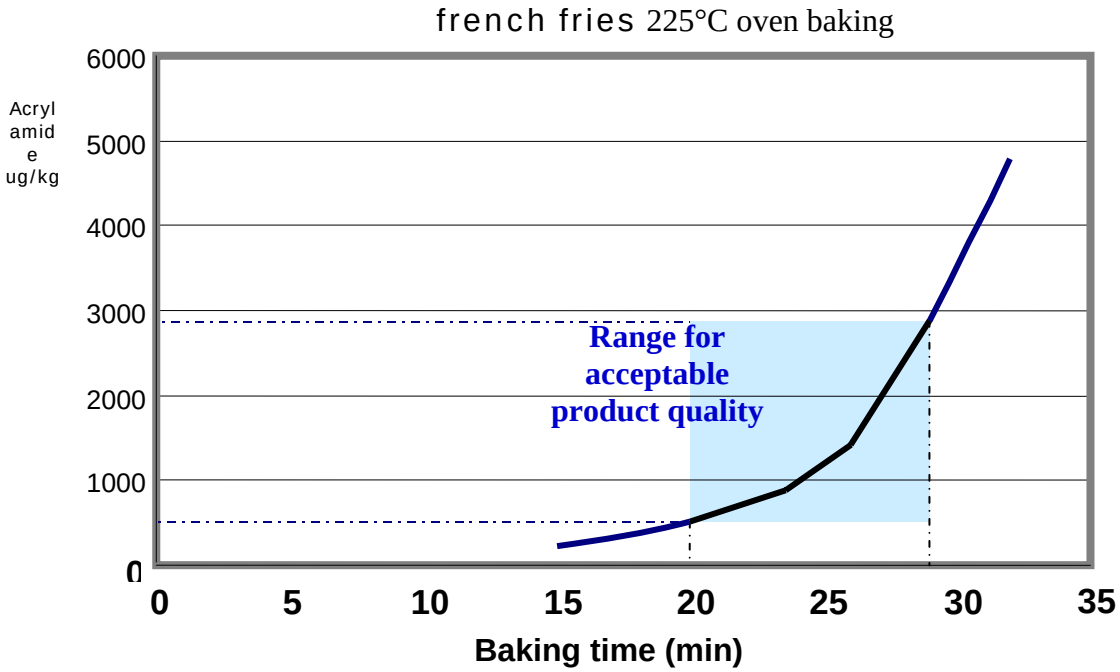


Fig 4

Since pre-fried french fries do not contain acrylamide when leaving the factory, it is important to instruct users to cook the products in a proper way. Instructions on time and temperature should be clearly stated on the package. They should also consider the volume of product to be cooked. For frying the ratio of oil-to-product should be clear. For oven cooking, the electrical power-to-product ratio should be indicated. The frying time needs to be reduced if a smaller amount than indicated is prepared.

The power of household equipment (ovens and deep fryers) should be taken into account. In particular, suppliers of deep fryer should provide recommendations for suitable cooking parameters, incl. oil/product ratio, power setting and frying time. Producers of consumer appliances could improve their product by using better time and temperature controls.

- *Golden, not brown!*

Avoiding overcooking is probably by far the most important action that the consumer can undertake in order to limit the acrylamide intake from home cooked foods. National and local authorities should consider advising domestic consumers to avoid over-heating potato and cereal-based foodstuffs when using high temperature cooking processes. Such advice could include recommendations that french fries and roast potatoes be cooked to a golden-yellow rather than golden-brown colour. Dark pieces, for instance the tips, can be removed.
Authorities should also see to that producers of pre-prepared foods print relevant cooking instructions on the package.

- *Larger pieces*

Larger items accumulate less acrylamide during frying since formation occurs mainly in the surface parts.

Bread, biscuits, etc.

- *Raising agent*

Replacement of ammonium carbonate by other raising agents (sodium or potassium carbonate) when baking cookies, biscuits, etc., can radically reduce the acrylamide formation.

Note: Must be tested for each individual recipe, since it can change the product quality.

- *Yeast fermentation*

Yeast fermentation in bread baking reduces the asparagine content of the dough, and thereby also the acrylamide levels in the bread.

Note: Prolonged fermentation time might increase the amount of other toxicants (Ethyl carbamate, 3-MCPD)

- *Light toasting*

The consumer could be advised to aim to toast bread to the lightest colour acceptable.

6b Consumption

General points

Diet changes can potentially give a significant reduction of the exposure to acrylamide This is especially true for consumer groups with extreme eating habits. However it is important to rely on more than one strategy in order to reduce the exposure to acrylamide, hence both reduced levels in food and changes in consumption patterns should be pursued.

In Europe exposure to acrylamide comes from three major sources, potato products, cereal products and coffee. In many countries each of these major sources contributes with roughly equal amounts to the total exposure.

Generally speaking, a number of potato products with high acrylamide levels have a lower “nutritional value” due to the high fat content than many cereal products with high acrylamide content, for example crispbread. The nutritional value of coffee is very limited. This means that, as shown below, many national food consumption advices issued out of a purely nutritional view will also reduce the exposure to acrylamide.

For other compounds like furan, HMF, 3-MCPD and ethyl carbamate, there are either not enough data for a risk assessment, or the margin of exposure (MOE) is considerably higher than for acrylamide.

As pointed out in Chapter 3 it is very difficult to perform risk/benefit assessments. With the knowledge available at present, where whole grain products have been shown to reduce, for example, some cardiovascular disease, it seems unwise to recommend a decreased consumption of bread, and especially whole grain bread.

It is impossible to recommend a diet free from acrylamide that would be accepted by most consumers. Even with healthy diets recommended by nutritionists there will be a significant acrylamide exposure. However, such diets would still decrease the exposure as compared to the “normal” diets eaten by most consumers.

National authorities are encouraged to perform diet surveys detailed enough to facilitate exposure assessment of acrylamide. Information on which food commodities to concentrate on can be found in the national surveys for acrylamide commissioned by the Commission. Brand loyalty can be of great importance for certain high exposed groups.

Existing advice

The ways that lessen the intake of acrylamide agree in many ways with the predominant diet recommendation to eat a varied and balanced diet with less fat and more fruit and vegetables. Therefore many authorities have stated that there is no need to issue special advice related to acrylamide. This has been erroneously understood by some as there is no need to change the diet because of acrylamide.
Some official recommendations also specify that consumption of large amounts of potato crisps, potato chips and coffee should be avoided.
The Swedish food authority, Livsmedelsverket, has calculated that following its general diet recommendations the average intake would halve, more than halve if no coffee is consumed.

HEATOX advice

- Balance the diet as proposed in national diet recommendations.
- Integrate acrylamide considerations into the "normal" dietary recommendations**.**
- Avoid over-consumption of fried products (reduces the intake of acrylamide, heterocyclic amines and fat).
- Cut down on fried potatoes, crisps and chips (reduces the intake of acrylamide and fat; although pre-prepared french fries finished in the oven contains about 2.5 % fat).
    - Consider mentioning alternative food items and clearly state that boiled potatoes do not contain acrylamide.
- Do not decrease the intake of bread and breakfast cereals products, even if they contain acrylamide. On the contrary increase the intake of whole grain products (epidemiological data have shown that a diet rich in whole grain is good for your health).
- Decrease the intake of biscuits and cookies, especially in children.
- Consider advice on coffee consumption since the contribution to the total exposure can be substantial.

Appendix

References

4 General background

4a Levels in different commodities

Table 1. Acrylamide levels (µg/kg) in some important groups of commercial food products from the European Commission database
http://www.irmm.jrc.be/html/activities/acrylamide/database.htm

4b Formation and mitigation

CIAA Acrylamide Toolbox 23 Sep 2005 Rev 6
http://www.ciaa.be/documents/positions/The%20CIAA%20Acrylamide%20Toolbox.pdf

Proposed Draft Code of Practise for the Reduction of Acrylamide in Food (N06-2006) at Codex Alimentarius meeting in Beijing 16-20 April 2007
ftp://ftp.fao.org/codex/cccf1/cf01_15e.pdf

4c Intake in different countries

Dybing, E., P. B. Farmer, et al. (2005). "Human exposure and internal dose assessments of acrylamide in food." Food and Chemical Toxicology 43(3): 365-410.
Fohgelberg et al, 2005 [Fohgelberg P, Rosen J, Hellenas K-E, Abramsson-Zetterberg L: The acrylamide intake via some common baby food for children in Sweden during their first year of life--an improved method for analysis of acrylamide. Food and Chemical Toxicology 2005, 43(6):951-959.]

Food Standards Agency (FSA) - *Analysis of Total Diet Study Samples for Acrylamide*
http://www.food.gov.uk/multimedia/pdfs/fsis712005.pdf

5 Home cooking

5a Results from experiments with specific foods

Charon Zondervan, Agrotechnology and Foodscience, Wageningen UR, presentation on homecooking of french fries in fryer or oven, at HEATOX meeting, 23th of January, 2007, Prague)

Marco Della Rosa, University of Bologna, presentation on 16th March 2006, CIAA meeting, Brussels

Romani, Bacchiocca, Rocculi, Dalla Rosa:
Accepted to be published on EUROPEAN FOOD RESEARCH AND TECHNOLOGY
Effect of frying time on acrylamide content and quality aspects of French fries
2006

5b Intake from home cooked foods

Influence of the frying temperature on acrylamide formation in French fries
Author: Fiselier K; Bazzocco D; Gama-Baumgartner F; Grob K Source: European Food Research and Technology, (Feb 2006) Volume 222, Number 3-4, pp. 414-419. DOI: 10.1007/s00217-005-0046-6

Good manufacturing practice (GMP) for French fries low in acrylamide: results of a pilot project
Authors: Fiselier K.; Gama-Baumgartner F.; Fiscalini A.; Biedermann M.; Grob K.; Imhof D.; Beer M. Source: Mitteilungen aus Lebensmitteluntersuchung und Hygiene, 2004, 95 (2), 127-134.

Boon PE, Mul Ad, Voet Hvd, Donkersgoed Gv, Brette M, Klaveren JDv: Calculation of dietary exposure to acrylamide. Mutat Res 2005, 580:143-155.

Food Standards Agency - C. Hamlet, S. Jayaratne, C. Morrison. Processing contaminants in bread from bread making machines, RHM technology, September 2005 (FSA C03020)

Fohgelberg P, Rosen J, Hellenas K-E, Abramsson-Zetterberg L: The acrylamide intake via some common baby food for children in Sweden during their first year of life--an improved method for analysis of acrylamide. Food and Chemical Toxicology 2005, 43(6):951-959.

Dybing E, Farmer PB, Andersen M, Fennell TR, Lalljie SPD, Muller DJG, Olin S, Petersen BJ, Schlatter J, Scholz G: Human exposure and internal dose assessments of acrylamide in food. Food and Chemical Toxicology 2005, 43(3):365-410

Jackson LS, Al-Taher F: Effects of consumer food preparation on acrylamide formation. In: Chemistry and safety of acrylamide in food. Edited by Friedman M, Mottram d, vol. 561: Springer science+business media; 2005

6 Advise

Home cooking practises and consumption

List of examples of advice on home cooking and consumption

Canada, Health Canada:
english: Acrylamide - What you can do to reduce exposure
http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_stmt-dec_acrylamide2_e.html
francais: Acrylamide - Comment réduire l'exposition
http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_stmt-dec_acrylamide2_f.html

Germany, Was-wir-essen.de:
Acrylamid tipps
http://www.was-wir-essen.de/sonstiges/schadstoffe_a.php
Foren Acrylamid: Fragen och expertantworten
http://www.was-wir-essen.de/fusetalk/categories.cfm?catid=9

Netherlands, Voedingscentrum: Acrylamide, Algemene adviezen
http://www.voedingscentrum.nl/voedingscentrum/Public/Dynamisch/voedselveiligheid/%28milieu%29verontreiniging/acrylamide/algemene+adviezen.htm

Norrway, Matportalen: Spørsmål og svar om akrylamid
http://matportalen.no/Matportalen/Saker/1052216588.16

Switzerland:
deutch: Bundesamt für Gesundheit: Empfehlungen für die Konsumentinnen und Konsumenten
http://www.bag.admin.ch/themen/ernaehrung/00171/00460/01839/index.html?lang=de
francais: Office fédéral de la santé public: Recommandations destinées aux consommateurs
http://www.bag.admin.ch/themen/ernaehrung/00171/00460/01839/index.html?lang=fr

Kantonales Labor Zürich:
- Hintergründe und Tipps für eine gute und acrylamidarme Rösti
- Tipps zur Zubereitung von acrylamidarmen Pommes frites
- STOP.Acrylamid - Acrylamid in Pommes frites
http://www.klzh.ch/infomaterial/index.cfm

United Kingdom: FSA consuming advice
http://www.eatwell.gov.uk/healthissues/factsbehindissues/acrylamide/

USA, FDA: Acrylamide Questions and Answers
http://www.cfsan.fda.gov/~dms/acryfaq.html