

Acrylamide in the home:
Home-cooking practices and
acrylamide formation

Appendices to the report for the Food
Standards Agency



BROOKLYNDHURST

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LITERATURE REVIEW

Appendices A to D contain information related to the literature review portion of the project. It provides supporting evidence and further detail to Section 2.1 of the main report. The literature review appendices are set out as follows.

- Appendix A sets out the approach to the literature review and the methods used to identify and shortlist documents for full review.
- Appendices B and C set out some of the key findings from the literature:
 - Appendix B provides some general information about acrylamide in foods
 - Appendix C looks at the different ways that consumers can influence acrylamide levels in foods through domestic practices
- Appendix D provides a bibliography of the documents that were fully reviewed and informed Appendices B and C.

A. Literature review approach

The first phase of this project involved a desk review, the objectives of which were to: identify existing evidence on acrylamide; and to use this evidence to inform the design of the fieldwork.

The FSA has its own evidence base regarding acrylamide literature and – as well as in-house experts - is in contact with many leading experts on the topic. The independent evidence review was included as part of this research project as there was no existing evidence known which examines consumers' *actual* domestic food practices, and the influence of these practices on acrylamide generation. The review therefore aimed to either uncover new sources, or to confirm that this was indeed a 'knowledge gap'.

Informing the fieldwork phase involves a number of different strands:

- The evidence review aimed to confirm which foods were most relevant for the fieldwork. Relevance to the fieldwork was based on:
 - which foods consumers cook the most;
 - which foods (when cooked) contain potentially significant levels of acrylamide; and
 - which foods acrylamide levels are most affected by cooking.
- The evidence review aimed to identify which cooking or other practices affect the levels of acrylamide in food, and therefore helped to identify what relevant behaviours and practices consumers may be engaging in, and which the fieldwork needs to examine.
- The review also potentially aimed to note whether there should be any deviation from a 'representative' sample of the UK population, if evidence was found to suggest that particular demographics tend to act in particular ways which may increase or decrease exposure to acrylamide through cooking practices.

The desk review involved the following stages:

- Initial identification of literature
- Selection of documents for detailed review
- Detailed review of selected sources

Initial identification of literature

The initial online search was conducted through a 'scrape' of the Google Scholar and Science Direct databases using Outwit Hub scraping tool¹. Each database was scraped three times, using the following search terms²:

- Acrylamide
- Acrylamide + home
- Acrylamide + home + cooking

Each scrape collected the titles, journal name, and authors of the 100 most relevant articles. A list of 600 documents was therefore generated through this process. This list was looked through manually by the research team, and relevant titles were selected to be on the shortlist. These documents were combined with documents provided by our expert academic advisors from the University of Surrey³, those identified during the bidding process for the project, and those signposted by the FSA, to form the final shortlist of 99 documents.

Selection of documents

A database was developed to record the literature sources identified on the shortlist (see Figure 1). Information we recorded included:

- Search terms used
- Source of document
- Title
- Author
- Date of publication
- Journal
- Weblink
- Abstract (or summary)
- Foods covered
- Cooking practices covered
- Key words

¹ <https://www.outwit.com/products/hub/> [Accessed 23 February 2015]

² The search dates were also limited, so that documents that pre-dated 2002 were excluded

³ The advisors from the University of Surrey were involved in the project largely thanks to their expertise conducting research into cooking practices, rather than specialist knowledge of acrylamide. This allowed the online searching to focus on acrylamide research, with the primary methodological input coming from the documents supplied by the advisors.

Figure 1 – A screen shot of the database

ID	Search terms	Source	Title	Author(s)	Date	Rating	Journal	Weblink	Abstract or equivalent
25	Acrylamide	Web search - G	The effects of low-temperature potato storage and washing	RS Burch, A Trzesicka	2008	2	Journal of the	http://online	Background: Since the discovery in 2002 of acryl
84	Acrylamide	Expert advisors	Domestic cooking practices and cooking skills: findings from	Short	2003	2			This paper reports on a study that came about i
99	Acrylamide	Expert advisors	Domestic Food and Sustainable Design: A Study of Univers	Clear, et al.	2013	2			In four university student kitchens over twenty
89	Acrylamide	Expert advisors	Cooking behaviours: understanding energy use to design p	Oliveira et al.	2011	3			Electric cookers and kettles are often the high
31	Acrylamide	Web search - G	The effect of domestic preparation of some potato product	J Michalak, E Gujska	2011	3	Plant foods fo	http://link.spr	The influence that food heating has on the conc
39	Acrylamide	Web search - G	Concentrations of free amino acids and sugars in nine pota	NG Halford, N Muttuc	2012	3	Journal of agr	http://pubs.ac	Acrylamide forms during cooking and processin
43	Acrylamide	Web search - S	Possible causes of variation in acrylamide concentration in	M. Sanny, S. Jinap, E.	2012	3	Food Chemist	http://www.sc	Acrylamide is a probable human carcinogen, ar
79	Acrylamide	FSA database	Factors affecting acrylamide formation in thermal treatme	Koutsidis et al.	2007	2			It is now well established that acrylamide is pr
80	Acrylamide	FSA database	Analysis of Total Diet Study samples for acrylamide.	Wilson and Castle	2004	2			Food samples from each of the 20 food groups c
81	Acrylamide	FSA database	Examination of the effect of domestic cooking on acrylamid	Burch	2007	2			This document is the final report on a project co
86	Acrylamide	Expert advisors	Effect of Cooking Method (Baking Compared with Frying) on	Palazoglu et al.	2009	2	Food Enginee		The effect of cooking method (baking compared
89	Acrylamide	Expert advisors	The Risks of Everyday Life: Fat content of chips, quality of fr	Morley-John et al.	2002	2			The prevalence of obesity is increasing in New Z
1	Acrylamide	Web search - G	Acrylamide in foods: occurrence, sources, and modeling	A Becalaki, BPY Lau, D	2003	2	Journal of Agr	http://pubs.ac	Acrylamide in food products - chiefly in commer
7	Acrylamide	Web search - G	Factors affecting the concentration of acrylamide during de	B Matthäus, NU Haas	2004	2	European Jou	http://online	The paper describes the effect of different factc
9	Acrylamide	Web search - G	Verification of the findings of acrylamide in heated foods	JS Ahn, L Castle, DB C	2002	2	Food Additive	http://www.ta	We report here the first confirmation of the rec
24	Acrylamide	Web search - G	Effect of frying time on acrylamide content and quality aspe	S Romani, M Bacchiod	2008	2	Food Researc	http://link.spr	The effect of frying time on quality and acrylami
27	Acrylamide	Web search - G	A farm-to-fork approach to lower acrylamide in fried potat	F Mesdagh, C Van Pe	2009	2	FOOD (2009	https://archive	Acrylamide is a probable human carcinogen, w
30	Acrylamide	Web search - G	The effect of domestic microwave oven cooking on acrylam	W HUANG, Q DENG, X	2005	2	Food Science	http://en.cnki	A method of examining Acrylamide(Am) in cerea
44	Acrylamide	Web search - G	Dietary exposure to acrylamide in adolescents from a Cana	Louise Normandin, M	2013	3	Food and Che	http://www.sc	The distribution of acrylamide in food items fre
48	Acrylamide	Web search - S	Influence of frying conditions on acrylamide content and oth	er quality charact	2009	2	Journal of Fo	http://www.sc	The objective of this work was to investigate th
63	Acrylamide	Expert advisors	Identification of critical points during domestic food prepa	Kennedy et al.	2011	3	British Food J		Purpose - The International Scientific Forum on
73	Acrylamide	Expert advisors	Burger preparation: what consumers say and do in the hon	Phang and Bruhn	2011	3	Journal of Fod		Ground beef has been linked to outbreaks of pa
96	Acrylamide	Expert advisors	Food Safety in the Domestic Environment: An Interdisciplin	Fischer et al.	2007	2	Risk Analysi		It has been established that, to a considerable
16	Acrylamide	Web search - G	Analysis of acrylamide in different foodstuffs using liquid of	K Hoenicke, R Gaters	2004	2	Analytica Chit	http://www.sc	Acrylamide levels over a wide range of differ
57	Acrylamide	Expert advisors	Self-reported and observed behavior of primary meal prep	Dedonder et al.	2009	2	British Food Journal		Purpose - The purpose of the present study wa

On top of this recording, the documents were scored them against a number of weighted⁴ criteria:

- date of publication;
- source reliability;
- method robustness; and
- relevance to the specific research questions.

A total score was produced from the weighted criteria, and the 20 highest scoring documents were selected for detailed review. After these 20 documents had been reviewed, the research team identified any outstanding evidence needs. Remaining documents were selected (largely from the shortlist⁵) to meet these needs. In total over 30 documents were included in the full evidence review, though additional gaps were filled through internet searches and use of large statistical databases (e.g. 2011 UK Census, National Diet and Nutrition Survey).

Detailed review of selected sources

The detailed review sought to extract further relevant information from the documents to inform the literature review. Documents were read in full, and information was recorded in the database under additional headings, including:

⁴ Relevance was given a weighting score several times higher than publication date, for example.

⁵ In addition to 30 reviewed documents identified through the short-listing process, a number of other documents were read (in part or in full) to enable the review to meet the objective of informing the fieldwork. These included, for example, data on the purchase and consumption of certain foodstuffs.

Table 1 – Data recorded in the full review (in addition to the short listing)	
In-home practices and contribution to acrylamide generation	Storage
	Preparation
	Cooking
	Are particular people more likely to do this?
Food and meal types	Evidence on cereals and breads
	Evidence on root vegetables
	In which foods are acrylamide levels most affected by cooking?
	How often do people cook these foods?

B. What is known about acrylamide in food?

Please note: all references in this appendix [in square brackets] can be found in full in the bibliography in Appendix D.

B.1 Background

The following box is a summary of the established knowledge regarding acrylamide in food.

- Acrylamide was first discovered in food in Sweden in the early 2000s.
- The formation of acrylamide is closely linked to the Maillard reaction, which is often associated with the dark, crunchy crust characteristic of roasted and fried foods.
- The precursors to acrylamide formation in foods are thought to be the free amino acid asparagine and reducing (or 'free') sugars, predominantly glucose and fructose.
- Acrylamide formation in food usually occurs when foods are subjected to cooking or other thermal processing at temperatures of above ~120°C.
- Low moisture content is also a condition that favours the formation of acrylamide; hence acrylamide formation does not usually occur in boiled foods.
- Acrylamide has been discovered in a wide range of thermally processed plant-based foods (all of which contain the essential amino acid asparagine), but predominantly in cereal- and potato-based foods.

B.2 Which foods contain acrylamide?

One of the aims of the literature review was to help identify which food types or meal formats are most relevant to this research. The aim of this section is therefore to identify in

which foods concentrations of acrylamide are found (and most influenced by cooking), and which of these foods are most often cooked by consumers.

Since the disclosure that acrylamide was present in cooked foods⁶, a large amount of research has been conducted in this area, including research relevant to this study which seeks to:

- quantify concentrations of acrylamide in various foods;
- identify which foods contain the highest concentrations; and
- identify which foods are the greatest contributors to dietary acrylamide exposure.

Acrylamide is predominantly found in plant-based foods which are high in carbohydrate, when these foods have been subjected to high temperatures during cooking or other thermal processing [JECFA, 2005].

Acrylamide has, however, been identified in a wide range of foods, in varying concentrations. These include: coffee, chocolate, bread, meats, cereals, potato products (including fries and crisps), biscuits, olives, dried fruits, roasted nuts, popcorn, pretzels and corn chips [Burch, 2007; Normandin et al., 2013].

Wilson and Castle for the FSA did an early analysis of the concentrations of acrylamide in food samples from each of the 20 food groups collected for the 2003 UK Total Diet Study, and found quantifiable concentrations in 7 of the 20 groups [Wilson and Castle, 2004]. Food groups containing acrylamide in this study were: bread; miscellaneous cereals; carcass meat; meat products; poultry; sugars and preserves; and potatoes. Table 2 below gives the concentrations of acrylamide encountered in these food groups in the study.

Table 2 – Analytical results for acrylamide testing [Wilson and Castle, 2004]

Total Diet Survey food group	Measured concentration of acrylamide (µg/kg)
Bread	12
Miscellaneous cereals	57
Carcass meat	10
Meat products	13
Poultry	6
Sugars and preserves	23
Potatoes (2003 group)	53
Potatoes (2001 group)	112

Food groups in which acrylamide levels were not quantifiable were: offal; fish; oils and fats; eggs; green vegetables; other vegetables (not including potatoes); canned vegetables; fresh fruit; fruit products; beverages; milk; dairy products; and nuts [Wilson and Castle, 2004].

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) published acrylamide occurrence data from 24 countries in 2005 (Table 3) which presented similar patterns of results: root vegetables and cereal based products appear to have relatively high levels of

⁶ Widely reported by the Swedish National Food Authority in 2002, but discovered a couple of years before by Tareke et al:
Tareke, E., Rydberg, P., Karlsson, P., Eriksson, S., Törnqvist, M., (2000). Acrylamide: a cooking carcinogen? Chemical Research in Toxicology, 13(6), 517-522.

acrylamide, while meats and contain relatively low levels. The JECFA results also show that relatively high levels of acrylamide are found in coffee, and appear to contradict the Wilson and Castle study regarding the acrylamide levels in nuts.

Table 3 – Summary of the distribution weighted concentration of acrylamide in several commodities from 2002 to 2004 [JECFA, 2005]

Commodities	Mean concentration (µg/kg)
Cereals and cereals-based products	343
Fish and seafood	25
Meat and offals	19
Milk and milk products	6
Nuts and oilseeds	84
Pulses	51
Roots and tubers	477
Stimulants and analogue	509
Sugars and honey	24
Vegetables	17

Since 2007, the FSA has been tracking the acrylamide levels in only the food groups that had been shown to contain significant levels of acrylamide, and as recommended by the European Food Safety Authority (EFSA)⁷. Their results show potato crisps to have the highest⁸ acrylamide levels (per kg) of the categories collected. Potato crisps were second highest and therefore have a higher acrylamide content, on average, than foods including: baby foods; cereal products; breads; and crackers. (It is this FSA data that is presented in Section 5 of the main report, as well as in Appendix K).

EFSA also regularly publish data on the concentrations of acrylamide in different relevant foodstuffs (Table 4) based on submissions from the FSA and the equivalents in other EU member states.

Table 4 – Distribution of acrylamide in foods in 2010 [EFSA, 2012]

Food category	Median (µg/kg)	Mean (µg/kg)
French fries, sold as ready to eat	240	338
Potato crisps	450	675
Pre-cooked French fries/potato products for home cooking	151	331
Soft bread	18	30
Breakfast cereals	91	138
Biscuits, crackers, crisp bread and similar	129	333
Coffee and coffee substitutes	242	527

The EFSA Panel on Contaminants in the Food Chain (CONTAM) draft opinion on acrylamide in food⁹ provides an update on results from food commodities collected and analysed since 2010. This also demonstrates that the highest levels of acrylamide were found in “Coffee and coffee substitutes” (average middle bound (MB) levels of 578 µg/kg), followed by “Potato crisps and snacks” (average MB level of 389 µg/kg) and “Potato fried products” (average MB level of 308 µg/kg).

⁷ See: <http://www.food.gov.uk/science/research/chemical-safety-research/pc-research/> [Accessed 23 February 2015]

⁸ The coffee category actually contained higher average acrylamide levels per kg, though this drops significantly below that of potato crisps and chips when analysed ‘as consumed’ (e.g. with water added). Vegetable crisps were also found to be high in acrylamide, though only eight samples were collected and this did not form a separate category.

⁹ <http://www.efsa.europa.eu/en/consultations/call/140701.htm> [Accessed 23 February 2015]

All of these studies indicate that the foods which have the potential to contain acrylamide in particularly high concentrations are:

- potatoes and potato products (particularly crisps and French fries)
- bread and cereal products (including biscuits crackers, and crispbreads)
- coffee and coffee substitutes.

Potato products in particular have been identified as having some of the highest concentrations of acrylamide by a number of studies [Michalak et al., 2011; Sanny et al., 2012], and it has been stated that “fried potato products are notorious for having the highest concentrations of acrylamide” [Palazoğlu et al., 2010]. These high concentrations of acrylamide are reflected in the fact that potato products were very prominent in the evidence encountered. This is true to a lesser extent of bread and cereal products (while coffee and coffee substitutes seem to feature even less).

Exposure

Potatoes, bread and coffee were also identified as being leading contributors to dietary acrylamide exposure [Burch, 2007], due to the fact that they are widely consumed. In the UK, for example, according to the Potato Council Consumer Report, “potatoes are the second most popular carbohydrate consumed in the home, after bread” [Potato Council, 2013]. The JECFA report of 2005 evaluated national dietary intake data for 17 countries, and concluded that the major contributing foods to total exposure for most countries were potato chips (16-30%), potato crisps (6-46%), coffee (13-39%), pastry and sweet biscuits (10-20%) and bread and rolls/toasts (10-30%) [JECFA, 2005].

The UK National Diet and Nutrition Survey confirmed that breads may be an important element of acrylamide exposure, due to their prominent consumption (Table 5).

Table 5 – Total quantities of food consumed (grams) per day: all adults aged 19-64Source: National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 (combined)¹⁰

Item	Consumption (g)	Item	Consumption (g)
Fruit	92	Cheese	15
Vegetables (not raw) including vegetable dishes	91	Bacon and ham	15
Breads	86	Biscuits	13
Pasta, rice, pizza and other miscellaneous cereals	85	Lamb and dishes	12
Chicken and turkey dishes	68	Sugars, including table sugar, preserves and sweet spreads	11
Beef, veal and dishes	48	Puddings	11
Other potatoes, potato salads and dishes	44	Pork and dishes	11
Salad and other raw vegetables	42	Fat spreads	11
Chips, fried and roast potatoes and potato products	41	Chocolate confectionery	9
Other meat products and dishes	37	Savoury snacks	7
Fish and fish dishes	37	Ice cream	5
Soup, manufactured/retail and homemade	31	Nuts and seeds	2
Yoghurt, fromage frais and other dairy desserts	27	Dry weight beverages	2
Cereals	26	Sugar confectionery	2
Savoury sauces, pickles, gravies and condiments	24	Commercial toddler foods	0
Buns, cakes, pastries and fruit pies	18		

Analysis of Defra's food datasets suggested that these consumption levels, and therefore potential exposure to acrylamide, are not evenly spread through the population¹¹. Potato consumption varied considerably by age (Table 6), ethnicity and household composition. Bread consumption also showed considerable variation amongst demographic groups, with – for example – people aged 65-74 appearing to consume more than people under 30 [Defra, 2013].

¹⁰ Report and appendices available from: <https://www.gov.uk/government/publications/national-diet-and-nutrition-survey-results-from-years-1-to-4-combined-of-the-rolling-programme-for-2008-and-2009-to-2011-and-2012> [Accessed 23 February 2015]

Please note that some categories have been combined and beverages have been excluded from the table.

¹¹ Defra Family Food Datasets (age of household reference person). Available from: <https://www.gov.uk/government/statistical-data-sets/family-food-datasets> [Accessed 23 February 2015]

Table 6 – Fresh and processed potatoes bought per person per week (average, grams), by age. Defra Food Datasets (2013)

	Age					
	<30	30-39	40-49	50-64	65-74	75+
Fresh	281	355	422	548	797	592
Processed	256	219	254	272	238	200
Total	537	573	676	819	1,034	792

Fieldwork implications

Of particular relevance for this research is the fact that - as well as being both high in acrylamide concentrations and leading contributors to dietary acrylamide exposure – both bread and potatoes have the potential to be strongly affected by domestic practices. This is an essential component of this research project. While coffee is clearly another leading source of exposure, the acrylamide content is already defined before the product reaches the home (unless people are roasting their own coffee beans). With potato products and bread that is then toasted, there is far more potential to influence the final acrylamide level in the home.

Potatoes and certain potato products, and bread and bread products are therefore of more relevance than coffee. Indeed, a great deal of evidence has looked at how the final concentrations of acrylamide in these foods can be affected by domestic preparation (see Appendix C).

In light of the above, it is proposed that the fieldwork phase of this research focus primarily on potatoes and potato products, and bread and bread products, given that they have been shown to be:

- a) high in acrylamide
- b) leading contributors to dietary acrylamide exposure and crucially
- c) the products in which final acrylamide levels may be the most affected by domestic preparation.

No other food types clearly meet these criteria, and were therefore not considered for inclusion in the fieldwork. Furthermore, focusing on a smaller number of food groups will enable a greater exploration of the effects of cooking on a wider variety of sub-types or variants within each category. Further specification of the sub-types for inclusion is provided in Appendix C.

Though marked differences in the potential levels of consumption of potatoes and bread between different demographic groups were noted, aiming to observe a representative spread of the population would be more valuable than prioritising particular sections.

Informing fieldwork:

- Fieldwork will gather data on potatoes (and potato products) and bread (and bread products) primarily.

C. How might consumers influence acrylamide formation?

This section explores which cooking methods and other practices are most relevant to the fieldwork phase. This builds on the previous section, which identified the most relevant foods for the study, and seeks to establish both: what should be observed; and which data should be recorded, during the in-home observations. It is also worth noting that there are other behaviours or practices, beyond cooking, in which consumers may be engaging that could affect the concentrations of acrylamide in food. These include storage and preparation. It is also important to note that none of the acrylamide-related evidence reviewed explored what consumers *actually* do. Any studies which attempted to explore the effects of consumer actions on acrylamide generation were conducted in laboratory conditions, using different methods as proxies for consumer behaviour.

Please note: all references in this appendix [in square brackets] can be found in full in the bibliography in Appendix D.

C.1 Storage

Findings summary:

- Longer storage times tend to increase the level of acrylamide precursors - namely 'reducing sugars' - in potatoes.
- Low storage temperatures tend to increase levels of 'reducing sugars' in potatoes.
- These fluctuations are quite heavily variety dependent.
- There was no evidence encountered regarding the effects of storage on acrylamide levels in

Evidence suggests that the way in which food – certainly in the case of potatoes – is stored can influence acrylamide concentrations. In the case of potatoes it is also clear that the variety or cultivar plays a crucial role in final acrylamide concentrations in cooked products. The consumer does not therefore necessarily have full control over either of these factors. Food is often stored for a considerable amount of time prior to purchase, and in the case of pre-prepared potato products, the consumer has limited control over which variety is used.

With these points in mind, the following attempts to draw out the evidence on the effect of storage and variety on acrylamide concentrations. This focuses, where possible, on consumer behaviour.

C.1.1. Potatoes and potato products

Storage time

A number of studies have been conducted which seek to examine the relationship between storage and concentrations of acrylamide in potatoes and potato products. The conclusions drawn in these studies tend to concur. Firstly, there is a generally positive relationship between the length of time that a raw potato is stored and the concentration of acrylamide in a final, cooked potato or potato product [Halford et al., 2012; Burch, 2007]. This is due to

the fact that ‘reducing sugars’ – mainly glucose and fructose - but also total sugars tend to increase with storage time [Burch, 2007; Burch et al., 2008; Halford et al., 2012; Skog et al., 2008]. As acrylamide is formed in a reaction between asparagine and reducing sugars, an increase in concentrations of reducing sugars in raw potatoes therefore leads to increased levels of acrylamide in final, cooked products.

Storage temperature

There is a second way in which storage can influence the acrylamide content of potatoes, and that is via the temperature at which the raw potato is stored. It is clearly highlighted in the evidence that storage at lower temperatures (for example at around 3.5°C) also tends to increase the concentrations of reducing sugars in raw potatoes [Burch et al., 2008]. Low temperature storage also makes the effect of longer storage more pronounced [Skog et al., 2008]. This is an apparently well-known phenomenon, and ‘low temperature sweetening’ can be prevented by storing potatoes at around 8-12°C [Romani et al., 2008].

Potato variety

Variety or cultivar is a further consideration. The variety can strongly influence the increase in reducing sugars in raw potatoes (and therefore concentrations of acrylamide in final, cooked potatoes and potato products). Several studies conducted on the influence of variety have concluded that the effect of storage (of different lengths and at different temperatures), and the change in reducing sugars is quite strongly variety dependent [Burch et al., 2008], in that some varieties are more prone to fluctuation than others [Halford et al., 2012].

Fieldwork implications

The extent to which these conclusions apply to domestic practices is less clear. There appears to be a lack of consumer facing research that exists regarding storage behaviours. The studies that were identified, and examined storage, considered timescales which are unlikely to be replicated in the home, for example, samples were taken monthly [Halford et al., 2012], or after 6, 16 and 34 weeks [Burch et al., 2008]. It is therefore also unclear the extent to which *short-term* low-temperature storage in the home – i.e. in the refrigerator – has an effect on levels of reducing sugars (in comparison to long-term low-temperature storage). All of these factors will therefore be built into the fieldwork observations.

C.1.2. Bread and bread products

No evidence was encountered regarding the influence of storage on acrylamide concentrations in bread or bread products. Given that bread is already (part) cooked it is likely that the reducing sugars would remain more stable.

Informing fieldwork:

- Fieldwork will seek to gather data on:
 - length of home storage
 - method (and temperature) of home storage
 - variety of potato (where possible)
- The fieldwork will gather similar information on bread, though no evidence was reviewed which established the links between storage and acrylamide generation.

C.2 Preparation

Findings summary:

- Pre-treatments such as washing, soaking in water or parboiling tend to reduce acrylamide concentrations in final, cooked potatoes.
- This occurs because acrylamide precursors are removed from the surface, where the Maillard reaction and acrylamide formation primarily take place.
- A high surface:volume ratio increases acrylamide concentrations in final, cooked products.
- There was little or no evidence encountered regarding the effects of preparation on acrylamide levels in bread.

Preparation is a further point¹² at which consumers may be engaging in actions or practices which might affect concentrations of acrylamide consumed in food. Preparation includes a number of possible actions, such as pre-treatments of foods – washing, soaking, parboiling etc. – and preparation of food for cooking by cutting/chopping. It is worth noting that, as with storage, this is not necessarily an area over which consumers have complete control. While consumers have full control if preparing foods from scratch, pre-prepared foods may have already been subjected to pre-treatments and have been cut to a certain size.

C.2.1. Potatoes and potato products

Pre-treatment

There were two key studies [Burch, 2007; Burch et al., 2008] in the evidence reviewed which examined the effect of pre-treatments on acrylamide concentrations in chips and roast potatoes. Both studies looked at pre-treatments which consumers could potentially undertake in the home, namely: washing; soaking (for either 30 minutes or two hours); and parboiling.

All of the pre-treatments for chips resulted in lower concentrations of acrylamide in the final, cooked product. Potatoes soaked for two hours showed the lowest concentrations [Burch, 2007]. Soaking was found to be more effective at reducing final acrylamide concentrations than washing, with levels being reduced by 35-50% and 15% and respectively on average [Burch et al., 2008].

For roast potatoes, reductions in acrylamide were seen with parboiling and soaking for two hours. As replicate results from the study were more variable, however, the results of pre-treatments for roast potatoes were less clear [Burch et al., 2008].

The generally accepted explanation for why pre-treatments such as washing and soaking reduce the concentrations of acrylamide in final, cooked potatoes is that these pre-treatments remove acrylamide precursors – namely reducing sugars – from the surface of the potato. The surface is where the Maillard reaction predominantly takes place and the majority of acrylamide is formed [Burch, 2007; Burch et al., 2008].

¹² After purchasing a particular variety and home storage

Whether consumers are engaging in these simple pre-treatments for potatoes was not examined in the literature reviewed, and therefore there were no estimate as to the extent that people are affecting their dietary acrylamide exposure through these practices.

Preparation

With regards to preparation of potatoes for cooking (i.e. cutting or chopping), the main finding from the evidence reviewed is that the surface:volume ratio achieved as a result of preparation is an important factor in determining final acrylamide concentrations. It is known that the relatively high concentrations of acrylamide in potato crisps are a result of a high surface:volume ratio [Palazoğlu et al., 2009], and that one tactic for minimising dietary acrylamide exposure is to encourage a lower surface:volume ratio for foods such as chips [Burch, 2007].

This means that for consumers, the simple act of cutting their potatoes (for chips or roast potatoes) into larger sizes will lower the surface:volume ratio and could decrease their dietary acrylamide exposure. Similarly, ‘fluffing’ up potatoes before roasting may lead to increased acrylamide generation during cooking as a result of a higher surface:volume ratio. A reduction could also be achieved for pre-prepared potato products by choosing ones with a lower surface:volume ratio – i.e. thick-cut chips rather than French fries.

Fieldwork implications

The evidence is conclusive on the possible pre-treatment and preparation actions which could influence the concentrations of acrylamide in final, cooked potatoes and potato products (if prepared from fresh). Washing and soaking potatoes will reduce potential acrylamide levels, as will cooking potatoes with a small surface:volume ratio. What is not known, however, is the extent to which these actions are being performed by consumers in the domestic environment. This will therefore be observed fully in the fieldwork.

C.2.2. Bread and bread products

As with storage, no evidence was encountered regarding preparation of bread on acrylamide concentrations in bread or bread products. It seems reasonable to assume that similar principles (e.g. soaking, surface:volume ratios) would apply to bread, though it is clearly less likely that consumers would naturally practice acrylamide-influencing preparation behaviours in the same way that they might with potato products.

Informing fieldwork:

- Fieldwork will collect data on whether any pre-treatments are undertaken, and for how long.
- Fieldwork will attempt to estimate surface:volume ratio of foods, and photographs will be taken.

C.3 Cooking

Findings summary:

- Roasting, baking, deep-frying, frying and grilling all lead to acrylamide formation. Boiling and steaming do not.
- Acrylamide concentrations increase exponentially with higher cooking temperatures.
- Acrylamide concentrations increase with longer cooking time.
- A darker cooked colour tends to indicate a higher acrylamide content.

Cooking is both the final point at which consumers may be engaging in domestic practices which are increasing their exposure to dietary acrylamide, and the one which has received the most attention in the literature. A significant amount of literature has been dedicated to exploring the effects of various cooking methods, of variations in time and temperature of cooking. Further to this, it touches on the effect of different approaches to ‘doneness’ on the overall concentration of acrylamide in cooked foods.

From amongst the various cooking methods, there has been a strong focus on deep-frying in particular, and roasting and baking to a slightly lesser extent. The relationship between various factors in cooking – and between cooking and those already discussed such as variety, storage and preparation – is generally considered to be fairly complex. There is agreement, however, that cooking temperature and time (duration) are the most important factors influencing the formation of acrylamide in foods (and therefore in the drive to minimise acrylamide formation). It is also clear that boiling and steaming do not produce significant levels acrylamide, due to high moisture levels, and that these are not of interest as cooking methods.

Cooking is also an area over which consumers have a considerable amount of control, both with regards to fresh food and pre-prepared, and therefore represents an area in which consumers’ actions may be having a significant effect on the formation of acrylamide.

C.3.1. Potatoes and potato products

As mentioned above, the key factors with regards to the formation of acrylamide during cooking of any foods, and in particular potatoes and potato products, are temperature, moisture levels, and time [Bethke and Bussan, 2013; Michalak et al., 2011; Sanny et al., 2012; Burch, 2007; Normandin et al., 2013; Romani et al., 2008; Matthaus et al., 2004].

Cooking temperature

Acrylamide formation usually begins to occur above temperatures of around 120°C¹³. A number of studies have discovered that acrylamide formation tends to be relatively low when cooked at temperatures of around 150-175°C, however [Matthaus et al., 2004; Burch, 2007]. At temperatures of 180°C, 190°C and above, acrylamide formation in potatoes and potato products rapidly increases. These higher temperatures have been described as leading to “drastically” [Matthaus et al., 2004] and “disproportionately” [Bethke and Bussan,

¹³ Acrylamide can form at temperatures of <100°C, such as during the processing of prunes and pears, and dehydration of other fruit. This is likely due to the reaction between asparagine and relatively reactive sugar derived precursors such as hydroxycarbonyls known to be present in these species, as well as the relatively long processing times [Becalski et al., 2011].

2013] higher concentrations of acrylamide. Bethke and Bussan, for example, found that acrylamide concentrations in chips cooked at 190°C were almost three times that of chips cooked at 170°C [Bethke and Bussan, 2013]. Acrylamide concentrations can increase exponentially with increasing cooking temperature [Matthaus et al., 2004] but this is typically distorted in foods due to competing reactions and the exhaustion of precursors. The correlation between temperature and formation of acrylamide, and acrylamide concentrations in final, cooked products is therefore clearly established in the evidence. That higher temperatures lead to higher concentrations of acrylamide, increasing rapidly as temperature increases beyond about 180°C is also well established.

Interestingly, a number of studies have shown that, especially with regards to deep-frying, it is not only the initial temperature which is of importance, but also the ability of the cooking apparatus to quickly regain and maintain a selected temperature which has an effect on overall acrylamide concentrations [Romani et al., 2008].

Moisture levels

A further condition for the formation of acrylamide is low moisture levels (particularly if water content drops below ~10% moisture [Bethke and Bussan, 2013]). Boiling, and steaming (with their high moisture levels and lower temperatures), do not appear to lead to significant acrylamide formation [Halford et al., 2012]¹⁴. Deep-frying, frying, roasting and baking on the other hand have been studied extensively, and do cause acrylamide generation.

Cooking time

Time, or duration of cooking is the other important factor in the formation of acrylamide. The conclusions that are drawn across the evidence reviewed seem to agree that there is a correlation between cooking time and final acrylamide concentrations. More specifically, acrylamide formation is low at shorter cooking times, and increases rapidly as cooking time increases. As Romani et al. conclude, "acrylamide content increased exponentially with the increasing of frying time with enhanced slope at longer times [Romani et al., 2008]." This 'enhanced slope' is thought to be a result of a combination of decreasing moisture levels towards the latter stages of cooking time [Palazoğlu et al., 2009], and increased surface temperature of the potato or potato product after a longer cooking time [Romani et al., 2008]. Longer cooking times therefore appear to have an exponential impact on acrylamide formation.

Microwaves

One area where the evidence encountered is unclear, is as to the effect of microwaving on acrylamide formation. Michalak et al. found that microwaving of frozen, pre-prepared potato products such as chips and wedges led to higher levels of acrylamide in the final, cooked product than any other cooking method [Michalak et al., 2011]. On the other hand, Burch found that fresh potatoes microwaved in their skins contained negligible levels of acrylamide [Burch, 2007].

¹⁴ Becalski et al found an exception to this rule during the boiling of prunes to create prune juice. This phenomenon was put down to the prolonged boiling and/or pasteurisation and possibly because the juice may become 'dry' (e.g. on the sides of the vessel [Becalski et al., 2011]).

Conclusions

One consequence of these findings, certainly with regards to consumer advice, is that no one cooking method – roasting, deep-frying, frying, baking – can be described as the ‘worst’ with regards to acrylamide formation. More important is the time and temperature employed for cooking [Burch, 2007].

There is strong agreement amongst the various evidence sources reviewed on the effect of variations in cooking on acrylamide concentrations in potatoes and potato products. Specifically that there is a strong correlation between: cooking temperature, moisture levels and time; and acrylamide concentration.

There is, however, one important caveat to the conclusions drawn in the evidence regarding cooking, which is that these studies were conducted in laboratory settings. They have therefore used various estimates as to what consumers might be doing in the domestic setting. No evidence was found (and therefore reviewed) regarding the practices in which consumers are engaging that could be increasing their exposure to dietary acrylamide. For example, it is not known whether consumers are cooking potatoes and potato products for longer or at higher temperatures than recommended, in order to achieve a desired texture or colour.

Fieldwork implications

The notion of desired texture or colour, or ‘doneness’, will be important for the fieldwork stage, as consumers may simply be cooking to arbitrary times and temperatures [Sörgel et al. (2002) (referenced in Normandin et al., 2013)] in order to achieve a certain level of ‘doneness’ to their liking. It will be necessary to establish *why* consumers consider food to be ‘done’ – whether that be time, texture, colour, or another measure.

An important implication of these findings regards the narrowing of food categories for inclusion in the fieldwork stage. Given that several cooking methods are proposed to be observed – deep-frying, frying, roasting, baking, grilling/toasting, and possibly microwaving – it is suggested that a small range of foods are included in the fieldwork. For the best fit with the cooking methods outlined above, it is proposed that the category of ‘potatoes and potato products’ be further refined to ‘chips’¹⁵ and ‘roast potatoes’. In addition to this, a number of ‘other potato products’ – such as jacket potatoes, fried potatoes, waffles, and hash browns - may be observed in order to capture any other behaviours not related to chips or roast potatoes.

C.3.2. Bread and bread products

The evidence for bread and bread products is highly similar to that for potatoes and potato products. Acrylamide levels in bread also increase with cooking time and temperature [Bråthen and Knutsen, 2005]. In bread and bread products also, acrylamide tends to form on the outside, i.e. the crust [Bråthen and Knutsen, 2005].

Where bread is toasted, colour is generally a reliable indicator of acrylamide formation. White or brown bread toasted to a light colour contains lower acrylamide concentrations than when toasted to a darker colour [Normandin et al., 2013]. Indeed, concentrations of acrylamide increase as bread is toasted to a progressively darker colour [Ahn et al., 2002].

¹⁵ With all varieties included – e.g. French fries, steak cut, crinkle cut, wedges etc.

Fieldwork implications

These findings suggest that there would be value in adding a simple task to the in-home observation, whereby all participants are asked to prepare two slices of toast¹⁶ - exactly as they would under “normal” circumstances. Participants would then be questioned briefly on the ‘doneness’ and how this is judged (e.g. preference for light or dark).

The research team also considered the possibility of including other bread products (e.g. garlic bread, pizza etc.) in the study. On balance it was felt that the primary focus should be on potatoes given the potential for a greater range of behaviours to be exhibited, and the greater potential for influencing acrylamide formation. As such it was determined that a secondary focus solely on toast would aid both the analytical process, and provide a greater clarity of findings and conclusions.

Informing fieldwork:

- Fieldwork will be limited to relevant cooking methods – deep-frying, frying, roasting, baking, grilling/toasting. A few participants may also use a microwave, to provide further confirmation regarding this method.
- Fieldwork will gather data on the temperature (intended and actual) and time (intended and actual) of cooking.
- Fieldwork will gather data on whether manufacturer’s instructions are followed.
- Fieldwork will explore how consumers check for ‘doneness’.

¹⁶ Any participants who do not eat toast would be excluded from this task.

D. Literature review bibliography

The following documents were selected for full review (see Appendix A), and formed the basis for the evidence review findings (as set out in appendices B and C):

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RESEARCH MATERIALS AND FURTHER INFORMATION

Appendices E to I provide further detail related to the methods and approach used in this study. Specifically:

- Appendix E provides some information regarding the pro forma used during the in-home observations (related to Section 2.2 of the main report)
- Appendix F displays a copy of the topic guide used in the follow up interviews (related to Section 2.4 of the main report)
- Appendix G gives details of how participants were recruited (Appendix G1); a demographic breakdown of participants (G2), and an example of the information that participants were given after recruitment (G3)
- Appendix H sets out the rationale for selecting the 15 follow up interviewees from the 50 participants involved (related to Section 2.4 of the main report)
- Appendix I covers some of the ethical considerations in the project and how these were addressed

E. Observation pro forma

A screenshot of the observation pro forma is shown on the right. The pro forma was designed in FileMaker and uploaded onto iPads which were used during the observations.

This screenshot shows the blank entry fields for the 'cooking' tab. There were seven such tabs for researchers to enter information during the household visits (Introduction, Storage, Pre-treatment, Preparation, Cooking, Toast, Follow-up).

The screenshot displays the 'Cooking' tab of an observation pro forma app. The interface includes a top navigation bar with tabs for Introduction, Storage, Pre-treatment, Preparation, Cooking (selected), Toast, and Follow-up. The 'Cooking' section contains the following fields:

- Cooking method:** Radio buttons for Deep-frying, Frying, Roasting, Baking, Grilling, and Microwaving.
- Cooking time:** Intended (minutes) and actual (seconds) input fields.
- Cooking temperature:** Intended (centigrade, fahrenheit, gas mark) and actual (centigrade) input fields.
- Did they follow manufacturers instructions?:** Radio buttons for Yes and No.
- How did they check for 'doneness?':** A large text input area.
- Any other cooking observations:** A large text input area.

At the bottom of the screen, there are two sections:

- Visit information:** Radio buttons for H.Wycombe, W.London, Slough, GW, GK, GH, and MF.
- Context:** Time (hh:mm) and Date (dd/mm/yyyy) input fields, Time of day (Lunch, Evening) checkboxes, Cooking for (number of people) input field, Age of people being cooked for input field, and Number of contributors to cooking input field.

The bottom status bar shows 'Observation data entry', 'Record 3 of 50', and navigation icons.

F. Follow up interview topic guide

Time	Instructions	Purpose of section
2 mins	Introduction	
0:02	<p><i>RESEARCHER NOTE: Preparation is required for each interview as several of the questions may not apply. It may be worth creating a unique version for each interview by deleting inappropriate questions and question options.</i></p> <ul style="list-style-type: none"> • Introduce yourself and Brook Lyndhurst • Thank participant for taking part • Purpose of interview: <ul style="list-style-type: none"> ○ In our visits we observed various kitchen behaviours to understand more about what people do with certain foods. This telephone interview aims to find out more about <u>why</u> people do the things that they do, and where these practices and behaviours have come from. • Explain that no answer is 'right' or 'wrong'. We want to understand what really happens and why. • Information will be anonymised and treated confidentially – as per the consent forms <ul style="list-style-type: none"> ○ get permission to use voice recorder • Any questions before we start? 	Warm up.
6 mins	Section 1 – The visit in context	
0:08	<p><i>Researcher to be equipped with iPad record in order to access all information gathered during the visit</i></p> <ul style="list-style-type: none"> • When I visited, you were cooking [describe meal]. Is this a meal you've had before? <ul style="list-style-type: none"> ○ How often do you have this meal (on average)? ○ [If eaten regularly] Are there any particular reasons that you eat this meal regularly? • You also cooked [describe potato/chips]. How often do you eat these? 	<p>To find out the extent to which the behaviours exhibited during the visit are regularly practiced.</p> <p>To find out more about why particular foods are selected in different households.</p>

- [If eaten regularly] Why is it that you eat them regularly?
[Potential probes] part of staple diet? did they eat them at home when they were young? Do they know if friends and other family members eat these too?
- [If not eaten regularly] Why is it that you do not eat them regularly?
- On which sorts of occasions do you tend to eat them?
 - Why were you cooking [potato/chips] on this occasion?
- Do you cook any other sorts of potatoes or potato products regularly?
[For each one]
 - How often?
 - On what sorts of occasions do you tend to eat them?
- You also cooked [describe potato/chips] [from scratch/pre-prepared]. Is this how you always have them?
 - [If not] How often do you do this?
 - Why do you do it this way as opposed to [from scratch/pre-prepared]?
 - Have you an idea of when you first cooked them this way? Why was that? Why has that stuck?
 - Where/when did you learn to make them like this? Did anyone teach you?
- You were using [potato variety/brand] when I visited, do you always use that [variety/brand] when you cook [describe potato/chips]?
 - [If yes] Why is that?
 - Have you an idea of when you first used this [variety/brand]? Why was that? Why has that stuck?
 - [If no] Are there any [potato variety/brands] you use more often? Why were you using [potato variety/brand] on this occasion? What other [varieties/brands] do you use? Do you use different varieties/brands for different purposes or different occasions?
- [If anything else of relevance observed with regard to regularity/context] I noticed/you mentioned that you did [observation] when you were cooking, can you explain why?

3 mins	<p>Section 2 - Storage</p>	
0:11	<ul style="list-style-type: none"> • The [potatoes/chips] you used were stored in a [location]. Do you always store them there? <ul style="list-style-type: none"> ○ [If yes] Why is that? Is that something you've always done? Do you remember when you first stored them this way? Why was that? Why has that stuck? ○ [If no] Where else do you store them? Why? Why might you store them in a different place? • [If fresh, not frozen] Some people store potatoes [in the fridge/outside of the fridge]. Are there any reasons why you wouldn't do that? • Do you pay any attention to the temperature at which they are stored? <ul style="list-style-type: none"> ○ Why/Why not? • You said that you'd had the [potato/chips] you were using for XX days/weeks/months. <ul style="list-style-type: none"> ○ Is that typical? Why/why not? ○ How long would you say you usually store [potatoes/chips] for? ○ And why is this? ○ Do you ever find yourself throwing potatoes away? Why? <p><i>[Potential probes] do they buy in bulk and store for a long time? Do they buy a small amount frequently?</i></p> <p>[If anything else of relevance to storage observed, ask about that]</p> 	<p>To further explore in-home storage behaviours and practices, and the reasons behind these.</p>
5 mins	<p>Section 3 – Preparation (NB only applies to foods prepared from scratch)</p>	
0:16	<ul style="list-style-type: none"> • You [peeled/didn't peel] the potatoes when you were cooking. Do you always do this when making [describe potatoes/chips] from scratch? <ul style="list-style-type: none"> ○ [If they did] Why is that? How long have you been doing this for? Why did you first start doing it? Why have you continued doing this? ○ [If they did not] How often do you leave the skin on? Why did you [peel/not peel] them on 	<p>To explore the reasons why people prepare potatoes in the ways that they do.</p> <p>Why is it that potatoes are - or are</p>

this occasion? Why would you usually [peel/not peel] them?

- Before you started cooking you [washed/didn't wash] the potatoes. Is this what you always do?
 - [If they did] Why is that? How long have you been doing this for? Why did you first start doing it? Why has this practice stuck?
 - [If they did not] How often do you wash potatoes when preparing [describe potatoes/chips]? Why do you usually [wash/not wash] the potatoes? Why did you [wash them/not wash them] this time?

- You also [soaked/didn't soak] the potatoes. Is this something you always do?
 - [If they did] Why is that? How long have you been doing this for? Why did you first start doing it? Why has this practice stuck? How long do you soak them for?
 - [If they did not] How often do you soak potatoes when preparing [describe potatoes/chips]? Why do you usually [soak/not soak] the potatoes? Why did you [soak them/not soak them] this time?

- Before you started cooking you [did/didn't] parboil the potatoes. Do you always do it that way?
 - [If they did] Why is that? How long have you been doing this for? Why did you first start doing it? Why have you continued doing this?
 - [If they did not] How often do you soak potatoes when preparing [describe potatoes/chips]? Why do you usually [parboil/not parboil] the potatoes? Why did you [parboil them/not parboil them] this time?

- How would you describe how you chopped the potato?
 - How would you describe the size of the [potatoes/chips]?
 - Is this what you always do?
 - [If it is] Why is that? Any other reasons why you chopped potatoes to this size?
 - [If not] How would you usually chop them? Why is that? Why did you do them that size this time?

[Potential probes] have they seen other people chopping potatoes either in a kitchen or on TV?

**not -
peeled/washed/soaked/parboiled?**

	<ul style="list-style-type: none"> • [If anything else of relevance to preparation observed, ask about that] 	
11 mins	<p>Exercise 4 – Cooking</p>	
0:27	<ul style="list-style-type: none"> • At the visit you [deep-fried/fried/roasted/grilled/microwaved] the potatoes. Is this how you always cook [describe chips/potatoes]? <ul style="list-style-type: none"> ○ [If yes] Why is that? ○ [If no] Why is that? Why did you do it this time? What other cooking methods do you usually use? • You [also added/didn't add] oil [or fat] to the pan. Is that something you always do? <ul style="list-style-type: none"> ○ [If they did] What kind of oil did you use? Why is that? How long have you been doing this for? Why did you first start doing it? Why has this practice stuck? ○ [If they did not] How often do you add oil when cooking [chips/potatoes] like that? Why do you usually [add oil/not add oil] to the potatoes? Why did you [add oil/not add oil this time? • You [did/didn't] preheat the oven. <ul style="list-style-type: none"> ○ Do you have a light on the oven to let you know when it's the right temperature? Do you pay attention to this light? ○ What is your usual strategy regarding pre-heating? How was it different this time? • You said that you would cook the [chips/potatoes] for [intended time]. Was that a precise timing? Why/why not? <ul style="list-style-type: none"> ○ Where did that time come from? ○ Is this how long you usually cook them for? Why this amount of time? <ul style="list-style-type: none"> ▪ [If not] How long would you usually cook them for? Why is that? Why was it different today? ○ [If not covered already] Did you follow the instructions on the packet or in a recipe book? Do you ever do this? How often? On what occasions? Do you follow them precisely? 	<p>To check that the cooking practices exhibited by participants were not affected by the visit.</p> <p>To unpick the social/cultural/other reasons why things are cooked in the way that they are.</p>

- We recorded that you cooked the [chips/potatoes] for [actual time]. Why do you think you cooked them for [less time/more time] than you initially intended?
 - Did you pay attention to how long they were cooking for?
 - [If yes] Why is that? Would you usually do this?
 - [If no] Why is that? Is this what you usually do?
 - Do you think the fact that you were being observed made any difference to your timing, or how conscious you were of time?

- You set your [oven/hob/other] to [intended temperature]. Is this what you would always do when cooking [chips/potatoes] in this way?
 - [If yes] Why do you use that particular temperature?
 - [If no] What temperature what you usually use? Why is that? Why did you use [intended temperature] this time?
 - [If not covered already] Did you follow the instructions on the packet or in a recipe book? Do you ever do this? How often? On what occasions? Do you follow them precisely?
[If adjusted temperature during cooking – ask why that was]

- Whilst you were cooking you [opened the oven once/a couple of times/regularly OR didn't open the oven at all], is this what you usually do?
 - Did the fact that you were being observed make a difference?
 - [If did open it] Why is that? What did you do [each time]?
 - [If no] Why did you do it this time? What would you usually do?

- On the day you mentioned that you decided if the [chips/potatoes] were done by [checking for doneness]. Can you tell me more about that?
 - Why do you think you use this way of deciding if they were done?
 - How long have you been using that technique for? Where did it come from?

- What characteristics does a perfectly cooked [chip/potato] have?
 - How do you achieve this?
 - Where do you think your idea of 'perfectly cooked' has come from?

- Have you seen other people cooking [chips/potatoes]? [If so] Do you think this has had any influence on the way that you cook [chips/potatoes]?
- You described the [chips/potatoes] as being [undercooked/just right/overcooked].
 - Do they often turn out like that? Why?
- How do you judge if [chips/potatoes] are cooked right FOR YOU?
 - Why do you like them like that? Any other reasons why you might like them cooked like that?
 - [If undercooked or overcooked] What was wrong with them the way they came out? Why is this not what you wanted?
 - [If cooking for more than one person] Did you take into account what other people like? How do you know that?

[If anything else of relevance to cooking observed, ask about that]

3 mins	<p>Section 5 – Toast</p>	
0:30	<ul style="list-style-type: none"> • Your bread was stored in a [location]. Is it always kept there? <ul style="list-style-type: none"> ○ [If yes] Why is that? ○ [If no] Where do you usually store it? Why is that? Why did you store it in a [location] this time? ○ Some people store bread in [a fridge/freezer/in the kitchen] – are there any reasons why you wouldn't store it there? • The bread you used was [bread brand/type], is that the bread you usually use for toast? <ul style="list-style-type: none"> ○ [If yes] Why is that? ○ [If no] What brand/type do you usually use? Why is that? Why were you using [bread brand/type] this time? • You set your toaster to [setting]. Why was it set to that? Do you pay attention to the settings? • You described the toast as [undercooked/just right/overcooked]. <ul style="list-style-type: none"> ○ Does the toast often turn out like that? Why? • How do you judge if a piece of toast is cooked right FOR YOU? Why do you like it like that? <p>[If anything else of relevance to toast observed, ask about that]</p>	<p>To further explore bread, bread storage and toasting behaviours, and the reasons behind them.</p>
	<p>Thank and close Remind participant of payment details</p>	

G. Participant recruitment

G.1 Recruitment

Using the conclusions drawn from the literature review, professional fieldwork recruiters Criteria Fieldwork¹⁷ were instructed to recruit people who regularly ate chips, roast potatoes or other (relevant) potato products. Participants were asked to prepare a meal that they would ordinarily make at home, choosing from a 'menu' of food types. Participants were recruited to participate at times at which they would normally prepare and eat the food types of interest, and on the basis of the fact that they were planning to use one of the relevant cooking methods (i.e. not boiling or steaming).

Recruiters were deployed in three hubs: West London, High Wycombe, and Slough. These locations were selected due to the convenience and lower cost of the research, and of deliveries to the Premier Analytical Services laboratory (PAS lab) in High Wycombe. Recruiters used a mix of methods including street recruitment, phone calls and existing databases, to contact potential participants. People in occupations related to research, food, or catering were excluded from participating.

Quotas were set so that at least the following numbers were observed:

- 15 people cooking chips
- 15 people roasting potatoes
- 10 people cooking other potato products
- 10 preparing chips or roast potatoes from scratch

Table 7 below shows the potato items that the recruited participants cooked, successfully meeting these quotas.

	Chips	Roast potatoes	Wedges	Waffles	Jacket potato	Hash browns	Other ¹⁸
Fresh	3	9	3	0	2	0	4
Pre-prepared	14	6	1	4	1	2	1
Total	17	15	4	4	3	2	5

As discussed above, participants were recruited to minimum quotas set to roughly reflect national demographic statistics. Nearly all quotas were achieved (see Table 8 in Appendix G2 below).

Those participants who were not excluded by the screener questions, were available and willing to be observed preparing a meal, and who met the socio-demographic and food quotas, were offered the chance to participate. Participants were given £40 in cash as a

¹⁷ Website: <http://www.criteria.co.uk/>

¹⁸ Sautéed potato, Curried potato, Potato croquettes, Potato as part of a tray bake

‘thank you’ for participating¹⁹, as an acknowledgment of any inconvenience caused, and as recompense for taking a small sample of the food they cook for analysis.

At this stage participants were told that the research would involve a visit and observation of cooking and preparation practices, and that it would involve temperature monitoring, voice recording, and photographs, as well as a sample of food being taken²⁰. Participants were told the study aimed to ‘better understand domestic cooking practices’ but not told that the study was related to acrylamide, as it was felt that this would likely alter ‘natural’ preparation and cooking behaviours.

G.2 Achieved sample

The table below shows the quotas that were set for the recruitment of 50 participants in this project, based on census data. The ‘achieved’ column on the right shows the demographic breakdown of the participants. This demonstrates that people from a range of socio-demographic groups took part in the study, and that these quotas were matched almost perfectly by the recruiters.

Sample profile		% of overall population ²¹	Quota	Achieved
Household size	1 Person	29%	14	15
	2 Person	35%	16	15
	3 Person	16%	8	8
	4 Person	14%	7	7
	5 Person +	6%	5	5
Age	18 - 34	28%	14	14
	35 - 54	36%	18	18
	55+	36%	18	18
Gender	Female	49%	Minimum 20	27
	Male	51%	Minimum 20	23
Socio-economic grade	AB	28%	14	13
	C1	30%	15	16
	C2	22%	11	11
	DE	20%	10	10
Ethnicity	White British	81%	32	32
	Other white	5%	4	4
	Asian	8%	6	6
	Black	3%	4	4
	Mixed	3%	Not set	4

¹⁹ This payment was actually given to participants at the end of the observation visit.

²⁰ Participants were told to cook a ‘generous extra portion’ of the potato element of the meal, for sampling. They were also told that a sample of toast would be taken.

²¹ ONS 2011 census data for England and Wales. Household size data is taken from the Labour Force Survey (LFS), Office for National Statistics. October 2013.

G.3 Information provided to participants

Following recruitment, participants were provided with an information sheet containing the following information, as well as contact details for the project managers at Brook Lyndhurst and the FSA.

What is the research about?

The research aims to better understand domestic cooking practices.

Who is carrying out the study?

Brook Lyndhurst is carrying out the research on behalf of the Food Standards Agency. Brook Lyndhurst is a professional research consultancy and abides by Market Research Society guidelines.

What will it involve?

The research will involve a visit to your home and observation of cooking and preparation practices, and will involve temperature monitoring, voice recording, and photographs, as well as a sample of food being taken. Samples will be a 'generous' (extra) portion of the potatoes or chips that you are cooking, as well as two slices of toast. The visit will take as long as it takes for you to prepare and cook a meal, and for the samples to be collected. You may also be asked to take part in a short follow-up telephone interview, if you agree to this.

What will happen to the information I give?

Information that could identify someone or their home - such as names and locations etc. - will not be included in the report, will be kept confidentially by Brook Lyndhurst, not used for purposes beyond this research, and destroyed within 6 months of publication of the research. All information will be treated in accordance with the Data Protection Act 1998, and will be anonymised, and personal information will be password protected and stored securely. No personal information will be passed to any third parties.

H. Rationale for follow-up interview selection

This section outlines our approach for the selection of participants for the 15 follow-up telephone interviews.

Behaviours of interest

The purpose of these interviews is to explore with consumers the underlying drivers of those cooking practices that lead to higher levels of acrylamide formation. Interviews, therefore, should be with those participants who, in the observational element of this work, demonstrated those particular behaviours and practices of interest to the greatest extent.

From the evidence review conducted at the beginning of the project, the key practices that were identified as the greatest drivers of acrylamide formation in potatoes (the key focus of the fieldwork) were:

- Cooking at higher temperatures
- Cooking for longer periods of time
- Preparing potatoes with a larger surface area : volume ratio
- Storing potatoes in the fridge
- Storing potatoes for longer periods of time

Participants were therefore selected on the basis of exhibiting these behaviours (e.g. those who cooked at the highest temperatures, or prepared particularly large surface area: volume ratio potatoes), with greatest priority given to higher cooking temperatures and longer cooking times (given the dominance of evidence on these factors identified in the evidence review), while ensuring that all behaviours of interest were covered. Preference was given to those demonstrating a combination of two or more of these behaviours.

In addition to the above, there was value to be gained in exploring those behaviours which are known to minimise levels of acrylamide exposure. Understanding why people undertake those behaviours, may help the FSA to identify the types of interventions or communications that would help to promote these behaviours more widely. These behaviours (in relation to potatoes) were identified from the evidence review as:

- Cooking at lower temperatures
- Cooking for shorter periods of time
- Pre-treating potatoes (i.e. washing, soaking or par-boiling)
- Preparing potatoes with a smaller surface area : volume ratio

The team also interviewed a small number of participants that exhibited one or more of these behaviours. Preference was again given to those exhibiting a combination of behaviours of interest.

Quotas

A quota was set so that a minimum of 10 interviews were with participants who exhibited those behaviours known to lead to higher levels of acrylamide formation; and a minimum of

five being with those who demonstrated behaviours known to minimise levels of acrylamide formation. This split is based on the main priority being to understand the drivers of higher levels of acrylamide exposure.

The table below gives the minimum quotas to be applied for each of the “acrylamide increasing behaviours”. Given the preference for those participants demonstrating a combination of these behaviours, the numbers add up to a total greater than 10 (and may indeed end up higher than stated).

Priority	Relevant behaviours	Selection criteria	Quota
1	High cooking temperature	Highest observed temperatures (intended) <i>(for pre-prepared this would be highest deviation from manufacturer cooking instructions)</i>	6
2	Long cooking time	Longest observed cooking times (actual) <i>(for pre-prepared this would be highest deviation from manufacturer cooking instructions)</i>	6
3	High surface area:volume ratio	Highest based on estimated size	2
4	Storing in the fridge	Observed storing potatoes in fridge	2
5	Long storage time	Longest recorded storage time	2

The approach to achieving these quotas was hierarchical – focusing on filling each behavioural quota in order of priority before moving on to the next. Interviewees would be selected on the basis of both demonstrating the relevant behaviour in question AND demonstrating other behaviours of interest²².

The minimum quotas for the “acrylamide minimising behaviours” are shown in the table below. Our approach to achieving these would work in the same way as described above.

Priority	Relevant behaviours	Selection criteria	Quota
1	Low cooking temperature	Lowest observed temperatures (intended)	3
2	Short cooking time	Shortest observed cooking times (actual)	3
3	Pre-treatments (e.g. soaking, parboiling)	Observed washing soaking/parboiling	3
4	Low surface area:volume ratio	Lowest based on estimated size	2

Other considerations

From scratch vs pre-prepared

Given that there are a greater number of steps at which consumers can influence acrylamide levels with fresh foods, it was determined that the majority of the interviews should be with those who cooked their meals from scratch at the observation phase. Across the range of behavioural quotas outlined above the research team aimed for 10 of the interviews to be

²² E.g. when attempting to first fill the “high cooking temperature” quota, participants would need to be both in the ‘top ten’ for cooking temperatures, and also have demonstrated some of the longest cooking times, and/or surface area:volume ratios, and/or have stored their potatoes in the fridge, and/or have stored their potatoes for the longest periods of time

with participants who had cooked their meals from scratch, with no more than five from those who had cooked pre-prepared products.

Acrylamide test results

The results from the lab tests of food samples collected at the observational stage were not available at the stage when this rationale was proposed. Given the limitations with the acrylamide data (see Section 2.3.3 of the main report), using observed practices as a basis for sampling provides a more reliable basis for participant selection in any case.

Demographics

No demographic quotas were proposed given the small sample of interviews, though efforts were made to ensure there was some diversity in terms of age, gender etc.

I. Ethical considerations

There were some important ethical considerations to be explored and dealt with both prior to and during the course of the research. Given that research was being conducted in the homes of participants and that researchers could have witnessed practices that were potentially hazardous to health, key considerations identified before fieldwork were:

- Informed consent
- Informed consent of any other persons present (besides those recruited to participate)
- Intrusiveness of the observational research
- Observing risky food behaviours

The key ethical issues, and the actions that were proposed to address them, are set out below. In addition, protocols for dealing with issues arising during the project are also outlined.

Informed consent

Principle 2 of the Government Social Research (GSR) guidelines on Ethical Assurance for Social Research in Government clearly states that informed consent must be gained from all participants in any research project. For informed consent to be given, participants “must be given sufficient information to enable them to make an informed decision”. This includes information on “the purpose and nature of the research, who is undertaking it, who the sponsor is, and plans for dissemination/feedback”.

A further consideration regarding informed consent for this research was Brook Lyndhurst’s view that the provision of full information on the purpose and nature of the research would run the substantial risk of priming research participants and altering their behaviour prior to the in-home observation stage – with subsequent consequences for the overall validity and robustness of the overall research.

In order to meet guidelines on informed consent whilst avoiding the possibility of priming participants, participants were informed that the purpose of the research was to ‘observe and explore in-home food cooking practices’ – but they were not provided specific details of the focus on acrylamide generation. It was felt that the potential benefits of the research in terms of public health outweighed any ethical concerns that resulted from obscuring the focus of the research (by providing participants with a broader explanation of its purpose).

Participants were provided at the recruitment stage with written details on the (generic) research purpose; the role of the researcher; what to expect during the observational research; and information on how the research would be used (see Appendix G3). Once recruitment was completed, a researcher from Brook Lyndhurst telephoned participants to explain the research again and to confirm consent. When arriving at participants’ homes, and before commencing the observation, participants were asked to complete and sign duplicate consent forms (in line with FSA guidance), which covered issues such as: participants’ understanding of the study; their participation in it; what would be done with their data; and specific permissions for actions such as recording conversations and taking photographs. One of these completed and signed forms was retained by the participant and

one was filed by Brook Lyndhurst. Finally, participants were left with contact details of the researcher who visited them so that they were able to contact the research team with any concerns or queries they had following the observation.

Informed consent – other persons present

Whilst the focus of the research was on the person preparing and cooking the meal, it was important to acknowledge that in many cases there was likely to be more than one person present. Indeed, it was deemed probable that in some cases more than one person would be involved in the activities we were observing. Given that the recruiters would only be recruiting one person per household – i.e. the person taking the lead role in cooking – additional steps were required to ensure that the consent of all other persons present was also given.

At the recruitment stage, participants were therefore asked to share the written information with all persons that were likely to be present during the observational research, and to ensure that they consented to the research taking place.

Additionally, on arrival, researchers fully explained the research process again to all persons present, and gave them the opportunity to ask any questions. Checks were then done to ensure that all present gave their consent for the research to take place.

Intrusiveness of the observational research

Principle 4 of the GSR ethical guidelines places emphasis on the importance of protecting the physical, social and psychological well-being of all participants and researchers in the conduct of any research. Of particular relevance to this project was the requirement to avoid an unnecessarily intrusive research process, and to be sensitive to participants' 'private space'.

We recognised that observational research in home – particularly around meal times – does have the potential to feel like an intrusion, and/or feel burdensome for participants. By stepping into the family space during what can be a busy time of day (e.g. children attempting to do homework, multiple household chores etc), there was a risk that the presence of a researcher could have caused undue stress to participants.

The Brook Lyndhurst team has substantial experience of conducting observational research, and research in people's homes. We were therefore fully cognisant of the need to be respectful of the participants' private space, and to make sure that participants feel comfortable with the researcher's presence. This was achieved in several ways, such as the provision of a full explanation of the intended research procedure, and by ensuring that participants understood that if required they could ask researcher to leave or step out for a while (e.g. if family needs to urgently discuss a sensitive issue, or if a child is misbehaving etc).

Observing risky food behaviours

Also relevant to principle 4 of the GSR was the potential for researchers to observe practices and behaviours in the cooking process that potentially posed a risk to participants. Firstly, it was highly likely that researchers would observe cooking practices that lead to increased levels of acrylamide exposure, and that they would learn that some participants are not aware of the health risks that such exposure can potentially pose. Given that acrylamide

exposure from foods is not immediately threatening to life and health, there was, in our view, no reason to intervene prior to the observation being completed.

Secondly, researchers may have also observed other cooking practices – not related to acrylamide – which are known to be unsafe (e.g. cross-contamination of chopping boards). In such cases researchers were required to take a judgement as to whether to intervene immediately (this would only have been in extreme circumstances, such as those posing immediate danger to life and health) or to wait until the observation was completed to provide participants with relevant safety advice. This would have taken the form of identifying the unsafe practice to the participant, and signposting them to relevant FSA safety guidance. Fortunately it was not necessary to do this during the course of the research, as no seriously unsafe cooking practices were observed.

Protocols for dealing with issues arising during the project

As well as the ethical considerations identified above, it is Brook Lyndhurst's practice on all research projects to keep a running register of risks and ethical considerations. This can be added to if and when further considerations occur. Regular internal meetings and communication between research team members (during fieldwork team members communicated progress and issues daily) ensured that any newly identified considerations could be addressed as quickly as possible. Likewise, regular correspondence with the FSA meant that any issues arising could be discussed directly with the team there if necessary, including the FSA's Ethical Advisor Ron Iphofen. Fortunately, in the course of this research no ethical considerations arose beyond those already considered and addressed above. As a result, the need to consult with the FSA's Ethical Advisor or to address new ethical issues did not occur.

ACRYLAMIDE RESULTS

Section 5 of the main report sets out the results collected in this study alongside ‘historic’ results from the FSA’s survey of acrylamide in UK. The appendices below set out the raw data.

- Appendix J provides a summary of key practices for all potato products cooked as part of this study, as well as the corresponding acrylamide levels
- Appendix K gives an overview of the relevant UK acrylamide survey data, and explains how it was used

J. Acrylamide results

J.1 Chips

Research ID	Potato variety	Storage time	Storage location	Peel	Preparation	Cooking method	Intended cooking temp. ²³	Cooking time (mins) ²⁴	Acrylamide level (µg/kg)
02	Maris Piper	5 days	Utility room	Yes	Parboiled	Roasting	Gas mark 7	80	621
11	Maris Piper	3 days	Kitchen	Yes	Washed	Deep fry	180C	8	249
36	‘Normal’	4 days	Kitchen	Yes	‘Soaked’ ²⁵	‘Health fry’ ²⁶	n/a	16	86

²³ The actual temperature was not recorded or is uncertain due to the cooking methods deployed in these three cases.

²⁴ In each table in this Appendix, this is the recorded cooking time as opposed to the ‘intended’ cooking time.

²⁵ As discussed in Section 4.2.2, no participants soaked potatoes for culinary purposes. Some samples were, however, left in water after peeling.

²⁶ This involved a countertop frying device that required one tablespoon of oil to prepare a portion of chips.

Table 12 – Summary of practices, and acrylamide levels for pre-prepared chip samples

Research ID	Cooking method	Intended cooking temp. ²⁷	Recorded cooking temps. ²⁸ (Centigrade)	Cooking time (mins)	Acrylamide level (µg/kg)
43	Baking	180	145-241	16	1062
47	Baking	220	100-205	39	425
08	Baking	220	171-213	16	207
18	Baking	200	71-154	21	185
22	Baking	250	~190	16	175
33	Baking	220	113-234	20	172
50	Microwave	n/a	n/a	19	171
20	Baking	200	172-188	33	141
21	Baking	220	64-166	18	87
12	Baking	160	141-190	20	67
49	Baking	230	205-235	18	62
37	Baking	200	100-197	15	43
25	Baking	200	150-184	43	31
48	Baking	220	Not recorded	29	26

²⁷ This is the temperature the oven was set to, as opposed to recorded information, due to the potential limitations in the use of the temperature monitor (as discussed in Section 2.2.3).

²⁸ These numbers show the range of results recorded by the oven temperature probes, whilst the chips were in the oven. The temperatures may have gone higher or lower than these numbers during that time and not been recorded, as recording was not done on a systematic basis. Furthermore, the temperature monitor itself may not be a reflection on oven or food temperature due to its positioning in the oven.

J.2 Roast potatoes

Table 13 – Summary of practices, and acrylamide levels for fresh roast potato samples

Research ID	Potato variety	Storage time	Storage location	Peel	Preparation	Cooking method	Intended cooking temp. (Centigrade)	Recorded cooking temps. ²⁹ (Centigrade)	Cooking time (mins)	Acrylamide level (µg/kg)
45	'Baking'	1 day	Fridge	Yes	Washed, Parboiled	Roasting	180	~180	24	490
32	Orchestra	1 day	Kitchen	Yes	Washed, Soaked, Parboiled	Roasting (Halogen oven)	180	Not recorded	38	254
05	Charlotte	1 day	Kitchen	No	Parboiled	Roasting	190	~195	52	192
41	[Not recorded]	5 days	Garage	Yes	Parboiled	Roasting	210	200-230	29	190
14	Saxon	<1 day	Kitchen	Yes	Parboiled	Roasting	215	160-170	37	176
24	Mozart	2 days	Fridge	Yes	Washed, Parboiled	Roasting	200	100-210	42	60
13	Maris Piper	3 days	Kitchen	Yes	Washed, Soaked, Parboiled	Roasting	180	Not recorded	39	25
29	Esmerelda	2 days	Kitchen	No	Parboiled	Roasting	250	Not recorded	22	6
46	Desiree	1 day	Kitchen	Yes	Soaked, Parboiled	Roasting	200	Not recorded	22	6

²⁹ These numbers show the range of results recorded by the oven temperature probes, whilst the chips were in the oven. The temperatures may have gone higher or lower than these numbers during that time and not been recorded, as recording was not done on a systematic basis. Furthermore, the temperature monitor itself may not be a reflection on oven or food temperature due to its positioning in the oven.

Table 14 – Summary of practices, and acrylamide levels for pre-prepared roast potato samples

Research ID	Cooking method	Intended cooking temp. ³⁰ (Centigrade)	Recorded cooking temps. ³¹ (Centigrade)	Cooking time (mins) ³²	Acrylamide level (µg/kg)
28	Baking	250	216-259	26	312
19	Baking	200	~220	39	94
31	Baking	235	160-215	35	67
16	Baking	185	178-190	35	35
09	Roasting	220	Not recorded	32	26
26	Roasting	200	167-182	56	14

³⁰ This is the temperature the oven was set to, as opposed to recorded information, due to the potential limitations in the use of the temperature monitor (as discussed in Section 2.2.3).

³¹ These numbers are show the range of results recorded by the oven temperature probes, whilst the chips were in the oven. The temperatures may have gone higher or lower than these numbers during that time and not been recorded, as recording was not done on a systematic basis. Furthermore, the temperature monitor itself may not be a reflection on oven or food temperature due to its positioning in the oven.

³² This is the recorded cooking time as opposed to the 'intended' cooking time.

J.3 Other products

Table 15 – Summary of practices, and acrylamide levels for ‘other’ samples

Research ID	Product	Acrylamide level (µg/kg)
01	Fried potato (as part of curry)	767
07	‘Tray baked’ new potatoes	210
35	Potato croquettes	57
04	Sweet potato	47
44	Sautéed potato	37

K. FSA acrylamide results

K.1 Chips

Table 17 below presents the results from 507 samples of chips collected for the FSA’s survey of acrylamide in UK retail products between 2007 and 2013. As in Section 5.1 of the main report, chips in Group 1 were collected from cafés, quick service restaurants and pubs. Chips in Group 3 were purchased from retailers and then cooked according to manufacturers’ instructions as a proxy for domestic cooking.

Chips in Group 1 were categorised as ‘Thin Cut’, ‘Thick Cut’, ‘Not applicable’, ‘Crinkle cut’ or ‘Chunky cut with skin on’. For this research, the latter three groups have been aggregated to a new category called ‘Other’.

Group 3 did not just contain chips however, and Table 16 shows how these potato products were categorised for the purposes of this research.

Table 16 – Categorising potato products in Group 3

INCLUSION	Yes			No
SUBCATEGORY	Thin	Thick	Other	-
Words in the product description that were used to categorise the products	French fries	Chunky	Crinkle cut	Crispy potatoes
	Fries	Steakhouse	Straight cut	Crispy potato bites
	Thin & crispy	Steak cut	Oven	Hasselback
	Thin cut		[No descriptor]	Micro chips
				Parmentier
				Roast potatoes

Table 17 – Acrylamide levels in chips

	Number of samples	Median (µg/kg)	Min (µg/kg)	Max (µg/kg)	Mean (µg/kg)
All Group 1	351	168	10	1556	230
Group 1 thin	91	265	44	888	268
Group 1 thick	239	136	10	1556	207
Group 1 other	21	273	119	847	326
All Group 3	156	117	9	2908	219
Group 3 thin	31	72	14	685	158
Group 3 thick	46	153	12	2908	329
Group 3 other	79	114	9	906	178
All	507	149	9	2908	226
All thin	122	210	14	888	240
All thick	285	136	10	2908	227
All other	100	142	9	906	209

K.2 Roast potatoes

Table 18 below presents the results from 52 samples of roast potatoes collected for the FSA's survey of acrylamide in UK retail products between 2007 and 2013. All samples that were explicitly described as roasts have been included. All roast potato samples in the survey were pre-prepared and were purchased from frozen or chilled sections of shops and supermarkets. This category therefore includes roast potatoes described as:

- Rustic roasts
- Goose fat roast potatoes
- Crispy roast potatoes
- Balsamic roast potatoes
- Ready to roast potatoes

Table 18 – Acrylamide levels in roast potatoes

	Number of samples	Median (µg/kg)	Min (µg/kg)	Max (µg/kg)	Mean (µg/kg)
Roast potatoes	52	184	13	3067	316

K.3 Other potato products

Table 19 displays results from samples of waffles, and potato wedges collected for the FSA's survey of acrylamide in UK retail products between 2007 and 2013.

Table 19 – Acrylamide levels in waffles and wedges					
	Number of samples	Median ($\mu\text{g}/\text{kg}$)	Min ($\mu\text{g}/\text{kg}$)	Max ($\mu\text{g}/\text{kg}$)	Mean ($\mu\text{g}/\text{kg}$)
Waffles	17	131	40	784	186
Wedges	8	47	18	161	56