



Mechanism(s) of Formation of Acrylamide in Foods

Independently and practically simultaneously, a number of research groups (Industry, Research Institutes, Government Laboratories) have published their findings related to the formation of acrylamide in food - all pointing essentially toward the involvement of Maillard reaction chemistry

- Proctor & Gamble
- Nestlé (Stadler *et al.*, *Nature*, **2002**, 419, 449-50)
- Universities of Reading & Leeds (Mottram *et al.*, *Nature*, **2002**, 419, 448-49)
- Health Canada
- Cantonal Laboratory, Zürich (K. Grob)
- Chemisches und Veterinäruntersuchungsamt Stuttgart (R. Weisshaar)

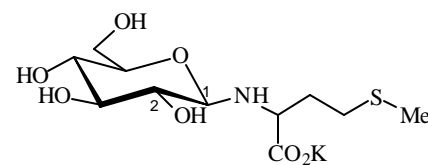
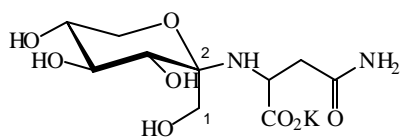
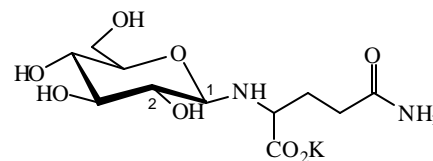
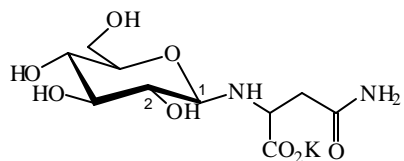


Mechanism(s) of Acrylamide Formation : Model Studies Conducted at the Nestlé Research Center

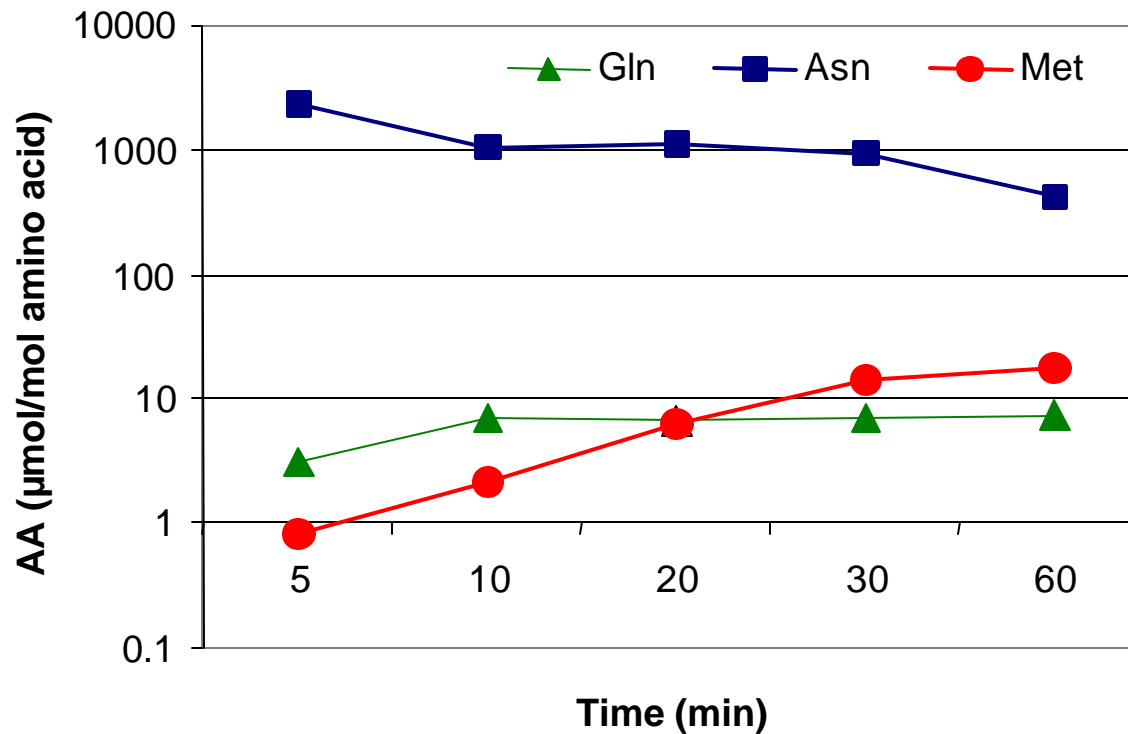
- Acrylamide is detectable upon thermal treatment of certain amino acids (Asn, Met)
- Pyrolysis (> 130°C) of amino acids in combination with reducing sugars lead to the release of acrylamide (Asn, Gln, Met, Cys)
- Early Maillard reaction products (*N*-glycosides) may be important precursors
- α -Dicarbonyls also react with certain amino acids to liberate acrylamide after thermal treatment
- Data indicates more than one mechanism of formation, dependent on the food category (precursor molecules and processing conditions)



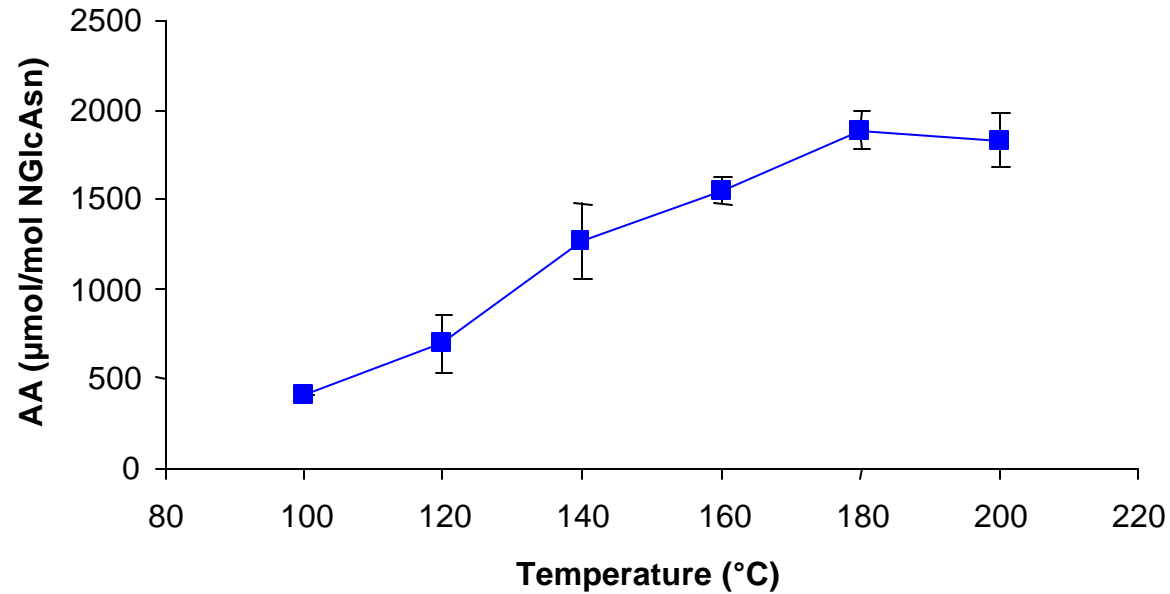
Glycosylamines as precursors of acrylamide under pyrolytic conditions



Formation of acrylamide (AA) from amino acid/glucose co-pyrollysates (0.2 mmol of reactants, 180°C, solid state reaction)



Release of acrylamide (AA) during thermolysis of NGlcAsn (0.2 mmol, 30 min incubation, solid state reaction)





Mechanisms of Formation of Acrylamide in Foods Involvement of the Maillard Reaction

Reaction rates and kinetics indicate different routes of formation, depending on the amino acid precursor (supported by ¹⁵N-labelling experiments)

Possible mechanistic pathway(s) via:

- Strecker degradation (α -dicarbonyl reacts with amino acid)
- glycosylamines as direct precursors (for Asn), (1) -CO₂ & heterocyclic (C-N) cleavage; (2) release of the Strecker aldehyde, reduction, - H₂O, acrylamide formation
- free radical pathways

Significant knowledge gap on Maillard reaction pathways in the solid state

Mechanism(s) Governing Formation of Acrylamide Dependent on the Food Category (1)

First studies indicate :

- No “Universal” solution to the control or reduction of acrylamide relevant to all food categories
- Individual studies for each category will be obligatory, identifying the critical parameters contributing to the release of acrylamide during processing/cooking



Mechanism(s) Governing Formation of Acrylamide Dependent on the Food Category (2)

Trial studies and kinetic modelling to identify critical parameters & rate limiting steps at the various stages in each industrial process

- **Raw materials (variety, storage)**
- **Precursors (reducing sugars, free amino acids, dicarbonyls)**
- **Processing conditions and technology**
 - **temperature/time**
 - **moisture**
 - **pressure**
 - **pH**

Aim: reduce acrylamide levels to as “low as technically feasible”