Acrylamide in Food
- Mitigation Options

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Structure

- The challenge
- Which are our main possibilities?
- What progress has been made so far?
  
  Some food categories
  - Potato products
  - Cereal based products
  - Coffee

- How should we proceed?
- Conclusions
The challenge

• Reduced acrylamide level
• Retained (or improved) product quality
  - flavour
  - colour
  - texture
  - safety
  - …

Each product and process needs its own solution!
It is not possible to generalize!
Mitigation possibilities…

1. The raw materials
   Selection of favorable raw materials
   Development of new raw materials
   Influence on cultivation conditions
     ● Low asparagine content
     ● Low sugar content
     ● Optimal amino acid balance?
     ● Content of protective component?
Mitigation possibilities…

2. **Pre-treatment procedures**
   Minimization of the content of reactants
   - Washing / Extraction
   - Enzymatic reactions
   - Chemical reactions
Mitigation possibilities...

3. Recipe modifications; additives

- Components competing with asparagine in the Maillard reaction
- Components binding or inactivating asparagine or sugars
- Components binding acrylamide or influencing its further reactions
- Additives influencing pH
Mitigation possibilities…

4. **Process optimization**
   Main parameters to control
   - Temperature
   - Time
   - Moisture
   - pH?
Mitigation possibilities…

5. **Actions on final product**
   - Sorting out of overheated items
   - Controlled degradation / transformation /evaporization of acrylamide
Potato products

1. Raw materials
   ● Sugar content limiting factor
   ● Raw material selection of key importance
   ● Potato storage time and conditions decisive
   ● Potential for new cultivars?
   ● Growing locations; climate conditions etc. of importance?
   ● Influence of fertilizers?
Potato products

2. Pre-treatment
   ● Blanching
   ● Enzymatic treatment?

3. Additives
   ● Citric acid; acetic acid
   ● Amino acids
   ● Salt
Potato products

4. Process optimization
   ● Lower temperature in final phase of frying
   ● Careful control of the final moisture content

5. Product treatment
   ● Removing dark crisps
Cereal based products

Bread

- Acrylamide concentrated to the crust
- Asparagine limiting factor in flour for bread baking
Effect of added asparagine and fructose on acrylamide content in bread crust

Cereal based products

Bread
- Acrylamide concentrated to the crust
- Asparagine limiting factor in flour for bread baking
- Survey of free asparagine content in raw materials and in cereal fractions
- Dough fermentation may affect
- Baking conditions may be influenced
Cereal based products

Crisp bread
- Yeast leavened bread have considerably lower levels than bread baked with baking powder
- Control of final moisture content
- No evident conclusions regarding various time-temperature conditions
Cereal based products

Breakfast cereals

- Complex product group
- Many different raw materials
- Various processes
- Specific solutions sought for each product, looking at
  - Raw materials
  - Process conditions
Coffee

- Acrylamide formed very early in the roasting process, concentration is then declining during processing.
Acrylamide development in coffee during roasting

- **Roasting temp. = 250°C**
- **Roasting temp. = 230°C**
- **Roasting temp. = 210°C**

**Commercial range**

Acrylamide (ppb/GC) vs. CTN (roasting level)

- Light roast
- Dark roast

From CIAA
Coffee

- Acrylamide formed very early in the roasting process, concentration is then declining during processing
- Roasting temperature has little effect
- Lower acrylamide levels in the darker roasted coffee
- Acrylamide not stable in finished product
How to proceed?

- Raw material mapping (total free amino acid profiles)
- Improved, fundamental understanding of reaction kinetics
  
  *In particular*
  
  - The role of water
  - Degradation mechanisms and kinetics

- Improved process evaluations
- Consideration of alternative processing technologies

Continued interaction science – industrial practice
Conclusions

• A broad perspective is needed for successful mitigation solutions.
• The challenge is to reduce the acrylamide content while retaining the product quality.
• We have seen significant progress already during these two years when basic knowledge has developed in parallel with the evolution of practical solutions.
• We now enter a phase when we can foresee a large output of fundamental, science based knowledge.
• This must form the platform for further applications and improvements.