Use of asparaginase to mitigate acrylamide formation in food

Katie Maloney, Ph.D.
Novozymes

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What is acrylamide?

- Acrylamide is a compound formed naturally during the preparation of foods.
- Major pathway involves reaction between asparagine and reducing sugar at temperatures in excess of 120°C (250°F) and low moisture.

Measured acrylamide content (ppb) in different food categories. Legends shown: Median, 1st quartile, and 3rd quartile. Source: www.irmm.jrc.be/html/activities/acrylamide
Why is acrylamide in food a concern?

- Acrylamide has been shown to be carcinogenic in animal studies.
  - US FDA National Toxicology Program (NTP): final report on the toxicology and carcinogenicity of acrylamide showing "clear evidence of carcinogenic activity in animals." (August 2012)
- Research into a possible carcinogenic link for humans has so far been inconclusive.
- Risk assessments indicate a human health concern for acrylamide in food.
  - Acrylamide has been classified by the International Agency for Research on Cancer (IARC) as "probably carcinogenic for humans." (1994)
  - A 3-year EU study of acrylamide (The HEATOX Project) concluded that "Increasing toxicological evidence suggests that acrylamide in food might be a cancer risk factor." (November 2007)
  - The Joint FAO/WHO Expert Committee on Food Additives (JECFA) reconfirmed that levels of dietary exposure to acrylamide indicate a "human health concern." (FAO/WHO/February 2010)
How can asparaginase help?

- Acrylamide is mainly formed in food as part of the Maillard reaction.

- The Maillard reaction is also responsible for the desirable flavor, aroma, and color compounds in baked, roasted, and fried foods.

- By converting asparagine into aspartic acid, asparaginase can effectively reduce the level of acrylamide without changing the taste and appearance of the end product.
Factors to consider when choosing an asparaginase
Acrylaway® for French fries

1. Peeling and cutting
2. Blanching
3. Dipping in SAPP* and glucose
4. Drying
5. Par-frying
6. Freezing

Acrylaway® addition

Add enzyme to SAPP and glucose dip
OR
Apply enzyme as a separate coating just before drying

*SAPP: Sodium Acid PyroPhosphate
Acrylamide mitigation in French fries

- Up to 64% reduction in acrylamide content in French fries

**Enzyme added to dip tank**

- 6x6 mm cut size
- Blanching: 79°C, 23 min
- 20,000 ASNU/L Acrylaway dosage
- Drying: 60°C, 9 min
- Par-frying: 190°C, 45 sec
- Final frying: 175°C, 2 min

**Enzyme applied as coating**

- 7x7 mm cut size
- Blanching: 72-78°C, 6-7 min
- 30,000 ASNU/L Acrylaway dosage
- Drying: 3 zones (70-60-40°C) for 9 min
- Par-frying: 153°C, 1-2 min
- Final frying: 175°C, 1.5 min
Acrylamide mitigation in dough-based snacks

- Up to 60% asparagine hydrolysis in snack pellet dough
- Up to 95% reduction in acrylamide content in final snack

- Enzyme added during mixing
- Mixing: ~35°C, 15 min
- Moisture: 35%
- Frying: 185-190°C, 21 sec
Acrylamide mitigation in crackers and cookies

- Up to 87% reduction in acrylamide content in crackers and cookies

**Graham crackers**

- Enzyme added during mixing
- Added water: 12.5%

**Ginger nut cookies**

- Enzyme added during mixing
- 1000 ASNU/kg flour
Acrylamide mitigation in coffee

• 32-64% reduction in acrylamide content in various types of coffee

![Chart showing acrylamide reduction in different types of coffee](chart.png)

- Control: 63% reduction
- Treated: 62% reduction
- Arabica A: 64% reduction
- Arabica B: 32% reduction
- Arabica C: 64% reduction
- Robusta-Arabica blend: 32% reduction

- Added water: ~50% based on weight of green beans
- Soaking: 55-60°C, 60-90 min
Acrylamide mitigation in breakfast cereals

- Up to 75% reduction in acrylamide content in breakfast cereals

**Batch cooked wheat flakes**

- Enzyme added during cooking
- Cooking: 104-105°C, 25 min
- Moisture content: 33%
- Toasting: 230-245°C

**Whole wheat and bran extruded flakes**

- Enzyme added during pre-conditioning
- Pre-conditioning: 90-100°C, 10-12 min
- Moisture content: 27%
- Extrusion: 100-140°C
"I think you should be more explicit here in Step Two."
Summary and conclusions

• Asparaginases can be used to mitigate acrylamide formation in many different foods

  40-65% mitigation

  50-75% mitigation

  Up to 95% mitigation

  Up to 70% mitigation

• The benefits of using asparaginase for acrylamide mitigation are related to food safety and brand protection

• Acrylaway® is currently being used in industrial scale to mitigate acrylamide formation in food