

Mitigation of acrylamide formation in cereal-based products

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This PhD Research Project aims to evaluate methods to reduce acrylamide formation in cereal-based products (bread, Neapolitan pizza, breakfast cereals etc) by acting on asparagine. The research will involve the study of wheat varieties with low asparagine levels, the assessment of processing conditions that affect acrylamide formation, and the evaluation of the enzyme L-asparaginase addition to the dough for the production of cereal-based products with low acrylamide content according to the Reg. (EU) 2017/2158.



1. State-of-the-Art

Acrylamide is a heat-generated process contaminant that is formed in carbohydrate and asparagine rich foods as a result of their processing at high temperature during frying, roasting, and baking. It has been classified as potential carcinogenic to humans (Group 2a) and indicated as genotoxic and neurotoxic to animals (Zilic et al., 2020). Foods that provide the highest acrylamide intake in the daily diet are bread, cereal-based products (Sarion et al., 2021), processed potatoes and coffee, due to their natural content of acrylamide precursors (Mesias et al., 2019). Depending on the culinary habits of various countries, the intake of this contaminant in the daily diet can vary between 10% – 30% for cereal-based products, and 10% – 20% for pastries. High levels of acrylamide are founded in Italy in pizza and flat bread, with values of 250 µg/kg and 230 µg/kg, respectively (Altissimi et al., 2017).

The Regulation (EU) 2017/2158 establish mitigation measures and benchmark levels for the reduction of the presence of acrylamide in food, with limit values ranging from 150 µg/kg for maize, oat, spelt, barley, and rice-based products to 300 µg/kg for bran products and wholegrain cereals.

Acrylamide in cereal-based products is generated through the Maillard reaction, a series of non-enzymatic reactions promoted by high temperature (>120 °C) and low moisture content, involves mainly the amino group of aminoacids and reducing sugars which is essential in bakery preparations for the generation of desired flavors, aroma, and color compounds.

Because asparagine is a key factor in the formation of acrylamide in cereal foods, reduction of the asparagine content in flour is the primary strategy to prevent acrylamide formation during cereals processing. Nevertheless, it is critical that any strategy aiming at preventing or reducing acrylamide formation should ensure that beneficial attributes of cooked foods are not negatively affected (Mesias et al., 2020).

2. PhD Thesis Objectives and Milestones

- A1) **Bibliographic research**
- A2) **Screening of analytical methods for acrylamide analysis and its assessment in cereal-based products**, through assessment of HPLC-UV or/and GC-MS methods for acrylamide analysis (A2.1), and evaluation of acrylamide content in cereal-based products (A2.2).
- A3) **Utilization of L-asparaginase during processing of cereal-based products**, through optimization of condition for enzyme utilization (A3.1) and evaluation of rheological properties of dough (A3.2).
- A4) **Utilization of wheat varieties with low asparagine content for bakery production**: the asparagine evaluation in new wheat line with reduced asparagine content will be carried out (A4.1) and milling and technological properties of flour with reduced asparagine content will be assessed (A4.2).
- A5) **Production of cereal-based products that will respect the benchmark levels of Reg. EU 2017/2158**: the assessment of the best condition in processing in cereal-based products (A5.1) and evaluation of acrylamide formation (A5.2) will be carried out.
- A6) **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications.

Gantt diagram for this PhD thesis project

Activities / Months		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
A1	Bibliographic research																		
A2	Screening of analytical methods for acrylamide analysis and its assessment in cereal-based products																		
	1) Assessment of HPLC-UV or/and GC-MS methods for acrylamide analysis																		
	2) Evaluation of acrylamide content in cereal-based products (bread, Neapolitan pizza, breakfast cereals etc)																		
A3	Utilization of L-asparaginase during processing of cereal-based products																		
	1) Optimization of condition for enzyme utilization																		
	2) Evaluation of rheological properties of dough																		
A4	Utilization of a wheat varieties with low asparagine content for cereal-based production																		
	1) Asparagine evaluation in new wheat line																		
	2) Assessment of milling and technological properties of flour with reduced asparagine content																		
A5	Production of cereal-based products that will respect the benchmark levels of Reg. EU 2017/2158 from the new wheat line and trough asparaginase utilization during process																		
	1) Assessment of the best condition in processing of cereal-based products																		
	2) Evaluation of acrylamide formation																		
A6	Reports, Thesis and Papers drafting																		

3. Selected references

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