Sourdough fermentation: an effective way to reduce acrylamide formation in baked products

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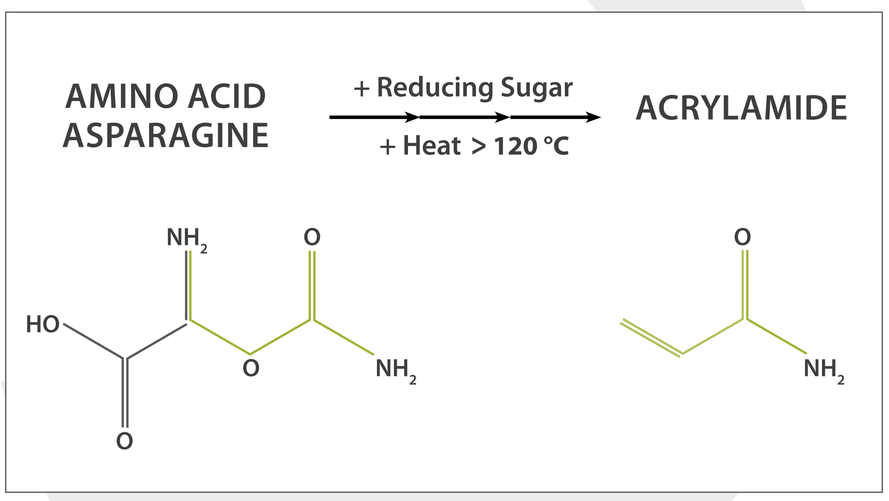
PURPOSE

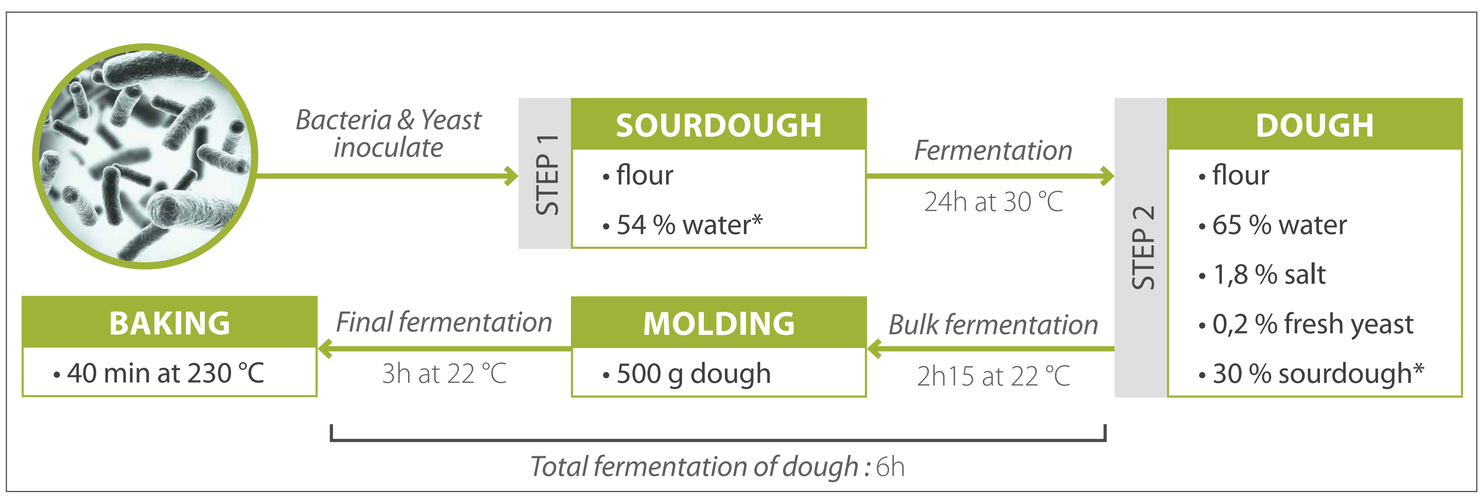
Acrylamide is a carcinogenic compound formed through a Maillard reaction between the amino acid asparagine and a reducing sugar at temperatures above 120°C. In bread products, acrylamide is formed in the crust during baking and migrates partially to the crumb. At the heart of public health concerns since 2002, acrylamide levels are not under regulation today. Nevertheless, the European Food Safety Authority recommends a maximum content of 80 µg/kg in wheat based breads. Low pH influences Maillard reaction, therefore the EFSA lists acidification as a mean to reduce acrylamide formation. This study aims at determining acrylamide levels in crusty breads; furthermore it demonstrates that the use of sourdough is efficient in reducing acrylamide formation.

METHODS

Wheat breads were prepared in a bakery laboratory following a standardised protocol, under controlled conditions of time and temperature. A commercial sourdough bread was analysed for comparison. To determine the effect of sourdough fermentation, the precursor asparagine was added to the sourdough preparation or final dough (0,3 % w/w on flour basis). pH and total titratable acidity of proofed doughs were measured. Acrylamide contents of breads were determined by an external laboratory, accredited ISO1725 standard, using an LC/MS quantification method.



➔ **Figure 1:** Acrylamide formation



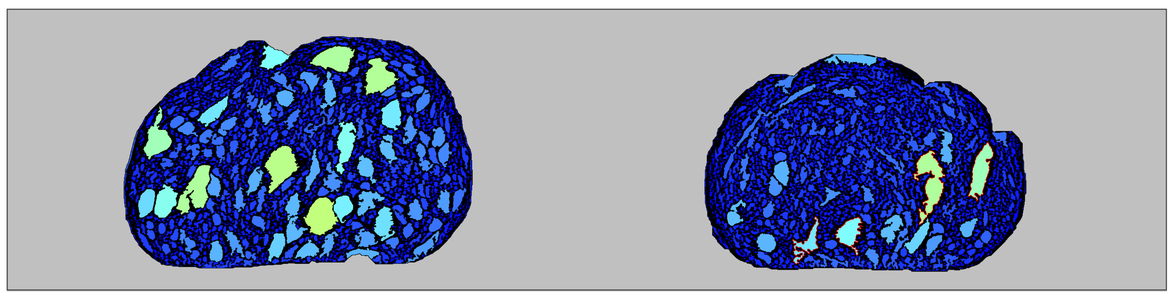
➔ **Figure 2:** Applied baking process. The precursor asparagine was either added to the sourdough or the dough phase. (**on flour basis*)

RESULTS

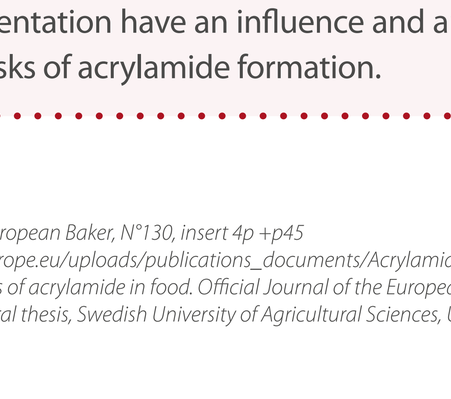
Effects tested	Added Asparagine (0,3%)	Bread acrylamide content		Crumb analysis	
		(µg/kg)	Difference	pH	TTA
Sourdough bread - off the shelf	-	21	-	4,30	5,3
Control bread	-	13	-	6,09	0,6
Control bread	in dough	990	negative	6,13	0,5
0,55% citric acid acidifier	in dough	390	-61 %	4,45	5,1
30% sourdough fermented with *L. brevis*	in sourdough	460	-54 %	4,26	4,0
30% sourdough fermented with *L. brevis* + *L. casei*	in sourdough	270	-73 %	4,23	3,8
30% sourdough fermented with *L. brevis*	in dough	780	-21 %	4,41	3,8
30% sourdough fermented with *L. brevis* + *L. casei*	in dough	630	-36 %	4,37	4,0

➔ **Table 1:** Acrylamide contents and acidity of bread crumbs in terms of pH and total titratable acidity (TTA) without addition of the precursor asparagine for control and off the shelf breads and with addition of 0.3% asparagine either in the sourdough or dough fermentation phase. Addition given on flour basis (w/w %).

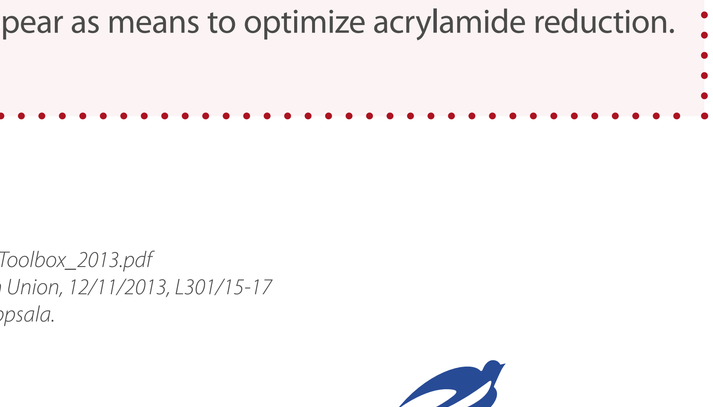
- Acrylamide contents of breads produced without the addition of asparagine are comparable to that of the commercial bread and below 20ppb *(Table 1)*.
- Acidification of the dough by sourdough fermentation or addition of acid reach similar pH levels *(Table 1)*.
- Sourdough fermentation leads to a reduction of up to 75% *(Table 1)*.
- Reduction levels vary according to the fermentation conditions used in terms of microorganisms present and duration. When asparagine is added to the sourdough phase rather than to the dough, acrylamide formation is reduced further by 10 to 40% whilst dough pH is unchanged *(Table 1)*.



➔ **Figure 3:** Image analysis of cell size within bread slices: small cells are dark blue and large cells are light blue to yellow). **Left**: *L. brevis* + *L. casei* sourdough bread; **Right** : acid containing bread.



➔ **Photo:** Breads with *L. casei* + *L. brevis* sourdough (left) and citric acid (right).



➔ **Figure 4:** Average diameter of cells analysed from 10 slices sampled from the center of the bread loaves.

- The use of acid reduces acrylamide formation by approximately 60% *(Table 1)*.
- However, direct acidification is detrimental to dough rheology. Average cell size of the sourdough containing bread is significantly greater than that of citric acid containing bread, at 0,001 significance level (non parametric test U Mann-Whitney for paired samples). *(Figures 3, 4 and photo)*.

CONCLUSION

This study highlights that acrylamide levels detected in crusty breads are far below recommended guidance values today. However, they were recently revised and lowered from 150 to 80µg/kg. Sourdough effectively reduces acrylamide formation via the production of organic acids and a progressive decrease of dough pH. The work also gives evidence that the type of sourdough and the microorganisms responsible for its fermentation have an influence and appear as means to optimize acrylamide reduction. These findings could be applied to other food processes which are more exposed to risks of acrylamide formation.

REFERENCES:

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