Sugars and the formation of acrylamide and 5-hydroxymethylfurfural

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Introduction

In bakery production, the Maillard reaction is important since it results in desirable flavours and colours of the products. The Maillard reaction, a form of non-enzymatic browning, is a chemical reaction between the carbonyl group of reducing sugars and the amino groups, and usually occurs during processing and storage of foods. However, this reaction may also result into undesired compounds, like acrylamide and 5-hydroxymethylfurfural (HMF), that can be harmful to human health. Sugar plays an important role in the formation of acrylamide and HMF, though exact effects are unknown yet.

Objective

To investigate the role of sugars in the formation of acrylamide and HMF during biscuit baking.

Methods

Three biscuit recipes were used varying in types (sucrose, glucose and fructose) and amounts of sugars.

Recipe 1 (R1)	
Ingredients	Amount (g)
Wheat flour	80
Refined palm oil	32
Sucrose	35
Water	17,6
NaHCO3	0,8
NH4HCO3	0,4

Recipe 2 (R2)	
Ingredients	Amount (g)
Wheat flour	80
Refined palm oil	32
Glucose +Fructose	17.5 + 17.5
Water	17,6
NaHCO3	0,8
NH4HCO3	0,4

Recipe 3 (R3)	
Ingredients	Amount (g)
Wheat flour	80
Refined palm oil	32
Fructose	17,5
Water	17,6
NaHCO3	0,8
NH4HCO3	0,4

- Baking temperature: 200°C in controlled oven conditions.
- Baking time: 16 min.
- Sampling: every two minutes of the baking process, six biscuits were collected and pooled as one sample.
- Chemical analysis: all samples were analysed for the Maillard precursors sucrose, glucose, fructose, asparagine, and the process contaminants acrylamide and HMF.

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Results

- The results in Figure 1 show that, while the concentration of sucrose in R1 did not decrease notably during the first 14 min of baking, the concentration of glucose and fructose in R2 and fructose in R3 started decreasing already after 2 min of baking. This coincides with the acrylamide formation which also starts after 2 min of baking (Figure 2).

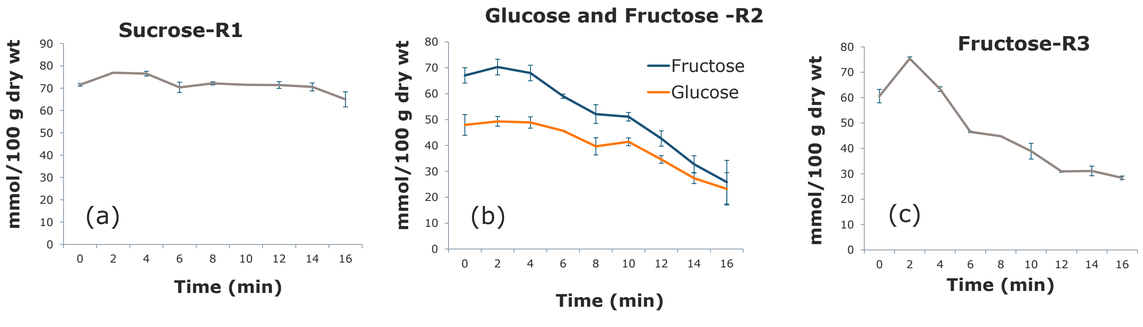

Figure 1. Concentration of sucrose in R1 (a), glucose and fructose in R2 (b), and fructose in R3 (c) during biscuit baking.

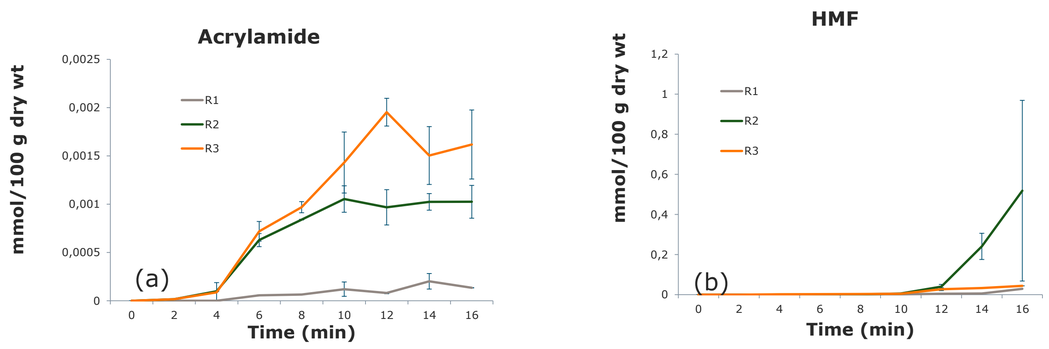

Figure 2. Concentration of acrylamide (a) and HMF (b) during baking biscuits of R1, R2, and R3.

- Biscuits prepared with sucrose in R1 contained the lowest concentrations of acrylamide and HMF at the end of the baking process. Biscuits prepared with fructose (R3) showed the highest concentration of acrylamide while biscuits prepared with a 1:1 mixture of glucose and fructose (R2) showed the highest concentration of HMF. Formation of HMF started only when the concentration of acrylamide had already reached its maximum.

Conclusions and Outlook

- The ratio of glucose and fructose influences acrylamide and HMF formation during biscuit baking.
- Using sucrose instead of glucose and fructose can minimize the formation of acrylamide and HMF in bakery products.
- Future work will include the role of asparagine as well as kinetic modelling of the formation of acrylamide and HMF formation.

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