Mitigation Strategies for Acrylamide in Bread

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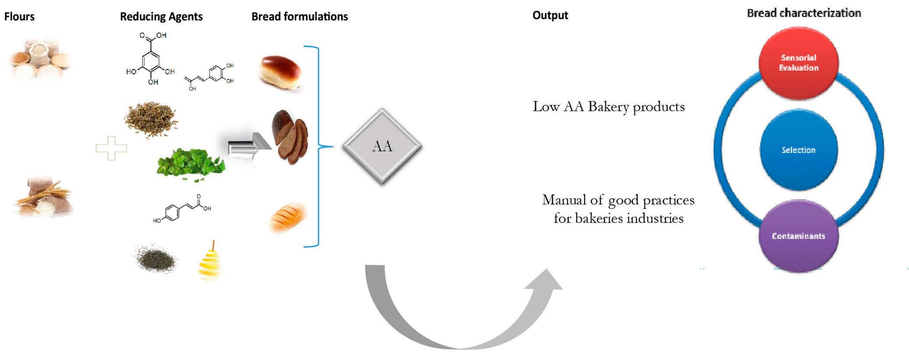
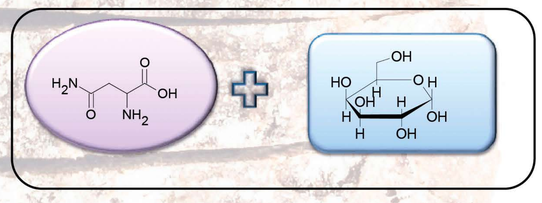
GRAPHICAL ABSTRACT



INTRODUCTION

The Maillard reaction is responsible for color, flavor and aroma in food products, but it can be responsible of the production of toxic substances such as acrylamide (AA) [1]. AA can be formed in foods such as bread, cereals and pastries. This contaminant is considered carcinogenic to animals and possibly humans and even neurotoxic and genotoxic [2,3]. Since the identification of acrylamide in 2002 in processed foods, reports have been conducted by the WHO and supported by EFSA scientific studies of great credibility [2].

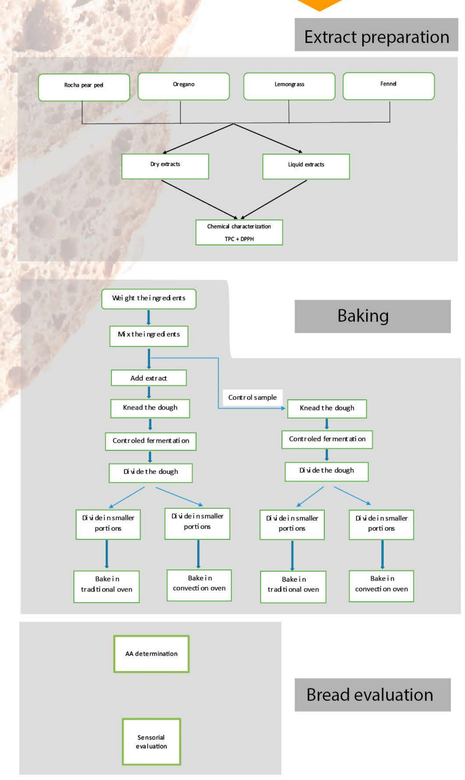


OBJECTIVES

Although several studies have already been developed, aiming at strategies to reduce AA in food during the Maillard reaction, there are few application studies in the bakery industry. Thus, the Project - MISAGE focuses on the development of different combinations of ingredients extracts - acrylamide reducing agents (ARA) to reduce AA content in breads with high consumption by the Portuguese population: rye bread and wheat bread. A final objective is to develop a set of cooking specifications with application by the baking industry.

METHODS

ARA extracts were obtained from preparations of peel of Rocha pear (Portuguese variety), oregano, fennel, and lemongrass, and produced in liquid and dry form [5]. The antioxidant capacity of the extracts was determined by the DPPH radical (DPPH) method, and the total phenol content (TPC) was determined by the Folin-Ciocalteau reagent method. After this, production tests (n=180) were performed in nine different combinations of ARA and in wheat and rye bread with two baking processes - conventional oven (O1) vs convection oven (O2). Afterwards sensorial evaluation and determination of AA by UPLC-MS/MS were done [6].



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RESULTS

Antioxidant activity of the extracts

The results showed a wide dispersion, and it did not demonstrate a correlation with the AA reduction. TPC value ranged from 0.7 to 88.5 (mg eq AC/g sample), and DPPH ranged from 0.2 to 9 (mg/ml).

ARA	TPC (mg eq AC/g sample)	DPPH (mg/ml)
Oregano	88,5	9
Lemongrass	85	5
Fennel	50	2,5
Pear peel	0,7	0,2

Table 1 – TPC and DPPH values for each extract.

Mitigation effects of the extracts

The most expressive mitigation effect was observed in the following extracts and combinations of bread and type of baking: Oregano in wheat bread 18.65% (O2), in rye bread 31.6% (O1) and 21.7% (O2); lemongrass in wheat bread 27.5% (O1), in rye bread 14.8% (O1) and 16.7% (O2); fennel in wheat bread 66.9% (O1) and 22.3% (O2), in rye bread 33.5% (O1) and 41.5% (O2); peel of Rocha pear in wheat bread 19,4% (O1) and 27.3% (O2), in rye bread 19.2% (O1) and 12.5% (O2) (Fig 1 and 2).

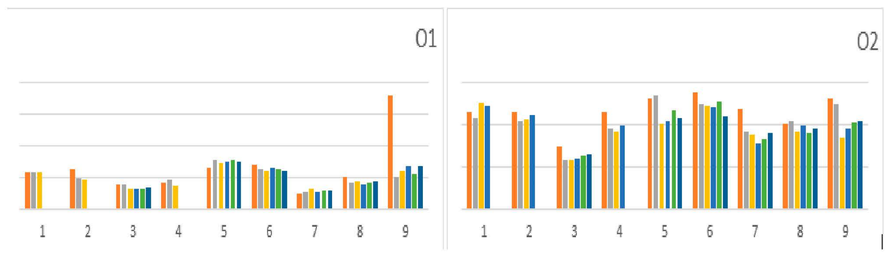

Fig. 1 – Acrylamide reduction in wheat bread baked in conventional oven (O1) and convection oven (O2).
1 – Lemongrass (liquid); 2 – Lemongrass (dry); 3 – Oregano (dry); 4 – Oregano (liquid); 5 – Fennel (dry); 6- Fennel (liquid); 7 – Rocha pear peel (dry); 8 – Rocha pear peel (liquid); 9 – Fennel (70/30).

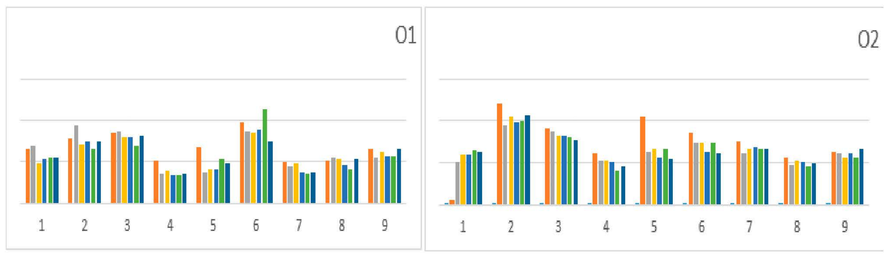

Fig. 2 – Acrylamide reduction in rye bread baked in conventional oven (O1) and convection oven (O2).
1 – Lemon grass (liquid); 2 – Lemon grass (dry); 3 – Oregano (dry); 4 – Oregano (liquid); 5 – Fennel (dry); 6- Fennel (liquid); 7 – Rocha pear peel (dry); 8 – Rocha pear peel (liquid); 9 – Fennel (70/30).

Sensorial characterization

Sensorial characterization showed an increase when compared to the control sample in the following extracts: oregano in rye bread (O2) from 7.1 to 7.7, oregano in wheat bread (O2) from 7.2 to 7.5, and lemongrass in rye bread (O2) from 7.1 to 7.8. For fennel and peel of Rocha pear extracts, the sensorial characterization showed no differences between samples (Fig 3 and 4).

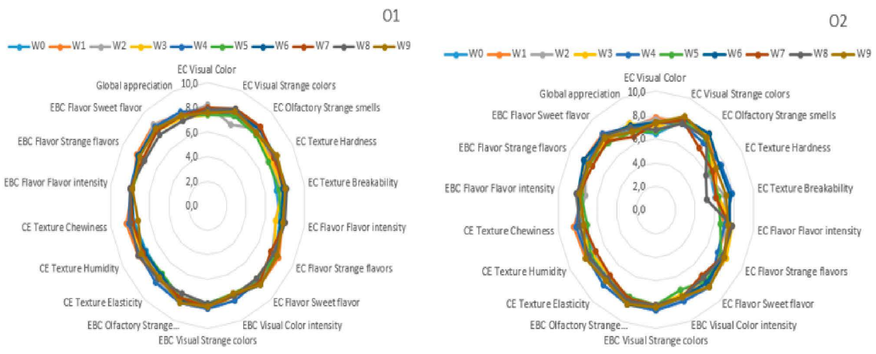

Fig. 3 – Sensorial evaluation in wheat bread baked in conventional oven (O1) and convection oven (O2).
1 – Lemon grass (liquid); 2 – Lemon grass (dry); 3 – Oregano (dry); 4 – Oregano (liquid); 5 – Fennel (dry); 6- Fennel (liquid); 7 – Rocha pear peel (dry); 8 – Rocha pear peel (liquid); 9 – Fennel (70/30).

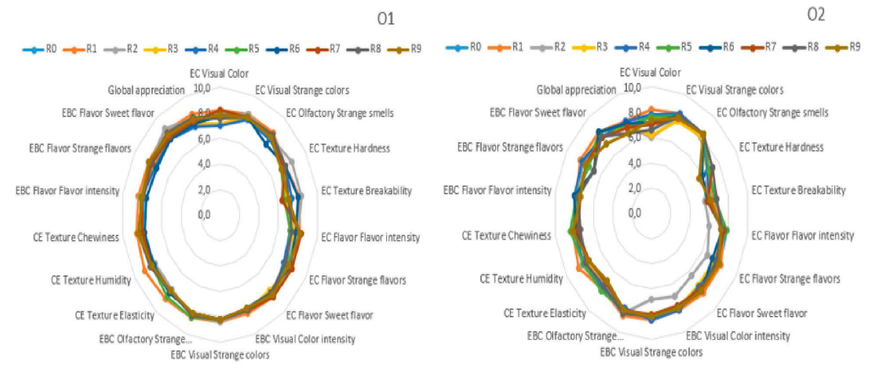

Fig. 4 – Sensorial evaluation in rye bread baked in conventional oven (O1) and convection oven (O2).
1 – Lemon grass (liquid); 2 – Lemon grass (dry); 3 – Oregano (dry); 4 – Oregano (liquid); 5 – Fennel (dry); 6- Fennel (liquid); 7 – Rocha pear peel (dry); 8 – Rocha pear peel (liquid); 9 – Fennel (70/30).

SIGNIFICANCE

Using natural extracts proves to be a feasible way to reduce ARA levels in bread, with good sensorial acceptance, allowing the development of technical specifications for bakery. Also the type of baking process affects the level of AA. The use of natural extracts represents an advantage in terms of risk communication and perception by consumers. Beside this, extracts like pear peel represent an advantage, in terms of sustainability and circular economy.

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