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Significance of microbial transglutaminase on the sensory, mechanical and crumb grain pattern of enzyme supplemented fresh pan breads

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Abstract

The impact of microbial transglutaminase (TGM) on the sensory, mechanical and crumb grain pattern of fresh pan breads has been investigated in white and wholemeal flour sponge dough samples supplemented with amylolytic-(NMYL) and non-amylolytic (PTP) enzymes. Assessment of bread performance has been carried out by physico-chemical measurements, texture profile analysis, sensory evaluation, digital image analysis and multivariate data handling. Improving effects of TGM addition were prominent when added to low extraction rate flours (increased cohesiveness by 11%, volume, aroma intensity by 31%, typical taste and crumb to cell ratio by 25% and decreased cell number by 17%). For white and whole flours, NMYL addition to TGM breads led to 16% softer breads. For the pool of enzyme supplemented samples tested, it was observed that the higher the specific volume of breads, the lower the acidification power, the better the mechanical behaviour with high cohesiveness and low hardness values and the higher the sensory scores for visual and textural attributes.

Keywords: Bread quality; Enzymes; Mechanical properties; Sensory profile; Crumb grain structure

1. Introduction

Enzymes in baking are useful tools for food formulators due to their capability to improve dough processing and final baked goods quality. Enhancement of the fresh quality and/or inhibition of staling of bakery products have been achieved by using starch- and non starch-degrading enzymes (Chinachoti, 2003). In addition to the traditional starch-hydrolysing enzymes—amylolytic/dextrinizing, saccharifying and debranching enzymes-, incorporation into bread doughs of non-starch polysaccharide degrading enzymes, and lipid and gluten modifying enzymes have proved to be effective, when properly adjusted, as dough conditioners and strengtheners (Collar, Andreu, & Martínez-Anaya, 1998; Collar, Martínez, Andreu, & Armero, 2000), initial crumb softeners (Haarasilta, Pullinen, Vaiasanen, & Tammersalo-Karsten, 1989), enhancers of the activities of yeast and endogenous flour enzymes (Van Dam & Hille, 1992), bread flavour enhancers (Chamberlain, Collins, & McDermott, 1981) and anti-staling principles (Collar & Armero, 1996; Armero & Collar, 1998; Primo-Martín, Martínez-Anaya, & Collar, 2004) by acting on major functional flour biopolymers. Microbial transglutaminase, TGM, a protein-glutamine γ-glutamyltransferase catalyses acyl transfer reactions introducing covalent crosslinking between proteins, peptides and primary

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amines (Nonaka et al., 1989), deamination of glutamine residues (Ando et al., 1989) and amine incorporation (Motoki & Seguro, 1998). The TGM-catalysed reactions modify the functional properties of baked goods via aggregation and polymerization of proteins (Sakamoto et al., 1995) by disulfide interchange reactions during mixing leading to a protein network with the viscoelastic properties required for breadmaking (Bollaín & Collar, 2004; Collar & Bollaín, 2004; Lindsay & Skerritt, 1999). The reinforced gluten structure can give texturized products with improved elasticity, water holding capacity (Zhu, Rinzema, Tramper, & Bol, 1995), improved crumb strength (Gerrard et al., 1998), firmness and heat stability (Kuraishi, Yamazaki, & Susa, 2001). The loaf volume of several breads may be increased or maintained by the addition of TGM, when some ingredients were substituted or reduced during mixing dough (Motoki & Seguro, 1998).

Enhancement of quality of enzyme-supplemented products has been mainly addressed by modifications to conventional enzymes (Hebeda, Bowles, & Martin Teague, 1990), by the development of new ones with optimum thermostability (Hebeda, Bowles, & Martin Teague, 1991), by adjusting the proper dosage to be used of single principles, and by design of proper associations of enzyme principles (Collar et al., 2000) and enzyme blends in baking agents (Bollaín & Collar, 2004; Collar & Bollaín, 2004). As components of baking agents, other enzymes in addition to TGM, such as amylases, proteases, and hemicellulases, as well as ascorbic acid, baking emulsifiers, hydrocolloids, salt, sugar or flour have been tested. Combining TGM with a protease avoided the decrease in extensibility observed in addition to the increase in dough resistance leading to an earlier breakage of the dough when testing extensibility (Gottmann & Sproessler, 1994). TGM when added to doughs containing the emulsifier DATEM (diacetyl tartaric acid ester of mono-diglycerides) and/or HPMC (hydroxypropylmethylcellulose), induced synergistic effects on suitable mixing parameters resulting in increasing water absorption, development time and stability. High cohesive doughs with improved water holding capacity and gluten strength during mixing and fermentation, and suitable pasting behaviour during cooking were achieved by TGM/pectin BIG/DATEM mixtures, mainly associated to suitable interactions of the pair TGM/DATEM and DATEM/BIG (Collar & Bollaín, 2004). Some synergistic effects of enzymes for dough conditioning—xylanase, hemicellulase/fungal α-amylase (Collar et al., 1998; Martínez-Anaya & Jiménez, 1997), xylanase, hemicellulase/lipase (Qi Si, 1997), xylanase, hemicellulase/amylase/lipase, glucose-oxidase/lipase/lipoxigenase (Sato, Sato, & Nagashima, 1991)-, dough strengthening-glucose-oxidase/fungal amylase, glucose-oxidase/lipase (Collar et al., 1998) and extending shelf-life, crumb softness and elasticity—xylanase/fungal α-amylase, hemicellulase/glucose-oxidase/α-amylase (Haarasilta et al., 1989), maltogenic α-amylase/fungal α-amylase/xylanase/lipase (Qi Si, 1997)—have been reported for specific breadmaking systems. Combinations of TGM/protease, TGM/ascorbic acid, and TGM/amylase/hemicellulase have been reported to improve bread crumb properties (Gottmann & Sproessler, 1994) when added to bakery flours or baking agents. Addition of TGM in combination with selected xylanase and amylase activities has proved to be suitable particularly for frozen dough and retarded and/or high speed mixing breadmaking processes (Díez-Poza, 2002).

The purpose of the present study was to investigate the effectiveness of amylolytic-, non-amylolytic- and gluten crosslinking enzymes added singly and in combination on the sensory, mechanical and crumb grain profiles of fresh pan breads made with white and wholemeal flour.

2. Materials and methods

2.1. Basic ingredients, additives and enzymes

Commercial blends of Spanish wheat flours (white/wholemeal) of 13.95/13.84% moisture, 0.66/1.33% ash content, 14.08/15.31% protein, 92/61 Gluten Index, and Chopin Alveograph parameters: Energy of Deformation = 308×10^{-4} J, and curve configuration ratio (white) = 0.79 were used. LAMBRECHT 80 PALM-H (Tecom Ingredients, Spain), a free flowing, creamy-white, spray dried powder containing 80% hydrogenated palm oil, maltodextrine, caseinates and a free flowing agent as vegetable fat and LAKTEIN 30 (Lacto serum France, France) a free lactose and demineralized lactoserum were added. Commercial compressed yeast (CCY) (10^{10} cells/g, dry matter) was used as starter. Enzymes included NOVAMYL 10000 BG a maltogenic bacterial alpha-amylase in granulate form (NMYL), PENTOPAN MONO BG a 1,4-endoxylanase in granulate form (PTP), both from Novozyms (Denmark) and MICROBIAL TRANSGLUTAMINASE ACTIVA WM a glutaminyl-peptide-γ-glutamyl tranferase in fine powder (TGM) from Apliena (Spain).

2.2. Dough and bread preparation

Qualitative basic dough formula consisted of fermented sponge, flour, water, salt, lactoserum, sucrose, vegetable fat, calcium propionate, and acetic acid glacial (Table 1). Enzymes were added according to the experimental design in Table 2. Process variables (qualitative and quantitative independent factors) tested at two levels (0, 1) included flour (white, wholemeal), NMYL (0, 7.5 mg/100 flour), PTP (0, 30 mg/100 g flour), and TGM (0, 500 mg/100 g flour). Sponge (sponge dough