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ENZYMATIC BIOCATALYSTS UTILIZED IN MUFFIN FABRICATION TECHNOLOGY

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Abstract: The present research investigates the application of alpha-amylase and xylanase as biocatalysts to refine the rheological properties of dough used in muffin production. By using alveographic method, the study assesses how discrete and combined enzymatic dosages influence the viscoelasticity of the flour-water system and the resulting structural characteristics of the baked muffins. Fungal alpha-amylase serves as a versatile biocatalyst within the food industry, with a primary application in cereal-based baking technologies. This enzyme facilitates the endo-hydrolysis of complex starch polysaccharides into fermentable mono- and disaccharides. These low-molecular-weight carbohydrates serve as the metabolic substrate for *Saccharomyces cerevisiae* (yeast) during fermentation, leading to the evolution of biogenic carbon dioxide which enhances the specific volume and resulting in a finished product with superior crumb porosity, soft textural attributes, and an improved organoleptic profile. Xylanase is a hydrolytic enzyme capable of catalyzing the degradation of xylan, a fundamental polysaccharide constituent of the plant cell wall. Xylanases primarily depolymerize the hemicellulosic xylan matrix by cleaving the glycosidic linkages and disrupting the network of covalent cross-links and hydrogen bonding within the xylan supramolecular structure. The application of consistographic analysis establishes standardized parameters for the enzymatic treatment of refined wheat flour, ensuring process homogeneity and product consistency. An optimized enzymatic dosage enhances oven spring and extensibility by modulating the starch-protein matrix. This intervention increases the concentration of fermentable reducing sugars, which act as precursors for the Maillard reaction and caramelization, resulting in a more intense crust pigmentation. Furthermore, amylase supplementation mitigates starch retrogradation, thereby extending shelf-life and kinetic freshness. The resulting finished products exhibit a superior porosity profile, increased specific volume, and a refined crumb morphology.

• Introduction

Fungal alpha-amylase catalyze the hydrolysis of starch into progressively smaller saccharide units, including dextrans, maltose, isomaltose, and glucose, depending on the extent of hydrolytic advancement.

Xylanase conduct their catalytic action by targeting xylans and arabinoxylans, as well as on their connections with other flour components, most important the gluten proteins. The technologically beneficial effect of xylanase activity is primarily attributed to the reduction of insoluble pentosan content and the subsequent hydrolysis of solubilized pentosans, a process that liberates bound water and enhances its availability for gluten network development and hydration.

• Material and method

The rheological characteristics of four flour samples were determined using the alveographic and consistographic methods. The Control sample does not contain any addition of enzymatic complex. Three samples contain increasing dosages of a alpha-amylase and xylanase enzymatic complex (AX) at 10g, 15g, and 25g per 100kg of flour, respectively.

The alveographic method evaluates the viscoelasticity of the flour-water system and the structural characteristics of the baked muffins by measuring the maximum resistance to deformation (P, mm H₂O), extensibility (L, mm), expansion index (G), dough strength and extensibility ratio (P/L), deformation energy (W, ×10⁻⁴ J), and elasticity index (Ie).

The consistographic method analyses : flour moisture (H₂O); maximum pressure (Pr MAX); hydration potential of the flour (HYDRA); time to reach the maximum pressure (Pr T MAX); tolerance or dough stability (TOL); degree of softening of the dough after 250 second and 450 seconds (D250, D450) and water absorption capacity (WAC).

• Results and discussions

The alveograph test shows that by using 15g AX/100kg flour in the preparation of the dough for baking we can see the highest value for the following indicators: the dough extensibility characteristics (L and G), the elasticity index (Ie) compared to the other samples. Using 10g AX/100kg presents small improvements of the dough extensibility characteristics compared to the Control sample. The worst values for all the indicator are obtained when using 25g AX/100kg. This high dosage shows a decrease in volume, the dough being sticky and is affecting the handling during the technological process.

The results of the consistographic tests show as well improvements of the dough quality when using 15g AX/100kg. The dough presents superior extensibility and elasticity characteristics, resulting in improved processability during production, while the final product demonstrates increased volume, along with enhanced crumb structure and porosity.

• Conclusions

Flour improvement through alpha-amylase and xylanase enzymatic complex (AX) used in correct dosages intensifies the amyolytic process, thereby elevating the concentration of fermentable carbohydrates in the dough via maltose generation. An optimized enzymatic dosage enhances oven spring and extensibility by modulating the starch-protein matrix. This intervention increases the concentration of fermentable reducing sugars, which act as precursors for the Maillard reaction and caramelization, resulting in a more intense crust pigmentation. Furthermore, amylase supplementation mitigates starch retrogradation, thereby extending shelf-life and kinetic freshness. The resulting finished products exhibit a superior porosity profile, increased specific volume, and a refined crumb morphology. Xylanase improves the workability and stability of the dough, the elasticity of the gluten network, the longer life of the finished product and the structure of the crust.