



ULST Timisoara  
**Multidisciplinary Conference on  
Sustainable Development**  
21-22 May 2026



## IMPACT OF ENZYMATIC TREATMENT ON THE RHEOLOGICAL AND TECHNOLOGICAL PARAMETERS OF WAFER BATTER

Ioan DAVID<sup>1</sup>, Ariana VELCIOV<sup>1</sup>, Calin JIANU<sup>1</sup>, Nicoleta HADARUGA<sup>1</sup>, Ersilia Calina ALEXA<sup>1</sup>, Gabriel BUJANCA<sup>1</sup>

<sup>1</sup> University of Life Sciences "King Mihai I" from Timisoara, Faculty of Food Engineering, Department Food Science, e-mail: ioandavid@usvt.ro

**Abstract:** *This study evaluates the biocatalytic modulation of the rheological profiles of refined wheat flour batters intended for wafer fabrication, specifically focusing on the synergistic or individual effects of xylanase and asparaginase. Utilizing alveographic analysis and the Falling Number method, the research quantifies the impact of varying enzyme concentrations on the viscoelastic behavior of the aqueous flour matrix and the structural integrity of the final aerated confection. The incorporation of xylanase facilitates the hemicellulose backbone to reduce the degree of polymerization and systematically cleave terminal units to yield low-molecular-weight saccharide. Concurrently, asparaginase catalyzes the deamination of L-asparagine into L-aspartic acid and ammonia, effectively mitigating the precursor for acrylamide synthesis via the Maillard reaction without compromising the organoleptic profile of the wafer. Experimental results indicate that these enzymatic interventions adjust batter viscosity and extensibility, yielding wafer sheets with enhanced porosity and textural fragility. The alveographic parameters—specifically dough resistance to deformation, the extensibility and elasticity properties of the dough—were utilized to characterize the dough's resistance to biaxial deformation and its elastic recovery. Notably, high enzymatic dosages induced an adverse transition toward a soft and adhesive (sticky) dough consistency. While an increase in specific volume was observed, the macrostructure of the crumb exhibited degradation. This localized loss of structural integrity and increased adhesiveness is attributed to the release of low-molecular-weight oligosaccharides, which possess a reduced water-binding capacity compared to the high-molecular-weight arabinoxylan precursors, leading to an excess of free water in the gluten-starch matrix.*

### • Introduction

Xylanase is commonly used in baking applications due to the catalytic action upon both xylans and arabinoxylans, as well as their associations with gluten proteins. When incorporated during milling or dough development, xylanase tends to reduce water absorption, dough development time, and stability; however, its addition during the tempering stage yields significant improvements in dough quality and sensory attributes, with results varying proportionally to enzyme dosage.

Several scientific researchers (Gazi S. & co, Hendriksen HV. & co) have evaluated the efficacy of asparaginase across various baked products such as rotary cut biscuits, crackers, wire-cut cookies, and wafer batters with different processing conditions resulting in acrylamide reductions, attributed to the relatively high water activity of their dough systems. Moreover asparaginase addition had no significant influence on surface color or spread ratio.

### • Material and method

The rheological properties of four flour samples were determined using the alveographic method and the Falling Number method. The base sample does not contain enzymatic supplementation, while three samples contain increasing concentrations of a xylanase and asparaginase (X&A) enzymatic complex at 1g, 7g, and 14g per 100kg of flour, respectively.

The Falling Number method determine  $\alpha$ -amylase activity by measuring the descent time (seconds) of a standardized stirrer through a gelatinized starch-water suspension at near-boiling temperature.

The alveographic method evaluates the viscoelastic behavior of dough by recording key rheological indices — maximum resistance to deformation (P, mm H<sub>2</sub>O), extensibility (L, mm), expansion index (G), dough strength and extensibility ratio (P/L), deformation energy (W,  $\times 10^{-4}$  J), and elasticity index (Ie).

### • Results and discussions

Sample with the most intense enzymatic activity is the Base sample - no enzymes. Addition of xylanase and asparaginase enzyme compound increased falling time by 10 seconds for Sample 1g X&A/100kg flour, by 25 seconds for Sample 7g X&A/100kg flour and by 65 seconds for Sample 14g X&A/100kg flour, showing the correlation of decreased enzyme activity with the increase of X&A enzyme compound, making the dough more dense.

The alveographic method shows that sample 7g X&A/100kg flour has the most suitable values for the manufacture of wafer dough. The resistance of the dough to deformation (P) is low, the elasticity index (Ie) is higher than that of Base sample, and the curve configuration ratio (P/L), as well as the total amount of energy absorbed by the dough when stretching (W) are low compared to the Base sample.

### • Conclusions

Falling Number analysis revealed that the Base sample - no enzymes has the highest  $\alpha$ -amylase activity, while the addition of the xylanase-asparaginase (X&A bioenzimatic compound) progressively increased falling time by up to 65 seconds in Sample 14g X&A per 100 kg flour, reflecting a reduction in enzymatic activity and increased dough density. Alveographic parameters demonstrated that the addition of 7g X&A per 100 kg flour optimally reduced dough resistance to deformation while enhancing elasticity, in comparison to the 1g X&A per 100 kg flour dosage which showed small improvements in extensibility relative to the Base sample. The addition of xylanase to flour brings improvements in the rheological properties and implicitly improvements in the quality of the finished products of the dough. 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. The asparaginase enzyme serves a distinct functional role by hydrolyzing free asparagine, thereby limiting its availability for Maillard-driven acrylamide formation — a reaction of significant food safety concern given acrylamide's classification as a potential human carcinogen. Optimal enzyme dosage should therefore be determined based on the dough's rheological profile, selecting the concentration that yields the most favorable balance of technological and quality parameters.