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Rheological Effects of Some Xylanase on Doughs from High and Low Extraction Flours

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Abstract

The xylanases are widely used in breadmaking with positive effects on bread quality but how they act in doughs is not fully understand yet. The aim of this study is to determine how different xylanolytic preparations modify the rheology of dough prepared from low and high extraction flours and the correlation between the rheological changes induced in dough and the viscosity and xylan content of flour extracts. Four flours, two white and two black, and three xylanolytic preparation was used in study. The rheological characteristics of dough were measured with the Extensograph. The xylan content and viscosity of flour extracts with xylanase were determined. In doughs from white flours xylanases increased the energy, maximum resistance and extensibility while in doughs from black flours decreased the energy and maximum resistance and increased the extensibility. The extensographic effects of xylanases were compared with their capacity to modify the viscosity and xylan content of aqueous flours extracts. The changes of extensographic indicators are well correlated with the changes of xylan content of extracts for white flour while for black flour correlations were observed with the changes of extracts viscosity. The capacity of xylanases to modify the viscosity of extract and convert the insoluble xylans in soluble xylans could be used to predict the performance of xylanases.

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Keywords: flour; arabinoxylans; xylanases; rheology

1. Introduction

Arabinoxylans (AX), formerly named hemicelluloses or pentosans, are polysaccharides widely spread in cell wall of plant and are mainly composed of a backbone formed by molecule of D-xylopiranose linked β(1→4) substituted with units of arabinofuranose [1]. Some arabinose units are esterified with ferulic acid. In wheat kernel AX occur in cell wall of cells from starchy endosperm but also in cells from

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aleuronic layer or outer layer of seed. AX are minor components of wheat flour, they represent 1.37% to 2.06% [2] or 1.66% to 1.86% [3]. The AX content of white flours is lower than black flours because the participation of outer layer of kernel to flours, the AX content of bran is 19.38% [2] while Maes and Delcour report AX content in commercial bran about 20-25% [4].

The AX from wheat flour are characterized by their extractability (solubility) in water as water extractable arabinoxylans (WEAX) or water unextractable arabinoxylans (WUAX). Despite AX are just a minor component of wheat flours they play an important role during breadmaking. The most important function of AX, WEAX or WUAX, is their capacity to bind large amount of water in dough. One gram of AX could bind 15g of water according to Bushuk [5], 10g according to Autio [6] or just 6.5g of water according to Linko et al [7]. The water bounded in dough has a great impact in dough rheology, especially if it is possible to mobilize it through xylanase hydrolysis. The WEAX have positive effects because the WEAX form solutions with a high viscosity [6-10]. The aqueous phase from dough is a viscous solution which stabilizes the dough porosity by sealing the gas cells [11] and the gas retention is improved and loaf specific volume increased. According to the same theory the cell wall fragment disrupt the gas cell walls and stimulate the coalescence of pores and gas release. The WUAX present in cell wall fragment reduce the gas retention in dough and specific volume of breads.

The conversion of WUAX with negative effects in WEAX with positive effects it is supposed to have positive effects on breads characteristics. The conversions could be realised with enzymes which are very efficient tools in food industry due their specificity of substrates and reactions. On wheat AX could act several enzymes, endo-β-(1,4)-D-xylanases, β-xylosidases, α-L-arabinofuranosidases, ferulic acid esterases [13]. From these only endo-β-(1,4)-D-xylanases (usually named xylanases) are largely used in breadmaking due their capacity to split the xylan backbone of AX with formation of two molecules with different properties. If the hydrolysed AX are WUAX the effects it is presumed to be positive by their conversion and if WEAX are hydrolysed the effects will be negative because the AX obtained have negative or no effects [14, 15]. Different xylanases have different effects on AX in term of substrate specificity and product of hydrolysis with different effects on breadmaking [16]. The technological effects of xylanases depend on their specificity for WUAX and the ability to form AX with high molecular weight and capacity to increase the viscosity of liquid phase of dough. A wide range of xylanolytic preparation is now available for breadmaking and more and more sources of xylanases are tested.

Xylanases from different sources will act different in dough, with different degree of solubilisation of AX and will increase or decrease the viscosity of liquid phase from dough. The degree of solubilisation of WUAX could be evaluate by measuring the increases of AX content in four extracts prepared with xylanases toward the extracts without xylanases and the impact on WEAX could be evaluated by measuring the viscosity of flour extracts. In ours previous studies we observed a good correlation between the changes of dough and bread properties and AX solubilisation for white wheat flours and with viscosity changes of extracts for black wheat flours [17-19]. In this study we evaluate the extensographic effects of some commercial xylanase on dough rheology.

2. Materials & Methods

Three commercial enzymatic preparation of xylanase was used for this study, Depol 333P, from Biocatalysts Ltd, UK, Veron 393 provided by AB Enzymes GmbH and Xila L from Belpan with 265.8 IRV/g (Inverse Reciprocal Viscosity), 3.7 IRV/g and respectively 13.8 IRV/g endo-xylanase at a pH 5.5. The unsupplemented flours were purchased from a local mill (Cibin Mill, from Sibiu). For the experiment were used two white flours coded F1 and F2 and two black flours coded F3 and F4. The flours F1 and F2 had 13.1% and 13.5% moisture, 29.6% and respective 29.8% wet gluten and 0.41% and respective 0.45% ash d.b. while the black flours F3 and F4 had 13.6% and respective 14.1% moisture, 1.30 and 1.25% ash d.b. and 27.8 and respective 28.1% wet gluten.

The xylanase activity was determined by viscometric method proposed by Megazyme with soluble wheat xylan (medium viscosity) as substrate, at pH 5.5.