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Technological effects of some xylanolytic preparations on black flour

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Abstract

Arabinoxylans (AX) represent only to 1.5 to 2.5% from wheat flour weight but they play an important role in breadmaking. The xylanases are generally used, to convert the unfavorable water unextractable arabinoxylans (WUAX) in water extractable arabinoxylans (WEAX) with positive effects on bread quality. A large number of endoxylanases which increases or decreases the viscosity of aqueous phase from dough and convert the WUAX to WEAX with different rates are available. The aim of this study is to investigate if any correlation could be established between the solubilisation of AX and viscosity changes induced by xylanases on the one hand and the changes of bread characteristics on the other hand. The changes of porosity and elasticity of bread crumb made from black flours are strongly correlated with the viscosity changes of flour extracts (R^2 = 0.9967) while the specific volume of breads is well correlated with AX solubilisation (R^2 = 0.6784).

Keywords: wheat flours, arabinoxylans, endoxylanases, bread

1. Introduction

At about the middle of last century the researchers from cereal science discover the importance of AX for breadmaking despite they represent only a small fraction of flour. In last decades the researchers are focusing on xylanase and their role in breadmaking. Arabinoxylans (AX), depending on their solubility in water, have a positive effects on bread quality – in the case of water extractable arabinoxylans (WEAX), or a negative effects in the case of water unextractable arabinoxylans (WUAX). The total AX represent just a small fraction from flour weight, 1.37 ÷2.06% [1] or 1.66÷1.86% [2]. The WEAX represent a smaller fraction, 0.54÷0.68% [1] or 0.7÷0.83% [2]. The AX content in whole wheat is higher because they are present in bran in high amount but the WEAX remain almost unchanged. The AX and WEAX content in bran is 19.38 and 0.88% and in whole wheat is 5.77 and 0.59 [1].

In the low grade flour the pentosans content is higher than in high grade flour because the bran presents in higher quantity. Maes and Delcour [3] report 20÷25% AX in commercial wheat bran.

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 oh water according to Bushuk [4], 10g according to Autio [5] or just 6.5g of water according to Linko et al [6]. This 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 [5,7-910]. 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.

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According to the same theory the cell wall fragment disrupt the gas cell walls and stimulate the coalescence and gas release. The WUAX present in cell wall fragment reduce the gas retention in dough and specific volume of breads.

The xylanases can be used to transform the WUAX in WEAX. In flour the xylanase activity is very low but is responsible for variability of water loosed in doughs from different wheat varieties by hydrolysis of 15 to 20% from AX [12]. The exogenous xylanases are used in breadmaking very often now to convert the WUAX in WEAX and to manage the water equilibrium in dough.

Different xylanase have different effects on AX in term of substrate specificity, product of hydrolysis with different effects on breadmaking [13].

In a previous study the authors evaluated some commercial xylanase preparation against theirs capacity to modify the viscosity of a flour extract and capacity to convert WUAX in WEAX [14].

The aim of this study is to investigate the technological potential of some commercial emzymatic preparation and correlations between the bread characteristics and the capacity of xylanases to modify the viscosity of flour slurry or to solubilise the WUAX.

2. Materials and Method

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 pH 5.5. For experiments have been used two black flours, F1 and F2, with 1.25% and respectively 1.30% ash content, 13.5% and 13.8% moisture, 27.5% and respectively 26% gluten content. The flour, unsupplemented, was purchased from a local mill (Cibin Mill, from Sibiu).

The xylanase activity was determined by viscometric method proposed by Megazyme with soluble wheat xylan as substrate, at pH 5.5. The measure the liquefying capacity of xylanases 5 g of flour was vigorously mixed with 25 ml of water and an amount of xylanase to reach 25 IRV/100 kg of flour. The mix was kept at 30ºC with constant stirring in a water bath and after that was centrifuged for 10 minutes at 1000 x g.

The viscosity of supernatant was determined with an Ubbelohde type glass viscometer. To measure the capacity to solubilise WUAX was determined the amount of AX from supernatant by orcinol method described by Hashimoto et all [2, 14] and modified by Delcour et all [15]. Previously 1 ml of extract was diluted with 14 ml of water and 1 ml of this dilution was analyzed. The results were compared with the control probe, prepared in the same way but without xylanase. The baking of heart bread sample were prepared according to AACC method 10-09.The mixing was made with the Farinograph until the consistency of dough decrease with 10 U.F. No sugar, oxidants, malts or yeast food. Fungal α-amylase was added (0.2g of Clarase to 300g of flour). The xylanase preparations have been added to reach, 25, 50and 200 IRV/100 kg of flour, to reach the dosage recommended by producer for each preparation. The specific volume of bread was measured by rape seed displacement. The elasticity of bread crumb was measured by height recovery of a crumb cylinder after his compression at half of height for 1 minute followed by 1 minute to recovery. The porosity of crumb was measured by differences between the volume of a bread crumb cylinder and the volume compressed crumb cylinder measured by oil displacement with a graduated cylinder. The H/D ratio was determined also (height / diameter).

3. Results and Discussion

The hearth bread represents the main category of bread preferred by population and for this category of bread the ratio between height (H) and diameter (D) is an important characteristic. In figure 1 is presented the effect of xylanase preparations on H / D ratio. At 25 IRV xylanase activity per 100 kg of flour was observed a slight improvement. The most consequent effects was observed for Depol 333 P preparation. The xylanases had different effect when the flours was changed. This fact demonstrates that the flours have different sensitivity to xylanases action. For flour F1 the increases of enzyme dosage lead to higher H / D ration than control while for flour F2 lower ratio was observed.

In figure 2 is presented the effect of preparations on specific volume of loafs. Better results were observed for samples with xylanases added, except the sample with Depol 333P at 25 IRV / 100 kg of flour. The improvement of specific volume was observed at higher dosage. The samples prepared with black flour F1 showed a greater improvement of specific volume than samples prepared from flour F2.

Flour F2 was less sensitive to xylanases action. Somehow similar results were observed for crumb porosity (data showed in figure 3). The samples prepared from flour F2 had lower scores than control. The samples from flour F1 had higher scores than control sample and slight higher when higher dosage were used. The crumb elasticity is slightly improved by xylanase addition.

In figure 4 are shown the results. The improvement of breads prepared from flour 2 is lower than for breads prepared from flour F1. The characteristics of control sample from flour F1 are better than for control prepared from F2 and also the flour f1 respond better to xylanase addition. From these we can presume that the that a good flour are more easily improved by xylanase addition than poor flour as in the case of

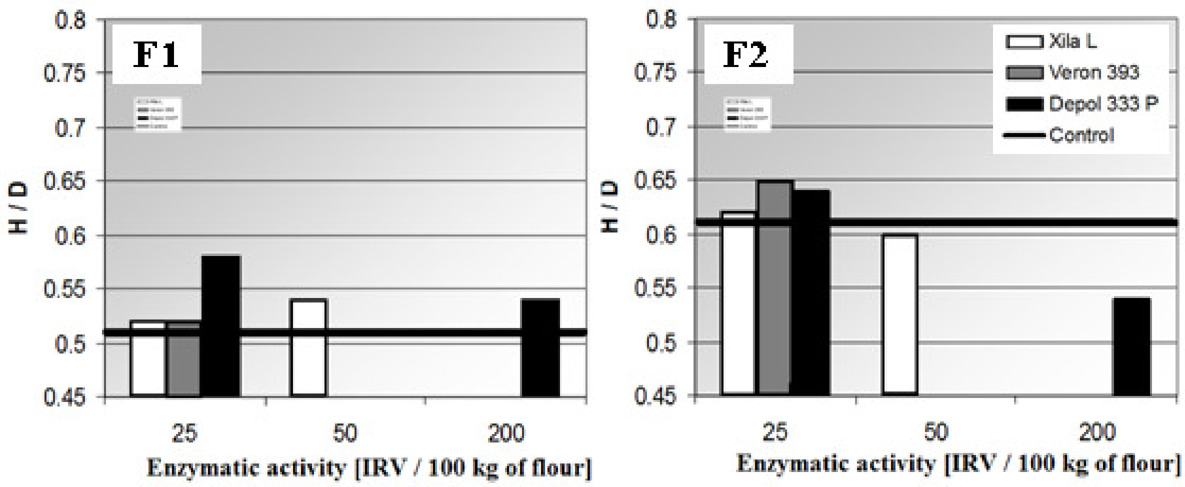

Figure 1. H/D ratio of loafs prepared with xylanases

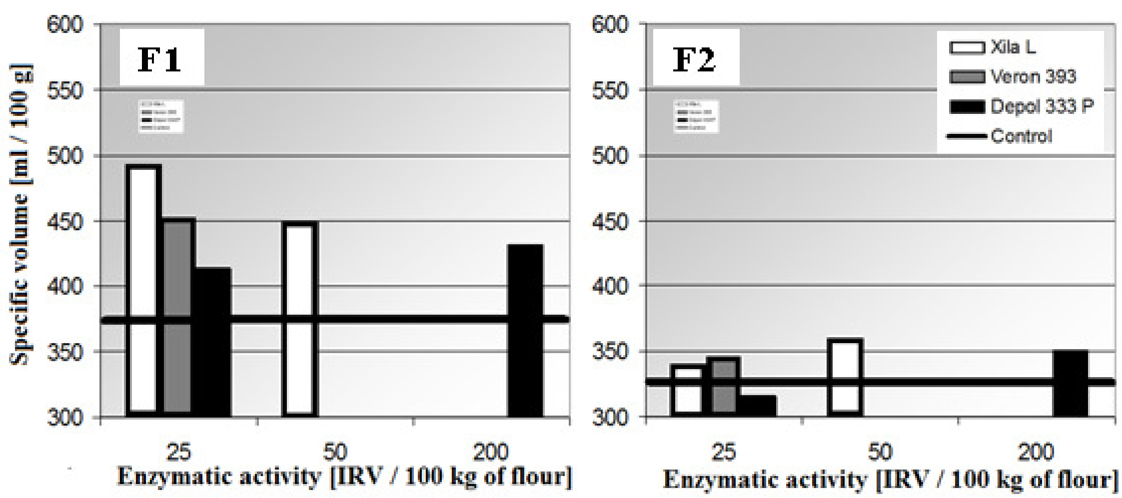

Figure 2. Specific volume of loafs prepared with commercial xylanases

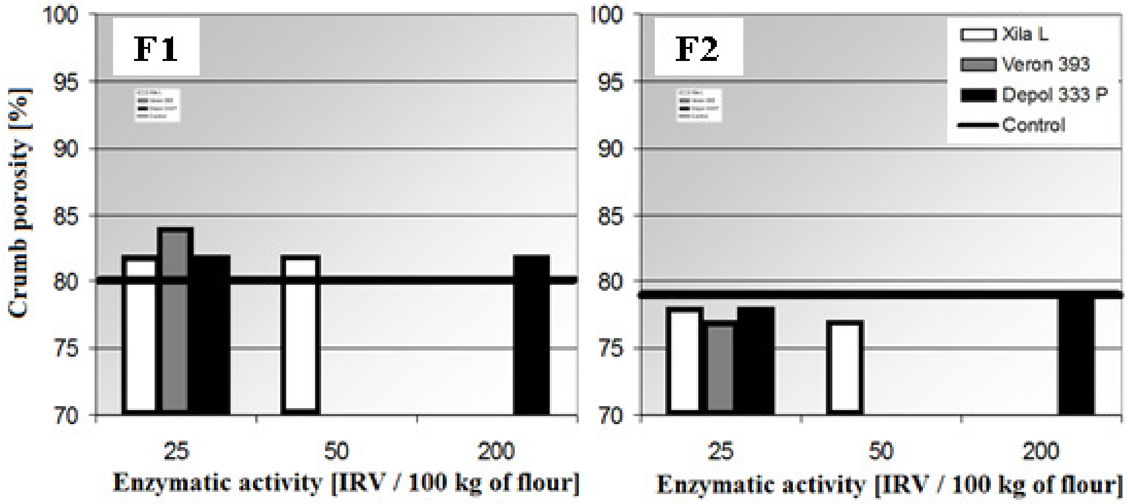

Figura 3. Crumb porosity of breads prepared with commercial xylanase

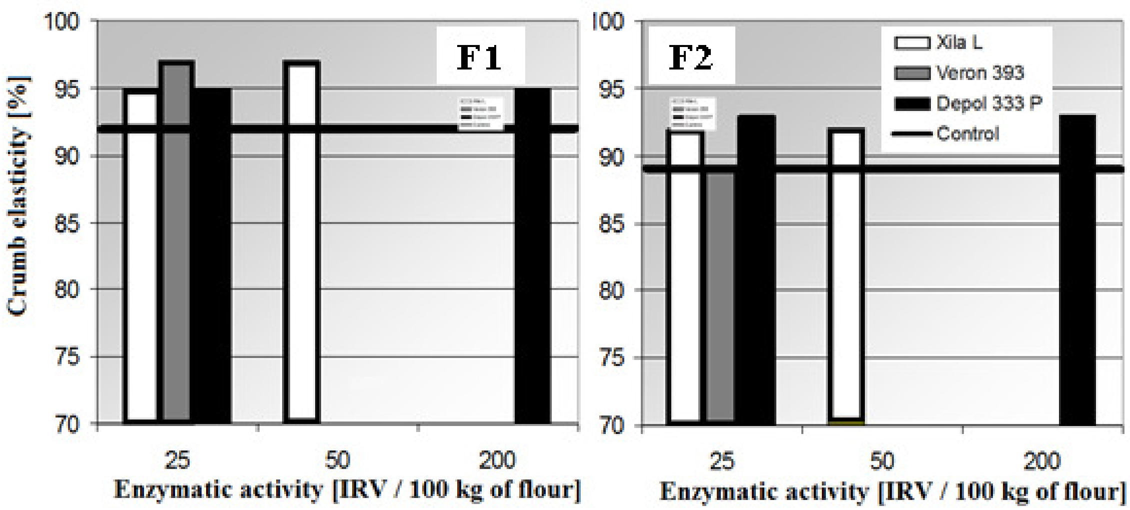

Figure 4. Crumb elasticity variations at xylanase addition

For flour F1 was determined the impact of xylanases as WUAX solubilisation measured as the increasing of xylan content in aqueous extracts of flours and also the hydrolysis of WEAX measured by viscosity decreases of flour extract. All xylanase preparation increased the content of AX in extracts, as was expected. The viscosities of flour extracts with xylanases were, in all cases, lower than viscosity of unsupplemented extracts. We must point that the viscosity of extracts is the result of two action, on the one hand the increasing of viscosity by the conversion of WUAX in WSAX with high molecular mass and on the other hand the decreasing viscosity by hydrolysis of WEAS in fraction with low molecular mass.

Also during the centrifugation the xylanases hydrolyse just the WEAX from extract. The variation of solubilisation of WUAX and hydrolysis of WEAX were compared with technological effect on bread quality. For breads prepared from black flour F1 the variation of AX content from flour extract are correlated (R^2 = 0.6784) with specific volume of breads. The correlation isn't it strong. The trendline of linear correlation is presented in figure 5. The specific volume of bread was higher when the AX ccontent of extract was higher. Conversion of AX had a positive effect on bread volume but the correlation isn't it too strong because the black flour have a great content of WUAX and still remain a great amount of WUAX with negative effect.

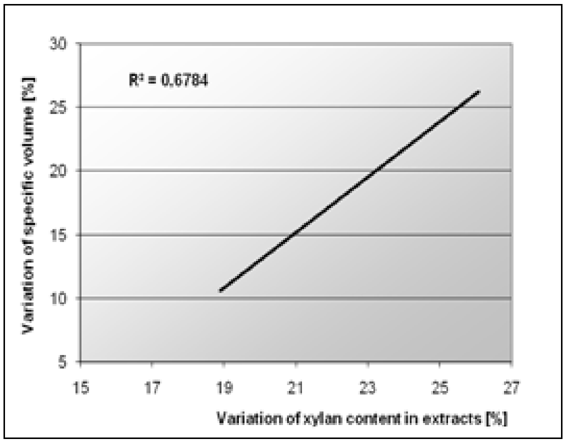

Figure 5. Trendline of linear correlation between specific volume variations and AX content in flour extract

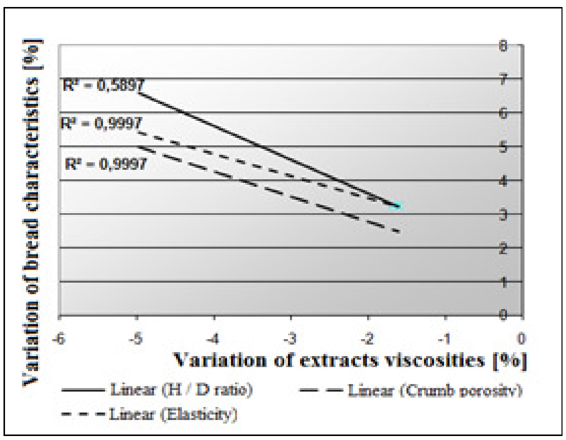

Figure 6. Trendline of linear correlation between bread characteristics variations and extract viscosity

The variation of extract viscosity show a very good correlation with crumb elasticity and porosity with R^2 = 0.9997 and a weak correlation with H / D ratio (R^2 = 0.5897). Unexpected, the best breads characteristics was observed at lower viscosity.

4. Conclusion

Xyalanase preparations induce in dough as in aqueous slurry flour similar transformation. This experiment confirm the presumption that conversion of WUAX in WEAX lead to an improvement of bread characteristics and also the viscosity of aqueous phase of dough have impact on bread characteristics. Similar results we obtain our previous works [15-17].

Usualy, the changes of dough rheological properties prepared from white flour are well correlated with solubilisation of WUAX while for dough from black flour the correlations are established with viscosity changes. These were observed both for farinographic [18] and extensographic (Ognean, unpublished data) approaches. From these researches we can presume the fact that the efficiency of xylanases used in breadmaking could be predicted by monitoring the solubilisation of WUAS for white flour and viscosity for black flours. Probably the viscosity of aqueous phase from white flour doughs are influenced by other factors and the content in WUAS is lower and changing them the dough rheology is improved. For black flours the proportion of WUAX is higher and by solubilisation we can modify the structure and properties of cell wall fragment too little while changes of viscosity have higher impact.

Further researches are needed to confirm these hypothesis and explain the mechanism of xylanase action in breadmaking.

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