RESEARCH ON THE FACTORS WITH IMPLICATIONS ON RHEOLOGICAL PROPERTIES OF DOUGHS

— short presentation PHD thesis —

MIHAI OGNEAN[1], IOAN DANCIU

Faculty of Agricultural Sciences, Food Industry and Environmental Protection, "Lucian Blaga" University of Sibiu, Sibiu, Romania

Abstract: The aim of this work is to contribute to the knowledge and the understanding the mechanisms of action of xylans and xylanases which is not fully understood yet. The xylanases are used extensively with positive results in breadmaking, along amylase and ascorbic acid. The use of xylanases is based on transforming insoluble xylans with negative effects on baking in soluble xylans with positive effects. The soluble xylans could be hydrolyzed too which lower the viscosity of medium. This study aims to determine how different xylanases modify the viscosity of xylans solution, haw much insoluble pentosans could be solubilized and mostly how the dough's rheological properties of are modified.

Keywords: soluble xylans, insoluble xylans, xylanases, dough rheology

INTRODUCTION

Pentosans or arabinoxylans are nonstarch polysaccharides present in all tissues of wheat seeds. They are minor components of grain but are the predominant component of polysaccharides matrix of cell walls (Izydorcszyk et all, 2003). They help to maintain tissue integrity, control the migration of water and soluble components of low molecular weight, maintain osmotic pressure and are a barrier against bacteria, fungi and insects (Autio, 2006). The arabinoxylans represent 70% of total nonstarch polysaccharides (Maes and Delcour, 2002).

Arabinoxylans are formed by a linear backbone composed from xylose linked through (1→4)-β bonds. Arabinose or even short chains formed by two or more molecules of arabinose are attached to xylan backbone in O-2, O-3 or O-2,3 position (Izydorczyk and Biliaderis, 1995), (Belitz et all, 2009),

[1] Corresponding author. Mailing address: University "Lucian Blaga" of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, I. Raţiu 7-9, 550012 Sibiu, Romania. Phone: 0040/269/211338. Fax: 0040269212558. E-mail address: mihai.ognean@ulbsibiu.ro

(Anderson et all, 2006), (Izydorcszyk et all, 2003). Unsubstituted segments alternate with high substituted segments (Gruppen et all,1993). The presence of ferulic acid imparts to the pentosans same peculiar and specific properties like the oxidative gelation (Izydorczyk et all, 1991), (McLauchlan et all, 1999), (Carvajal-Millan et all, 2005), (Ciacco and D'Appolonia, 1982), (Cleemput et all, 1997).

Arabinoxylans have some chemical and physical properties which present interest for the breadmaking. The most important is the properties to increase the viscosity of solution. The intrinsic viscosity of soluble arabinoxylans varies from 2.8 to 6.9 g/dl while the intrinsic viscosity of arabinogalactans varies between 0.05 and 0.06 g/dl (Autio, 2006). Arabinoxylans are responsible for 2/3 from flour extracts viscosity (Udy,1956).

Arabinoxylans have a great affinity for water and they have a great capacity to bind water in to the dough. Despite the pentosans represent just 2-3% from flour weight they bind 25% from the water absorbed by flour (Autio, 2006). and 1 g of pentosans can bind 15 g of water (Bushuk, 1966). Javainen and Linko (1997) affirm that 1g of pentosans can bind just 6.5 g of water and they are responsible just for 15% from water bounded in dough but even so they have the greatest water binding properties into the dough.

Some authors (Autio, 2006),(Eliasson and Larsson, 1993) investigate the tensioactive properties of arabinoxylans and this property are related with bubble formations and stabilization in dough.

The oxidative gelation of arabinoxylans was investigated by many researchers (Geissman and Neukom, 1973) (Izydorczyk et all, 1991), (Meuser and Suckow, 1986), (Carvajal-Millan et all, 2005), (Ciacco and D'Appolonia, 1982), (Dervilly-Pinel et all, 2001), (Hoseney and Faubion, 1981), (Izydorczyk and Biliaderis, 2007), (Piber and Koehler, 2005). According to these authors the ferulic acid is oxidized in presence by H_2O_2 and form a dimmer which is a bridge between two arabinoxylan molecules. As a result the solution is converted in to a gel. A link between ferulic acid and cysteine or tyrosine it is very possible to be formed and a link between an arabinoxylan ands a protein molecule it is formed.

The arabinoxylans have important effects in breadmaking. The soluble and insoluble arabinoxylans have a common property, they adsorb a high amount of water in to the dough but otherwise they have opposite effect in breadmaking. All arabinoxylans increase dough consistency and slow down dough development because their high affinity to water. The soluble arabinoxylans have a general positive effect on dough and bread properties while the insoluble arabinoxylans have slightly controversial negative

effects. The soluble arabinoxylans increases the viscosity of liquid fraction from dough and the gas retention in dough is improved. The insoluble arabinoxylans disrupt the gas cell so the dough's gas retention is reduced.
The negative effects of insoluble arabinoxylans could be related with the fact that they are present in to the flour as discrete fragment of cell walls and the coalescence of pores are due of these.
The arabinoxylans affect the shelf life of breads, especially the freshness of bread crumb. Many authors affirm they didn't interact with the starch gel during retrogradation and their positive effect is due the supplementary amount of water (Biliaderis et all, 1995), (Gudmuson et all, 1991) but another authors (Benamrouche, et all, 2002), (Devesa and Martinez-Anaya, 2003), (Kim and D'Appolonia,1977b) affirm the opposite, the arabinoxylans interact with starch and slow down the retrogradation rate.
The positive effect of xylanases was accidentally observed at the fungal amylase preparations. The xylanase convert the insoluble arabinoxylans with negative effects in to the soluble arabinoxylans with positive effects in breadmaking (Goesaert et all, 2005), (Courtin and Delcour, 2002). Another possibility is the modification of discrete fragments of cell wall. It is know a large number of xylanases but in breadmaking are used endoxylanase which split the xylan backbone in large fragment. One problem is the specificity (Courtin and Delcour, 2001), (Courtin et all, 2001), (Goesaert et all, 2006) of xylanase for insoluble or soluble xylans because these preparations have not a high specificity for one or another type of xylans.
The xylanase have positive effects on extensibility, elasticity and stability of dough (Courtin et all, 2001), (Rouau et all, 1994), oven rise (Courtin et all, 2001) and specific volume of bread (Courtin et all, 2001), (Sprossler, 1997), (Martinez-Anaya and Jimeney, 1997). The use of xylanase in breadmaking impose much care because its have different sensibility of substrate (wheat flour) and in wheat flour exists some xylanase inhibitors (Gebrueurs et all, 2004), (Goesaert et all, 2004), (Gebrueurs et all, 20014), (Juge and Payan, 2004), (McLauchlan et all, 1999), (Debyser and Delcour, 1997a), (Debyser and Delcour, 1997b), and an overdose have adverse effects.

CONCLUSIONS

Viscosity of flour extracts decreases during extracts incubation, more pronounced in the first hours of storage and then viscosity decrease is linear. Viscosity changes do not seem to be caused by endogenous xylanases because after heat treatment viscosity of extracts continues to fall, albeit at a

slower speed. Protein fraction appears to influence this behavior, the lowering of viscosity is reduced but not stopped, which is the fact that not all proteins in the extract may be removed by boiling. It is possible that the components of the extract form associations and that lead to a lower viscosity.

Viscosity of extracts decreases with increasing extraction time while the dry matter content of the extracts increased. This can be attributed to its enzymatic activity of flour. Endogenous hydrolases convert high molecular weight compounds affecting the viscosity in the lower molecular weight compounds, with lower impact. It is also possible and likely in the extraction phase to take place the same processes as in extracts. Increased pentosan and protein content in the extract results in lower viscosity extracts although was determined that the viscosity of solutions prepared from purified pentosans increases with increasing their concentration.

From studies on extracts viscosity and solubility of insoluble pentosans is observed that enzyme preparations, at the same activity, have different effects which could indicate that the method is not sufficiently representative to assess enzymatic activity. An accurate and complete assessment of xylanase activity can not be made by a single analysis because of their great diversity, diversity manifested by different substrate specificity, site of action and different sensitivity to inhibitor action. The preparations have different effects depending on the type of flour used as a substrate.

Farinographic characteristics of doughs prepared from flour with xylanases added have minor changes. The consistency of doughs prepared with xylanases had positive and negative changes to the consistency of dough control, as well as development time and time to break down of the dough. Stability, as well as the degree of softening of dough, decreased for all enzyme preparations used. The changes are small and are due to reduced time of action of enzymes. Much obvious are the changes in the doughs when the mixing was interrupt for 40 minutes after the peak was achieved. Dough consistency is improved for all enzyme preparations. Changes in dough stability is different, depending on the preparation used for observing the changes positive or negative, like the dough elasticity and degree of softening. While mixing tolerance index of the dough is higher for doughs with added pentosanase their consistency to 5 minutes to achieve maximum is higher than the control dough.

Doughs prepared from low grade flour have lower changes of rheological characteristics. All farinographic characteristic, except elasticity, shows a worsening of dough rheology from low grade flour.

Better correlation of farinographic characteristics with pentosans content of extracts is observed for dough from high grade while for low grade flour best correlations are established with variation of extracts viscosity.
Extensographic studies revealed that the additions of xylanases lead to improvements in the rheological characteristics of doughs prepared from high grade flour while the characteristics of doughs from low grade flour are worse. The addition of xylanases to high grade flours led to small increases in energy and resistance to constant extension and significant rises of maximum resistance and extensibility of dough. The effect of xylanases to low grade flours on the extensographic characteristics is generally negative, except extensibility, for some cases, positive changes.
The use of xylanases to obtain bread has different effect. Improvement is more obvious for loaves prepared from stronger flours than weaker flour. The research notes improvements in H / D ratio and specific volume for both low and high grade flours, the enhancement varies with the preparation and the dose used.. The use of xylanases led to products with improved softness but also to the emergence of large pores under crust.

PERSPECTIVES

The usual methods for assessing enzyme activity evaluate the just the endoxylanolythic or exoxylanolyithic activities and correlation with the technological effects of technology is not known. It is necessary to develop new methods to be as close to the technological conditions from bakery. Changing viscosity of flour extracts and solubilising activity of insoluble pentosans correlate well with changes in the rheological characteristics of dough and the changes of bread characteristics. The good correlation established allow the development of assessment methods based on these effects of xylanases. These new methods may be appropriate and could make the evaluation and the use of enzymatic preparations much easier for those working in the mill and bakery.
The production of whole flour bread represent a segment of breadmaking which is in fast growing today and the uses of xylanases represent a important tool in obtaining products with a much clean label. Understanding the mechanism of action of these enzymes in dough is a very important task.
It is necessary to choose the right assay to measure the xylanase activities or to determine the type of xylanase. To select the appropriate method for milling and breadmaking sector it is need to find which one correlate better with technological effects of these enzymes in breadmaking.

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