L-CYSTEINE INFLUENCE ON THE PHYSICAL PROPERTIES OF BREAD FROM HIGH EXTRACTION FLOURS WITH NORMAL GLUTEN

Alexandru Stoica, Corina Popescu, Elena Bărăscu, Maria Iordan
Valahia University of Târgovişte, Faculty of Environmental Engineering and Biotechnology,
Departament of Food Products Engineering, Unirii Bd., 18-24, 130082, Târgovişte, Romania
E-mail: stoicaandi@yahoo.com

Abstract
Reducing agents like L-cysteine are used in bread baking of strong flours, with short gluten to reduce mixing and fermentation time. The aim of this study is to determine if L-cysteine may be an improving agent for the quality of bread obtained from high extraction flours with normal gluten.
The tested high extraction flour was analyzed by determination of several quality indicators such as wet gluten content, gluten deformation index, moisture, ash, Falling Number index and alveogram parameters of dough. The results indicate that flour has a normal gluten network, is "good" for bread making and has a normal α-amylase activity.
After its addition to dough, L-cysteine improves the physical properties of bread made with high extraction flour. The observed increase for bread volume was maximum 10%, for porosity maximum 5,75% and for elasticity maximum 2,58%, comparing with reference bread.
The proposed solution can be assimilated into pan bread making technology.

Keywords: L-cysteine, gluten network, high extraction flours, non-starch polysaccharides.

1. INTRODUCTION

Several agents can potentially affect the bread making performance of the wheat flours. L-cysteine is a reducing agent in practical use today, beeing first patented in 1962 [1].
Cysteine is an amino acid constituent of all proteins and produced by hydrolysis of extremely cysteine-rich proteins such as those from feathers or hair and complex purification procedures or by synthetic means. Also, L-cysteine occurs naturally in wheat flours [2].
The reducing agents are added to doughs to shorten mixing and fermentation time [3]. It reacts with SS bonds in dough, breaking them with concomitant reduction to SH groups. The overall effect is to reduce the average molecular weight of glutenin protein aggregates [4].
Cysteine supplementation results in dough weakening, with decreases in the elastic and viscous properties, mixing time and tolerance to mixing. In contrast, adhesiveness, extensibility and machinability are increased [5, 6].
Generally, reducing agents are used in bread baking when flours are strong, with short gluten. The gluten of these flours is strong, resistant and has low extensibility, leading to products with low volume, dense crumb, undeveloped porosity and weak flavor. This is due to the poor dough extensibility under the action of the fermentation gases and low protein atacability by proteolytic enzymes [7].
The aim of this study is to determine if cysteine may be an improving agent for the quality of bread obtained from high extraction flours with normal gluten.

2. MATERIALS AND METHODS

2.1. Materials

Flours. In experiments, a high extraction flour from SC COMPAN S.A. Targoviste (FN4) was used. The used flour's determined characteristics are summarized in Table 1. The flour's quality indexes refer to the protein content (expressed by wet gluten content), moisture, the elastico-plastic characteristics of dough, purity and content of non-starch polysaccharides (judged by the ash content) and α-amylase activity.
L-cysteine (trade name Cisto'Pan - company Beldem Food Ingredients). The preparation is presented in the form of white powder with

Table 1. Characteristics of flour used in experiments

Flour code	Moisture (%)	Ash (% dry weight basis)	Wet gluten content (%)	Gluten deformation index (mm)	Glutenic index	Alveogram parameters	Falling Number (sec.)
FN4	13,86	0,95	27,80	9,5	38,43	P = 150 mmH_2O	273
						L = 19 mm	
						P/L = 7,89	
						W = 131×10e^{-4}J	

taste and flavor of sulfur, with a content of L-cysteine - 10% and ash - maximum 1%.

Compressed yeast. In baking tests, compressed baking yeast from Pakmaya (SC Rompak Paşcani LLC) has been used.

Salt (sodium chloride) - having the characteristics in accordance with STAS 1465-72.

2.1. Methods

Determination of flour moisture using drying method (ICC Method No 110/1). The setting of moisture was done by the indirect method, by drying. Analyzed flour was maintained at a certain temperature (classical method - at 105^{o}C for 4 hours; rapid method - at 130± 2^{o}C for one hour) until all the free water evaporates and other secondary effects that alter the chemical components not longer take place.

Determination of flour ash content using the burning method at 900-920^{o}C. Ash is defined (ICC Standard No. 104/1) as the quantity of mineral materials wich remains, after applying the burning methods, as incombustible residue of the analyzed sample. The result is expressed as a percentage by reporting the mass of the residue at the dry matter of the analyzed sample.

Determination of the flour wet gluten content. The method is based on separation of gluten by washing the dough made from flour with a solution of NaCl, concentration of 2%. The result is expressed as a percentage gained by relating the weight of the wet gluten to the weight of meal flour taken into consideration.

Determination of deformation gluten index. The method involves the maintaining of a wet gluten sphere (5g) at a temperature of 30^{o}C, for one hour and the determination of the deformation by measuring two medium horizontally diameters (in mm) - before and after the rest period - and calculating the difference between them.

Glutenic index was calculated according with the method proposed by ICA Bucharest.

Determination of α-amylase activity in flours by the "Falling Number" (ICC Method 106/1, AACC 56-81B). The Falling Number is defined as the time in seconds required to stir and to allow a viscometer stirrer to fall a fixed distance through a hot aqueous flour suspension undergoing liquefaction due to the presence of α-amylase activity. The higher the α-amylase activity level, the faster the stirrer will fall through the suspension.

Alveographic method for determining the rheological properties of dough (ICC Method No.121, AACC 54-30A, ISO No 5530/4). Produced by Chopin, the Alveograph is an instrument that gives valuable information about the rheological properties of dough sample by measuring the pressures attained during the inflation of dough into a bubble. The alveogram characteristics are: P - known as the overpressure, P is the maximum pressure (mmH_2O), measured as the maximum height (h) in mm on the alveogram and multiplied by a factor of 1.1, P value being usually used as an indicator of dough tenacity and resistance to deformation; L - is the average length (mm) of the curve from the point where the dough bubble starts to inflate to the point where the bubble bursts and the pressure drops suddenly, L being commonly used as a measure of dough extensibility; P/L – configuration curve ratio is thought to indicate general gluten performance; W - represents the energy required to inflate the dough bubble until rupture and generally indicates the baking strength of the sample [8, 9].

The baking test. In experiments, baking bread Moulinex machines have been used, which carry out all the process operations - mixing-kneading, re-kneading, fermentation, final proof, baking - in the same room in which operations parameters (temperature, time) are strictly controlled relying on the program, offering the possibility to correctly compare the obtained results. The dough was prepared using the direct method and the recipe (expressed for 100g flour):100g flour, yeast-3g (3%), salt-1,5g (1.5%), water – 60g (60%), L-cysteine - different doses related to flour weight. The quantities of flour used were 300 grams.

Determination of bread volume by the method with the Fornet apparatus. The principle of this method is measuring the volume of rape seeds replaced by the bread using the Fornet apparatus, the results being expressed for 100g product.

Determination of bread porosity - STAS 91-83 method. The method consists in determination of the total volume of pores of a known volume of crumb, knowing its mass and density. To obtain an average of porosity, bread was cross-sectioned, removing the crust and crumb-shaped in three cylinders, from three different areas, which were subjected to measurement method.

Determination of bread elasticity - STAS 91-83 method. The method consists of pressing a piece of crumb cylinder for one minute and measure its return to the original position, after removing the force and after a rest for one minute. To achieve the analysis, crumb cylinders from the porosity test were used.

3. RESULTS AND DISCUSSION

According with the Table 1, the analyzed and tested flour (FN4) is a high extraction flour (ash content is 0,95% reported the dry weight flour), with a normal gluten network (Id=9,5), "good" for bread making (Gluten index - 38,43) and having a normal α-amylase activity.

As shown in Fig. 1, that describes the modifications in the volume of bread obtained from FN4 flour depending on the dosage of added L-cysteine, results that, once with the increase of amino acid dose to a specific value, occurs the corresponding increase in the bread volume. In doughs from high extraction flours, besides gluten, a growing role in the increase of system capacity to retain the fermentation gases to it has the increasing viscosity of the dough. In this case, non-starch polysaccharides (pentosans, mainly arabinoxylans) which exist

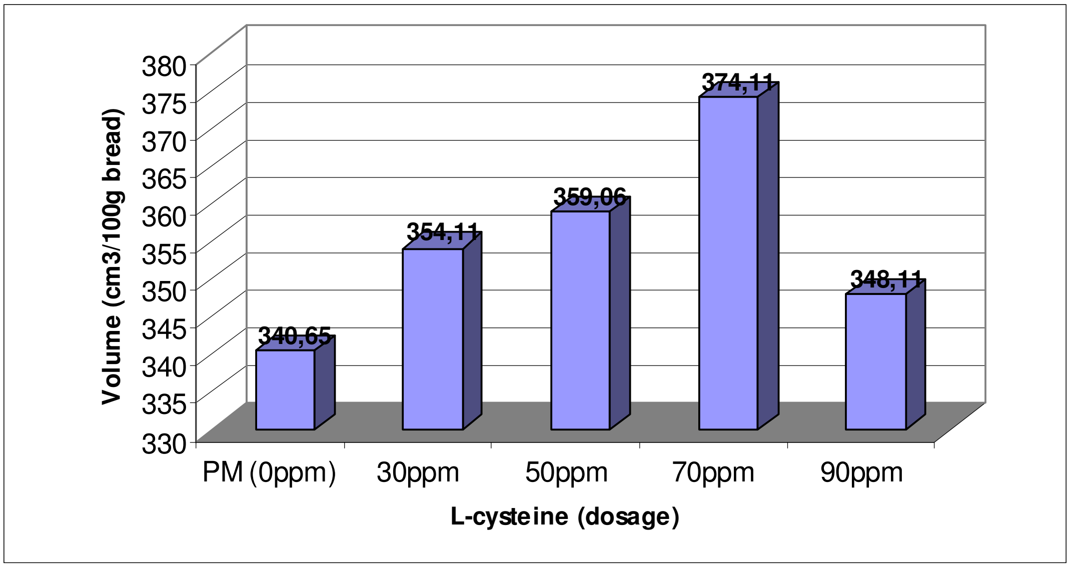

Figure 1. Comparative changes in the volume of bread supplemented with L-cysteine (FN4 flour).

in higher quantities in outer layers of wheat grain have the main role in creating a high viscosity. Pentosan content in wheat flours increases with the extraction rate of the flour due to the contamination with bran and aleurone fragments. Water released by gluten proteins following the cysteine action will be utilized by arabinoxylans to create a high viscosity in the system which will balance the decrease in gluten network resistance and will promote the retention of fermentation gases and increase volume of resulted bread. By further increasing the L-cysteine dose, over the optimal level (for the specific conditions of making the baking test), bread volume declines. This is a result of diminishing the dough ability to retain the fermentation gases.

Fig. 2. demonstrates that the bread porosity reaches higher values when the dough is supplemented with the reducing agent. The maximum value of bread porosity is achieved for the same dose of L-cysteine as in the case of the bread volume. At the same time, it can be observed that the bread crumb elasticity increases when reducing agent is added to the dough, but reaches its maximum value for a lower dose of additive than in the case of bread volume and bread porosity.

Table 2 shows the percentage variation (relative to reference bread) of the three bread physical quality indices depending on the dose of amino acid added to the dough .

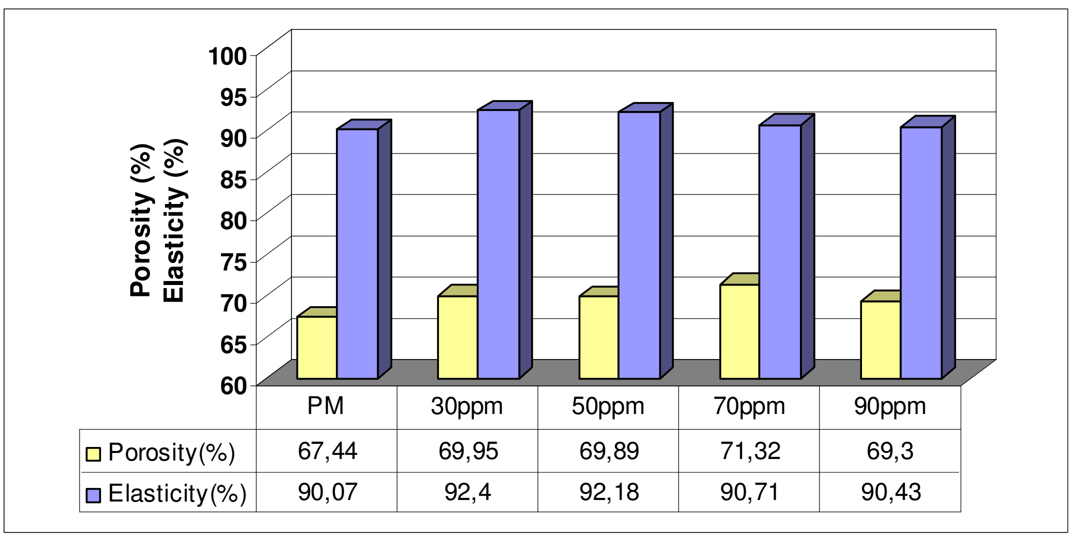

Figure 2. Comparative changes in the porosity and elasticity of bread supplemented with L-cysteine (FN4 flour).

Table 2. The percentual variation of the bread volume, porosity and elasticity depending on the dosage of L-cysteine added.

PERCENTUAL VARIATION OF:	**FN4**	**L-Cysteine**			
	0 ppm (PM)	30 ppm	50 ppm	70 ppm	90 ppm
Volume	0	+3,95	+5,40	**+9,82**	+2,18
Porosity	0	+3,72	+3,63	**+5,75**	+2,75
Elasticity	0	**+2,58**	+2,34	+0,71	+0,39

4. CONCLUSIONS

Although L-cysteine is a suitable additive for strong flours, by supplementing the high extraction flours having normal gluten with this amino acid, physical properties (volume, porosity and elasticity) of resulted bread have improved.

The using of L-cysteine is indicated in technologies that provide short fermentation and processing times, because lead to increases in volume (up to 10%), porosity and elasticity of the products.

The proposed solution can be assimilated into pan bread making technology, considering the fact that all operations of the technological process take place in the bowl of bread machine.

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