EFFECT OF EGG YOLK POWDER ADDITION ON RHEOLOGICAL PARAMETERS OF WHEAT FLOUR DOUGH AND BREAD QUALITY

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Abstract: The addition of 0.1 to 0.5% of egg yolk powder (EYP) in wheat flour (WF) on dough rheological parameters and bread quality were studied. The Alveograph parameters, like extensibility (L) and deformation energy (W) increased significantly with the increased amount of egg yolk powder. The Alveograph dough tenacity (P) and P/L ratio decreased significantly with the addition of egg powder in wheat flour. From the point of view of the dough rheological parameters recorded by Mixolab device at 0.4% egg yolk powder addition we noticed an decrease of the C1 torque and an increase of the Mixolab dough rheological parameters like stability, gelatinization temperature, dough temperature of amylolytic activity and dough's opposed torque at the starch gelling. The bread quality characteristics (porosity, elasticity, loaf volume) were improved by egg yolk powder addition in doses of 0.1-0.4%. For dose of 0.5% addition was noticed a slightly decrease of the values of this parameters. Therefore, the results indicate that the optimum dose for egg yolk powder addition in wheat flour dough is of 0.4%. At this dose were improved the dough rheological parameters of wheat flour and the physical properties of bread, probably due to the higher values of phospholipids from egg yolk powder.

Keywords: wheat flour, egg yolk powder, Alveograph, Mixolab, bread

Introduction

During the centuries, the bakers have added small quantities of some ingredients to improve bread quality characteristics like taste, flavor, color, loaf volume, preservation, e.g. From these ingredients commonly used as additives in the wheat flour dough are the eggs used for their binding capacity, coagulant properties, taste and flavor. Eggs present a composition rich in nutrients with small variations depending on its species. The eggs composition contain water (69%), proteins (11%), carbohydrates (0.8%) and lipids (8.1%) [Herron & Fernandez, 2004]. From egg yolk lipids the main components are neutral lipids (65%) and phospholipids (30%) [Kim, H., 2007] which represent approximately 10% of the wet weight of the egg yolks [Chi, Y., & Lin, S., 2002].

Lipids are essential in bread baking technology because their high content of triglycerides (66%) and phospholipids (28%) which led to significant emulsifiers properties in wheat flour dough. Although there are some reports on the effect of egg yolk addition in wheat flour [Kim, H., 2008] studies regarding its effect on the wheat flour dough rheological behavior and the bread quality are very few.

The aim of this research paper is to present the effect of egg yolk powder addition in wheat flour on dough rheological behavior and bread quality.

Materials and methods

Egg yolk powder was purchased from the Enzyme & Derivates S.A., Costisa Neamt, Romania.

Wheat flour used in the experimental research is flour with a medium quality for bread making, purchased from the local market.

Samples formulations. Egg yolk powder was added in wheat flour at different levels (w/w on wheat flour basis): 0; 0.1; 0.2; 0.3; 0.4 and 0.5%. Single wheat flour was used as control sample.

Chemical analysis. The analytical parameters of the wheat flour were determined according to the approved method of ICC or Romanian standard methods: moisture content (ICC Standard No. 110/1), protein content (ICC Standard No. 202), wet gluten content (ICC Standard No. 106/1), gluten deformation index (SR No. 90), ash content (ICC No 104/1) and Falling Number index (ICC No. 107/1).

Rheological characteristics. The Alveograph parameters: maximum pressure (P), deformation energy (W), extensibility (L), swelling index (G) and Alveograph ratio (P/L) were determined according to SR EN ISO 27971:2008. The rheological parameters of wheat flour dough were determined by Mixolab device (CHOPIN, TRIPETTE and RENAUD) using the standard option „Chopin+" protocol, according to the international standard (ICC-Standard Method No. 173, 2008), for the 0.4% level of egg yolk powder addition, level were the bakery products parameters presented optimal values. The Mixolab parameters curve recorded are: dough stability (ST, min), protein weakening (C2, N·m), starch gelatinization (C3, N·m), amylolytic activity (C4, N·m) and starch gelling (C5, N·m and difference of the points C5-C4). The constant water absorption (57%) was followed for determination of rheological parameters for each sample.

Bread making. The baking test was performed according to the Romanian method (STAS 90:2007) and the protocol used was: 2100g flour, 63g yeast, 31.5g salt, egg yolk powder in different doses (0%- control sample, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%) and water - 1176 ml to 29-30°C. Bread volume was determined after two hours of cooling by means of rape seeds (SR 91:2007). The elasticity and porosity parameters of bread have also been determined according to the methods described by SR 91:2007.

Statistical methods. All determinations were performed at least in triplicate. The values reported are expressed as the average ± standard deviation to a confidence interval of 95%. All data was processed with Microsoft Excel 2003.

Results and Discussion

The analytical parameters of wheat flour used in this study are shown in Table 1.

Table 1. Flour analytical parameters

Parameters	Average value ± standard deviation
Moisture content (%)	13.9 ± 0.02
Protein content (%)	10.72 ± 0.20
Wet gluten content (%)	23.8 ± 0.60
Gluten deformation index (mm)	13 ± 0.80
Ash content (%)	0.64
Falling Number index (s)	255 ± 4.00

Rheological parameters. The average values specific to Alveograph parameters for the control samples in that were gradually added different quantities of egg yolk powder are shown in Table 2.

Table 2. Effect egg yolk powder addition in wheat flour on Alveograph parameters

Parameters	Egg yolk powder addition in wheat flour					
	0	**0.1 %**	**0.2 %**	**0.3 %**	**0.4%**	**0.5%**
Tenacity, P (mm)	67 ± 0.40	65 ± 0.3	63 ± 0.30	62 ± 0.30	61 ± 0.10	61 ± 0.20
Extensibility, L (mm)	81 ± 0.50	82 ± 0.50	88 ± 0.40	90 ± 0.40	91 ± 0.20	93 ± 0.20
Swelling index, G (mm)	20 ± 0.20	20.10 ± 0.10	20.80 ± 0.20	21 ± 0.10	21.10 ± 0.05	17.70 ± 0.10
Deformation energy, W (10^{-4}J)	165 ± 2.00	181 ± 2.00	189 ± 1.00	200 ± 1.00	214 ± 1.00	228 ± 2.00
Alveograph ratio, P/L	0.83	0.79	0.72	0.69	0.67	0.66

[*]Results are expressed as the mean determination followed by the standard deviation.

The results shown that the dough tenacity values (resistance to the dough deformation) decreased with the increase of egg yolk powder addition in wheat flour, whereas an increase trend in the deformation energy and extensibility was observed with the increase level of egg yolk powder addition. The swelling index of the dough ranged from 17.70 to 20 mm while the Alveograph ratio ranged between 0.66 and 0.83. Although wheat flour dough with different doses of egg yolk powder addition has tenacity lower than control sample, these values presented a positive effect on dough rheological behavior by positively changes on the Alveograph ratio P/L and dough strength (by the increase of W deformation energy).

The variations of rheological parameters in wheat flour (WF) dough - control sample and in sample with 0.4% egg yolk powder (EYP) addition in wheat flour on Mixolab parameters are shown in Table 3.

Although wheat flour dough obtained with different egg yolk powder addition indicate lower C1 torque value (by it decrease) compared with the control sample this changes in dough rheological behavior seems to have a positive effect on Mixolab dough stability which significantly increase to 0.4% egg yolk powder addition in wheat flour dough, Figure 1. Regarding the values from the Mixolab first heating stage it can be noticed a slightly decrease of the C2 torque value and an increase of the dough temperature that indicate a delay of the starch gelatinization in the Mixolab first heating stage when egg yolk powder is added probably due to its high lipids content that induce distinct changes on dough pasting rheological behavior.

Table 3. The effect of 0.4% egg yolk powder addition in wheat flour on Mixolab parameters

Parameters	Samples	
	Control	**0.4 % EYP**
Dough stability (min)	5.49 ± 0.47	8.54 ± 0.62
Maximum consistency during stage 1 - C1 (N·m)	1.12 ± 0.06	1.02 ± 0.04
Maximum consistency during stage 2 - C2 (N·m)	0.37 ± 0.03	0.35 ± 0.03
Maximum consistency during stage 3 - C3 (N·m))	1.56 ± 0.06	1.61 ± 0.05
Dough temperature during stage 3 (ºC)	75.9 ± 0.80	82.50 ± 0.50
Minimum consistency during stage 4 - C4 (N·m)	1.11 ± 0.04	0.97 ± 0.03
Dough temperature during stage 4 (ºC)	76.30 ± 0.60	81.70 ± 0.40
Maximum consistency during stage 5 - C5 (N·m)	1.40 ± 0.05	1.56 ± 0.04
Difference of the points C5 and C4 (N·m)	0.29 ± 0.01	0.59 ± 0.01

[*] Results are expressed as the mean determination followed by the standard deviation.

During the baking process, by work input the wheat flour dough dynamic balance changes and by starch gelatinization and gluten proteins denaturation it can be turned into bread. Starch changes its structure by gelling, free glucan chains appear and hydrophobic and hydrophilic surfaces begin to change.


a)   b)
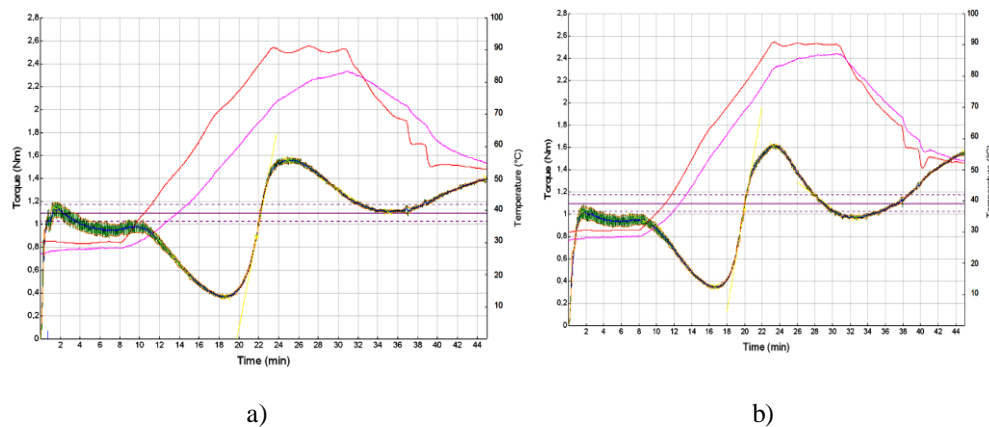
Fig. 1. The Mixolab curves recorded for: a) wheat flour; b) wheat flour with egg yolk powder at the level of 0.4g/100 g addition

Gluten proteins structure irreversible changes by thermal denaturation. In these conditions a translocation of lipids in the product takes place. Polar lipids migrates from the gluten proteins to the wheat flour starch partial gelatinized while nonpolar lipids form complexes with starch amylose and amylopectin slowing its recrystallization after bread baking. By Mixolab, this slowdown which reflect the decrease of bread preservation is shown by an increase of the difference of the points C4 and C5, increase caused by the polar lipids addition.

Regarding the baking tests results, as shown in Figure 2, it was noticed an increase in loaf volume, probably due to the increase of gas retention capacity by the wheat flour dough. Bread porosity and elasticity variations follow a similar trend with a slightly increase with egg yolk powder addition. The increase of porosity values is due to the fact that by dough mixing in the air presence hydrosoluble proteins from egg yolk powder addition turns into thin films due to the viscosity and cohesion forces. Moreover, their fat content ensures the carbon dioxide bubbles integrity (present in the liquid film existing around them), therefore to the pores which will lead to the increase of the wheat flour dough gas retention capacity and bread loaf volume obtained.

As a result of the dough rheological and baking tests values we can conclude that the best results were obtained for the samples with 0.4% egg yolk powder addition.
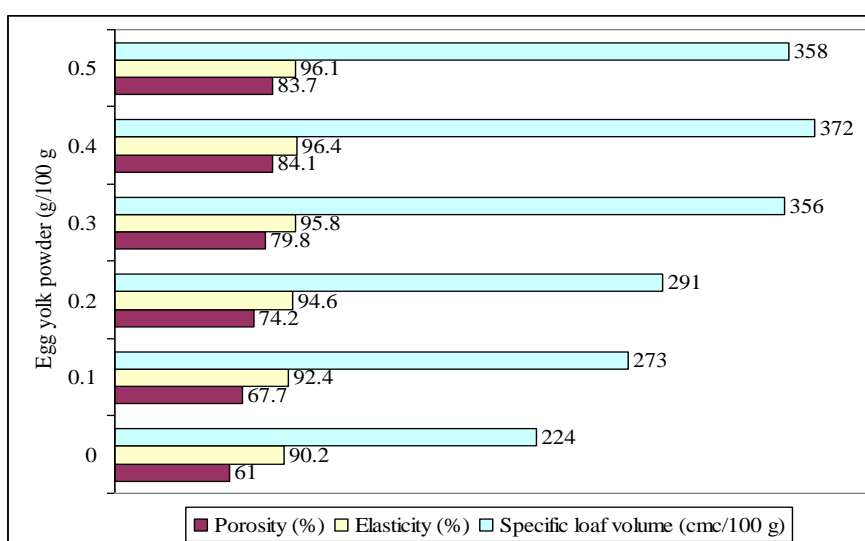
Fig. 2. Loaf volume, porosity and elasticity of bread for different egg yolk powder addition

Conclusions

The positive effect of egg yolk powder addition in wheat flour dough is due to its functional properties: solubility, hydration properties (sorption, water retention capacity, swelling, and viscosity), gelatinization, protein-lipid interactions (emulsifying capacity). From the point of view of the Mixolab parameters curve, egg yolk powder addition causes a decrease of the C1 and C1 toque values and an increase of dough stability. From the point of view of the Alveograph values it was noticed a decrease of the dough tenacity (P) and an increase of the dough extensibility (L) and deformation energy (W).

From the point of view of bakery products obtained, egg yolk powder addition gives them some functional properties which improve quality parameters like loaf volume, porosity and elasticity.

The results obtained shown that the optimum dose of egg yolk powder addition which can be added in wheat flour dough is 0.4%, dose that improve dough rheological parameters and also the bread quality.

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