

THE ASSESSMENT OF RHEOLOGICAL QUALITIES WITH THE MIXOLAB OF DIFFERENT WHEAT FLOURS ENRICHED WITH THEIR BRAN

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Abstract

The increasement range of products with high dietary value of cereals, particularly bread, takes an important place in the contemporary bread making. Bread is basic food in the Balkan region and as such it can be used efficiently to reduce the deficit of some nutrients, especially of dietary fibers.

Precisely wheat bran as a milling by-product is important for the nutritional values, since they contain dietary fibers, minerals, proteins with high nutritional value, etc. Taking in consideration these reasons the addition of wheat bran in bread production will increase the nutritional value of bread, but it will also influence the technological qualities of dough, especially the rheological qualities.

From the obtained results with Mixolab, we can note that the water absorption increases with the increasing addition of wheat bran, as well as the dough stability increases too, but the mixture of wheat Novosadka rana 2 has much better quality than the others. The values of C1 and C2 are increasing with the wheat bran addition, while the values of C3, C4 and C5 are reducing with the addition of wheat bran.

Keywords: Dietary fibers, bread making, Mixolab, dough stability.

Introduction

There are many different recipes developed in order to increase the special bread and confectionery products production in the world nowadays as for instance the dietetic fiber enrichment from different bran types. Wheat bran constitute about 14.5% of the overall grain weight, but contain about 70% dietary fiber of the full wheat grain (Fincher & Stone, 1986). They are a middle-product of the milling wheat in the process of developing it into flour, which is mainly used as animal food.

The rheological properties of dough are important basis in the process of production of quality products (Collar and Armero, 1996; Létang et al., 1999; Rosell et al., 2007; Moreira et al., 2010). During the baking process, flour compounds are subject to mechanical work and heat treatment that promote changes in their rheological properties (Bollain and Collar, 2004). The wheat bran addition in different recipes influences the rheological qualities such as: increases the water absorption; increases the dough development time; reduces the dough elasticity.

One of the latest instruments used to determine the rheological quality of dough is Mixolab. Mixolab allows the characterization of the physicochemical behavior of dough when submitted to dual mixing and temperature constraints. Therefore, it is possible to record the mechanical changes due to mixing and heating simulate the mechanical work as well as the heat conditions that might be expected during the baking process (Rosell et al., 2007).

Therefore, the objectives of this paper attempts to bring the rheological qualities of dough from different wheat's cultivars with their bran in varying ratios measured with new equipment Mixolab Chopin⁺.

Materials and methods

For the actual study wheat cultivars from the Balkan region mostly referred to as: Mila from Croatia, EMS from Hungary, Novosadska rana 2 and Pobeda from Serbia and Orovcanka from Macedonia. All wheat cultivars are from the harvest year 2011, from each cultivar 20 kg of wheat were obtained and the wheat has been conditioned for 18-24 hours in order to reach the optimum moisture for grinding. All the wheat cultivars were milled in laboratory mill where we obtained flours with different radius and bran as in Table 1.

Table 1. Radius of flours from some wheat cultivars from the Balkan region

Wheat cultivars	Radius of flour	Bran (%)
Mila	74.65	23.60
Novosadska rana 2	75.40	23.90
Pobeda	76.10	23.20
Orovčanka	73.67	23.80
Emeshe	76.23	21.34

Obtained bran is sieved in sieve with 800 µm dimensions, stabilized and stored in the freezer until used.

Some chemical analyzes were performed in accordance with the standardized ICC methods (ICC moisture stand. 110/1, ICC ash stand. 104/1, wet gluten ICC stand. 106/2), whereas the determination of protein, fat, starch as well as and cellulose are conducted in accordance with the actual physic chemical methods of analysis for cereals, milling and baking products, pasta and frozen pasta (Official Methods of Analysis of the cereals, December 1988).

Rheological qualities have been analyzed with Mixolab Chopin⁺, according to the manual 2005, where access to this first issue had Haros et.al., 2006, Collar et. al., 2007 and Rosell et.al., 2007. It measures in real time the torque (expresses in Nm) produced by the passage of the dough between the two kneading arms, thus allows the study of rheological and enzymatic parameters: dough rheological characteristics (hydration capacity, development time, etc.), protein reduction, enzymatic activity, gelatinization and gelling of starch.

The procedure followed for the analysis of the mixing and pasting behavior to the mixolab is the following: mixing speed 80rpm, tank temperature 30°C, dough weight 75.0 g, heating rate 2°C/min, total analysis time 45 minute.

Means and standard deviation were calculated using Microsoft Office Exel 2007.

Results and Discussions

The physical and chemical qualities of flours are given in Table 2, from where we can see that all flour of cultivars have optimum moisture. The flour of cultivars Pobeda and Orovcanka have lower contents of ash with 0.56±0.063 % and 0.56±0.094%, while as the flour of cultivar Emeshe has higher contents of ash 0.64±0.075%. The flour of cultivar Orovcanka has higher content of wet gluten with 27.1±0.195%, while as Mila has the lowest with only 23.6±0.134%.

Table 2. Physical and chemical qualities of flours of some wheat cultivars from the Balkan Region

Physical and chemical qualities	Flours				
	<i>Mila</i>	<i>Novosadska rana 2</i>	<i>Pobeda</i>	<i>Orovcanka</i>	<i>Emeshe</i>
Moistures (%)	12.6 ±0.12	12.4±0.11	12.3±0.125	12.4±0.105	13.0±0.097
Ash (%)	0.61±0.085	0.62±0.070	0.56±0.063	0.56±0.094	0.64±0.075
Wet gluten (%)	23.6±0.134	24.8±0.172	24.9±0.165	27.1±0.195	26.9±0.205
Proteins (%)	13.22±0.203	13.84±0.187	13.43±0.192	13.87±0.145	13.76±0.175
Lipids (%)	1.02±0.09	1.03±0.103	1.05±0.161	0.97±0.112	1.09±0.29
Starch (%)	68.38±0.97	67.91±1.14	70.83±1.2	69.18±1.24	68.67±1.35
Cellulose (%)	1.16±0.08	0.94±0.097	0.72±0.102	0.79±0.085	0.85±0.15

Values represent the means; n = 3

The content of proteins for all flours is optimal and it is around 13.0%. Lower content of lipids has the flour of cultivar Orovçanka with $0.97\pm 0.112\%$, while Emeshe has higher content with $1.09\pm 0.29\%$. The content of starch is from $67.91\pm 1.14\%$ for the flour of cultivar Novosadska rana 2 until $70.83\pm 1.2\%$ for the flour of cultivar Pobeda. The content of cellulose is from $0.72\pm 0.102\%$ for the flour of cultivar Pobeda until $1.16\pm 0.08\%$ for Mila.

In Table 3 the physical and chemical qualities of bran for selected wheat cultivars are given, where we can notice that the moisture content of all wheat bran is optimal. The content of minerals is from $4.03\pm 0.078\%$ for bran of cultivar Emeshe until $4.10\pm 0.08\%$ for bran of cultivar Mila. The content of proteins is from $14.24\pm 0.185\%$ for bran of cultivar Novosadska rana 2 until $15.18\pm 0.109\%$ for bran of cultivar Pobeda. The content of lipids is from $4.81\pm 0.125\%$ for bran of cultivar Orovçanka until $5.25\pm 0.165\%$ for bran of cultivar Pobeda. The content of starch is from $49.95\pm 1.5\%$ for bran of cultivar Orovçanka until $52.11\pm 1.20\%$ for bran of cultivar Novosadska rana 2. The cellulose as a major factor of the content of dietary fibers is from $7.02\pm 0.145\%$ for bran of cultivar Orovçanka until $7.54\pm 0.09\%$ for bran of cultivar Mila.

Table 3. Physical and chemical qualities of bran of some wheat cultivars from the Balkan Region

Physical and chemical qualities	Bran				
	<i>Mila</i>	<i>Novosadska rana 2</i>	<i>Pobeda</i>	<i>Orovçanka</i>	<i>Emeshe</i>
Moistures (%)	11.5 ± 0.105	11.7 ± 0.15	11.2 ± 0.12	11.4 ± 0.095	11.5 ± 0.175
Ash (%)	4.10 ± 0.08	4.08 ± 0.065	4.06 ± 0.095	4.05 ± 0.071	4.03 ± 0.078
Proteins (%)	15.03 ± 0.109	14.24 ± 0.185	15.18 ± 0.109	14.79 ± 0.155	15.08 ± 0.16
Lipids (%)	5.04 ± 0.15	4.98 ± 0.115	5.25 ± 0.165	4.81 ± 0.125	4.96 ± 0.35
Starch (%)	50.86 ± 0.90	52.11 ± 1.20	50.23 ± 1.40	49.95 ± 1.5	51.39 ± 1.30
Cellulose (%)	7.54 ± 0.09	7.32 ± 0.103	7.03 ± 0.119	7.02 ± 0.145	7.05 ± 0.165

Values represent the means; n = 3

From the data shown in the table 2 and 3 we can realize that there is a correlation between the content of ash and cellulose in the flours and the bran. So, for example in the wheat cultivar Mila the cellulose in the flour is $1.16\pm 0.08\%$ while in the bran it is $7.54\pm 0.09\%$, in the wheat cultivar Novosadska rana 2 the cellulose in the flour decreases in $0.94\pm 0.097\%$ also in the bran $7.32\pm 0.103\%$, and it continues in the wheat cultivar Pobeda in the flour $0.72\pm 0.102\%$ and in the bran $7.03\pm 0.119\%$, likewise the ash. From these data between the content of the two indicators, so ash and cellulose, into flours and the bran, a regular connection that affects the content of dietary fibers in final products can be noticed.

Wheat bran addition in wheat flours varies the thermo mechanical behavior of dough defined with a Mixolab. Parameters derived from Mixolab curves are represented in Figure 1 and 2.

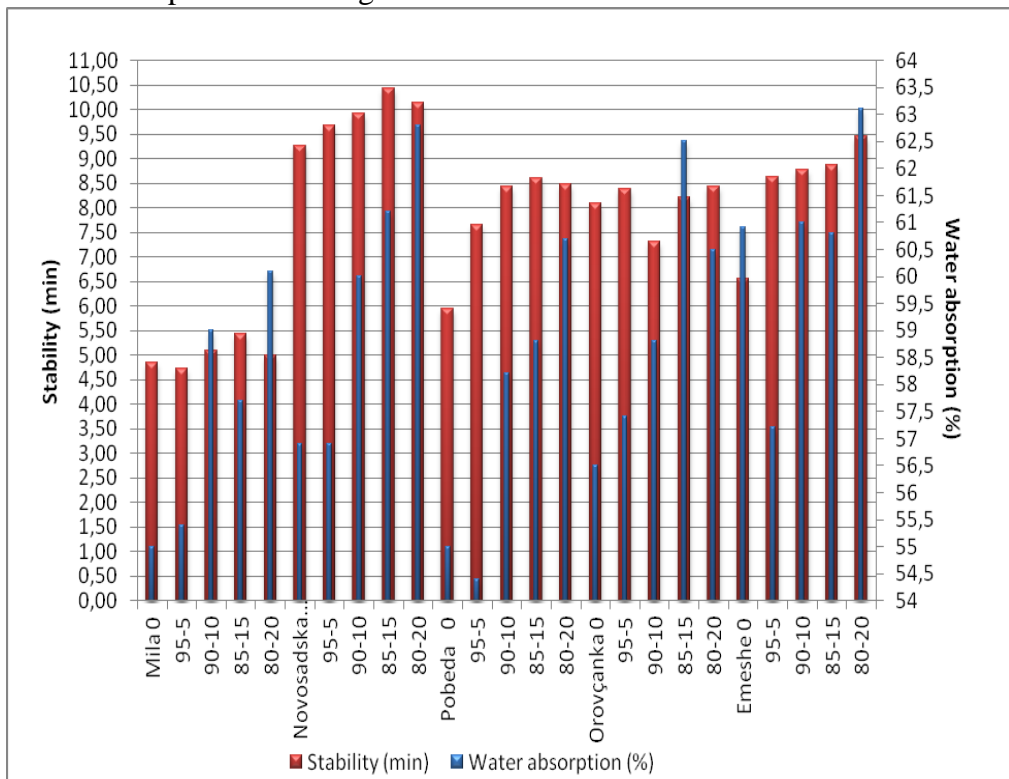


Figure 1. Water absorption and dough stability with the Mixolab in different wheat flours enriched with their bran

Figure 1 shows that generally if the addition of bran is from 5 to 20% the water absorption capacity increases too, but wheat flours Novosadska rana 2 and Emeshe have higher water absorption capacity than the other flours, while as Mila has weaker capacity, the results are in accordance with the results of other researchers that have used different types of fibers, as Gomez et al, 2003.

The dough stability with the wheat bran addition increases; this is so because of the increased interaction of hydrogen connections including hydroxides groups present in molecules. The dough from the wheat cultivar Novosadska rana 2 has much greater stability than all the other dough's for 9.27 minutes and this stability increases to 10.42 minutes with the addition of bran, compared with the dough of the wheat cultivar Mila with the stability of 4.85 minutes that increases until 5.42 minutes with the addition of bran.

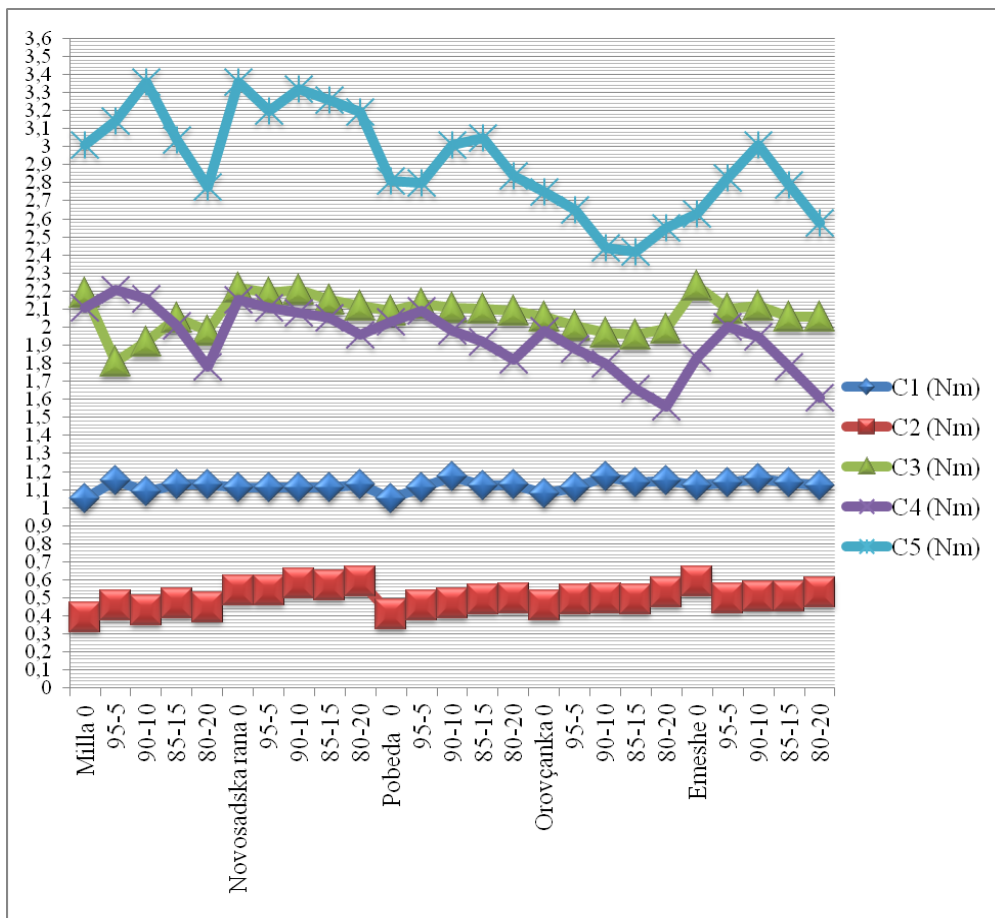


Figure 2. Dough qualities during the mixture and the heating in Mixolab

In figure 2 the qualities of dough during mixture and heating are given. The values of C1 and C2 (the dough development and the stability of proteins) increase with the addition of bran, but the greatest increase is in dough of the cultivar Novosadska rana 2. According to Collar et al. (2007) the degree of milling and the white flour production or whole meal flour is an important factor that affects the rheological qualities of dough. The cooking and the heating stage describe the starch behavior and it is characterized by the gelatinized ability of the starch (C3) and the amylase activity (C4). C3 values in all dough's are reduced with the addition of bran. The C4 dough's values are reduced with the addition of their bran also, since bran is mainly from the grain mantle that contains also large quantity of α -amylases the cause of the reduction of the above mentioned values. These results are in accordance with the results of Banu et al. (2012) who used wheat bran from 3-30%.

The cooling inhibition shows that the ability of the starch retrogradation (C5) decreases with the addition of bran in wheat flour; these data correspond with the results of Rosel et al. 2010 that have enriched flour with different fiber, like fibrulin, fiberx, exafine and swelite, in various reports.

Conclusion

From these data we can conclude that:

- From the chemical content there is a correlation between the ash content and the cellulose in flours and bran, respectively when the ash content is increased the cellulose content is increased too.
- Water absorption is increased with the addition of bran from 5 to 20%, but flours from cultivars Novosadska rana 2 and EMS have higher water absorption than other flours.
- The dough stability increases with the addition of wheat bran, Novosadska rana 2 has higher stability.
- The values of C1 and C2 (dough development and the stability of proteins) increase with the incorporation of bran, while as the values of C3 and C4 decrease with the incorporation of their bran, also the C5 values (retrogradation) decrease with the addition of wheat bran.

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