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THE SIGNIFICANCE OF SOME FLOUR QUALITY PARAMETERS AS QUALITY PREDICTORS OF BREAD

Ciprian–Nicolae POPA[1], Radiana-Maria TAMBA-BEREHOIU[2], Ana_Maria HUȚAN[2], Stela POPESCU[2]

[1] Farinsan S.A. Gradistea, Comana, Giurgiu district, cipnpopa@yahoo.com
[2]University of Agricultural Sciences and Veterinary Medicine, Faculty of Biotechnologies, 59 Marasti, sector 1, 011464, Bucharest, Romania, Phone: +40 21 318 25 64/232, Fax: + 40 21318 28 88, E-mail: radianatamba@yahoo.com, popescu0507@yahoo.com

Corresponding author's email: cipnpopa@yahoo.com

Abstract

The purpose of the present research has been the highlighting of the correlation between the protein content, the wet gluten content and the gluten index of flours, and some characteristics of bread, such as volume and the ratio height / diameter (H / D). In this respect, were analysed 19 samples of flour obtained from Romanian wheat, determining the protein content, wet gluten content and gluten index. At the same time were carried out baking tests corresponding to the 19 loaves of bread and were determined the parameters volume and the height / diameter ratio (H /D).
*The results showed that the best predictor for the bread quality parameters: volume and H / D ratio, is the gluten fraction of the gluten index parameter which remains on the sieve (highly significant positive correlation r = 0.79***, respectively r = 0.73***). Gluten index parameter correlates insignificantly with bread volume (r = 0.18) and significantly with the height / diameter ratio (0.51*). In conclusion, the parameter Gluten index itself, is not relevant for the baking qualities of flour; these quality parameters could be better predicted by remaining fraction of gluten on the sieve.*

***Keywords**: bread volume, gluten index, wheat flour.*

1. INTRODUCTION

The correlation of the analysis methods of flours quality with their technological performance has always represented a major interest for the experts in the field. The technological performance of flours depends on complex factors which are only partially revealed by the usual assessment tests for the flours quality. These factors are consisting of both physical and chemical parameters, such as protein content, ash content, wet gluten content, gluten index etc., as well as a range of parameters concerning the flours behavior in gel or dough stage, namely: falling number, amylografic viscosity, extensibility, resistance, strain energy, elasticity, development time, stability, softening, etc. [3, 5, 7, 10, 12, 14, 18, 19].
Besides this factors also the variability of the analysis methods by which these factors are determined, which can be very high, has to be considered.

The mixer, farinograph, extrudograph, mixograph, valorigraph, rheograph, give us indications about dough behavior during mixing.
The extensograph, alveograph, extensometer and glutograph give indications about dough behavior to stretch.
The fermentograph, the maturograph, the microclimate room, the zimotachigraph, the rheofermentometer, give indications about the behavior of dough during fermentation.
The amylograph, the viscograph, the rheotron, the consistometer, the penetrometer, the viscometer, give indications of penetration, viscosity and so on [13].
Several studies showed that the best predictor for bread volume is the protein content of wheat or flour [1, 4, 11].
R. Koppel and A. Ingver (2004) demonstrated interesting correlations for the flour processed from the Estonian wheat cultivated in the 1999 – 2003 period. Specifically, the researches focused in this case, on the linkages between physical and chemical parameters,

extensographic and farinographic parameters and the volume of the bread [8].

Gaines et al. (2006) tested 33 wheat samples of some varieties cultivated in the United States. Three of the parameters taken into consideration were proven to be superior with respect to predictability of technological characteristics: the alveographic mechanical work (W), the height of the mixographic peak and the capacity of retention of the solvents (Solvent Retention Capacity, AACC Method 56 – 11), against the gluten index ant the sedimentation indices (SDS)[6].

Similar investigations have been made by *Bettge et al.* (1989), *Kostyukovsky and Zohar* (2004), *Rashed et al.* (2007) [2, 9,15].

Różyło and Laskowski (2011) showed that the best predictors of bread quality on the volume and core are combinations of alveographic, physical and chemical parameters, namely: Zeleny sedimentation index , falling number, and alveographic work (W) or protein content, the falling number and alveographic extensibility [16] .

Sapirstein and Suchi (1999) obtained some results showing that the height of flour gel, obtained after centrifugation, in certain conditions of the flours dispersed in sodiumdodecilsulphate (SDS), correlates very strongly with bread volume (r^2 between 0.89 and 0.95) [17].

The purpose of the present research was to highlight the level of correlation between various parameters of flours (protein content, wet gluten content, gluten index) and some qualitative characteristics of bread, such as volume and the ratio height / diameter (H/D).

MATERIALS AND METHODS

We analyzed 19 samples of flour from the Romanian wheat harvest of the year 2012. We determined the following quality parameters: protein content (ICC 159-95 - NIR method, Perten Inframatic 8600), wet gluten content (ISO 21415-2:2007) and gluten index (SR ISO 21415-2:2007) [20,21].

Starting from the values of the parameter gluten index and wet gluten of the flour samples, we also calculated a different parameter. This refers to the fraction of wet gluten remained on the sieve (GRS), after centrifugation, shown in the standard for determining gluten index. Mathematically speaking, the amount of gluten fraction was calculated using the formula: GRS = (WG * GI) / 100.

For each of the 19 flour samples we carried out baking tests, in accordance with the prescription and technological parameters described in Table 1.

Table 1. Technological parameters and the recipe for baking samples

Specification	Value
Wheat flour	1 kg
Salt	13 g
Yeast	23 g
Water	Variable, depending on the technological requirements of flour: 550 – 607 ml
Slow kneading time	3 min
Intensive kneading time	Variable, approx. 5 – 8 min, depending on the technological requirements of flour
Bench proofing time (at room temperature)	Variable, approx. 20 – 25 min, depending on the technological requirements of flour
Proofing time (35^0C, 78 % humidity)	Variable, approx. 43 – 54 min, depending on the technological requirements of flour
Baking	220^0C, for 20 min

The dough was divided into portions of 350g each, in order to allow obtaining of a final product with the weight of 300g.

The equipment we used for making the baking samples included an intensive mixer with spiral and having the tank capacity of 30 kg, a dough moulder (for long format), a baking proofer with controlled temperature and humidity and an electric baking oven.

For each of the 19 samples we selected two loaves for which we measured, at 2 hours after baking, the following quality parameters:

- Volume (V, cm^3/100g) according to SR 91:2007, using a Fornet apparatus [22];
- Height/Diameter ratio (h/d). Bread height and diameter was measured by a calliper and the shape (height/diameter) was calculated.

The values used in the study represent the arithmetical average of the determinations carried out for the two loaves of bread, selected at each baking sample.

RESULTS AND DISCUSSIONS

The results obtained by determining the quality parameters of flours and corresponding samples of bread are shown in Table 2.

Table 2. Estimates of the quality parameters variability of flours and bread

Specifications	X ± s_x	Range of variation		CV (%)
		Min.	Max.	
Protein content (P %)	13.42 ± 1.17	11.79	16.50	8.74
Wet gluten (WG, %)	33.37 ± 6.48	19.73	43.40	19.43
Gluten index (GI)	83.81 ± 13.34	56	99	15.92
Bread volume (V, cm^3/100 g)	441.48 ± 73.54	290	573	16.66
Height/Diameter ratio (h/d)	0.71 ± 0.06	0.65	0.88	8.41
Gluten remaned on the sieve (GRS, %)	27.62 ± 5.59	18.95	39.25	20.26

From Table 2 we can see that the analyzed flour samples were characterized by average values of quality parameters, excellent for the bread production process (more than 13.0% protein content, wet gluten content more than 30.0% and gluten index over 80).

Regarding the gluten quality, it may be described as being tough, with very good qualities for the baking process.

Except for protein content, which showed relatively low variability (CV = 8.74%), all other quality parameters of flours had relatively high coefficients of variation.

Note that the analyzed flours have a very wide range of quality parameters, from flours with low wet gluten content (19.73%), to flours with high wet gluten content (43.40%), from flours with gluten of extremely poor quality (GI = 56), to flours with very strong gluten (GI = 99).

In terms of volume, the obtained bread showed high variability (CV = 16.656%), similar to the variability of quality parameters of the flours from which were derived (gluten index and wet gluten content).

Thus, we obtained improperly bread volume (290 cm^3/100 g), but also excellent bread volume ((573 cm^3/100 g).

The average volume of bread (441.484 cm^3/100 g), obtained from the 19 flour samples, do not reflect properly the average values of the quality parameters of these flours.

This is probably due to a big variability of these quality parameters.

Ratio h/d of bread was characterized by a rather small variability, similar to that observed for the protein content in the 19 analyzed flours.

The average value of the ratio h/d for the 19 obtained loaves of bread discloses a bread product with a curved profile, rather typical for strong gluten flour (see Figure 1).

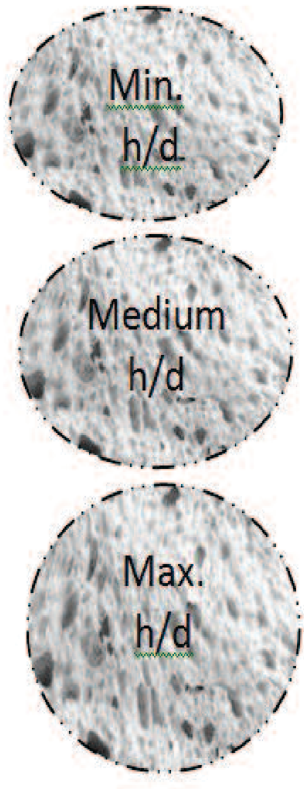

Figure 1. The bread loaves profile obtained from the 19 flours tested

Table 3 highlights the correlation between the technological parameters of flours and the quality parameters of obtained bread.

Table 3. Correlations between the technological parameters of flours and quality parameters of bread

Variable	P	WG	GI	V	h/d	C
P	1.00					
WG	0.51*	1.00				
GI	0.23	-0.43	1.00			
V	0.35	0.62**	0.18	1.00		
h/d	0.65**	0.27	0.51*	0.55**	1.00	
GRS	0.66**	0.66**	0.39	0.79***	0.73***	1

*p<0.05; **p<0.01; ***p<0.001

In table 3 we can notice that the volume of bread for the analyzed samples increased distinct significantly with increasing the wet gluten content of flour (r = 0.62**).

The protein content of the analyzed flours was not significantly correlated with bread volume, although this correlation is frequently described in the literature.

Apparently, the quality of gluten flours, as explained by the gluten index parameter, did not affect significantly the value of bread volume (r = 0.18 ns).

However, the fraction of gluten that remains on the sieve (GRS), which represents the percentage of the amount of strong gluten in flours, was the best predictor for the value of bread volume (r = 0.79***). Basically, this gluten fraction described in a proportion of 62.4% (r^2 = 0,624) the volume variability in analyzed bread samples.

The result suggests that the use of this fraction in assessing the quality of the flours, used to obtain bread, can be more useful than the value of the gluten index parameter itself.

The regression line and the corresponding regression equation are shown in Figure 2.

The amount of wet gluten remained on the sieve was also the best predictor for the height/diameter ratio of bread. This ratio has increased very significantly as the amount of gluten remained on the sieve was higher (r = 0.73***).

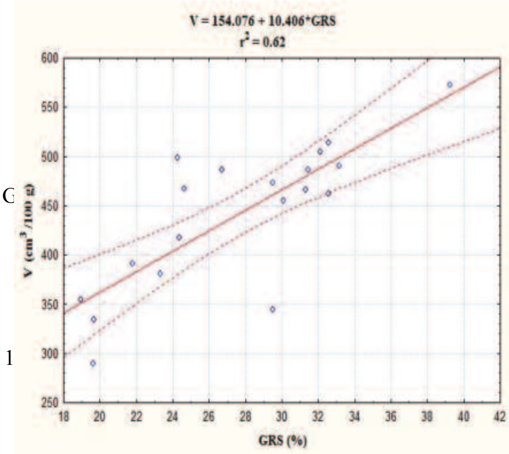

Figure 2. Regression of the bread volume and the amount of gluten remained on the sieve

Over 50% of the variation of the ratio h/d for the analyzed bread loaves is explained by the variation of the quantity of gluten remained on the sieve (r^2 = 0.53, Figure 3).

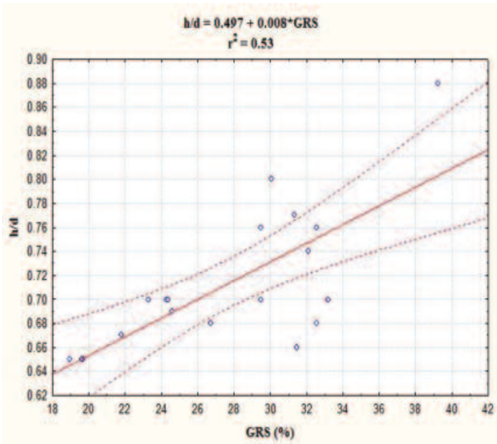

Figure 3. Regression of the h / d ratio and the amount of gluten remained on the sieve

The ratio between height and diameter at most of the 19 loaves increased distinct significantly as flour protein content increased (r = 0.66**). Also, the ratio h/d increased significantly as the value of the gluten index parameter was higher (r = 0.51*). These data suggest that the ratio h/d is strongly dependent on the tenacity of gluten, being higher as the more gluten is stronger.

Between the two quality parameters of bread, volume and h/d ratio, there have been noticed a distinct significant positive correlation, so that bread loaves with a higher h/d ratio had a larger volume (0.55**).

We believe that our results can be a starting point to conduct more extensive researches that take into account the evaluation of the gluten index parameter of flours as predictor of bread quality.

CONCLUSIONS

1. Our results showed that the best predictor of bread quality is not the gluten index parameter as such, but the amount of wet gluten remaining on the sieve (GRS) during the determination of this parameter. GRS correlated very significantly with both the volume of bread loaf (r = 0.79***) and the h/d ratio (r = 0.73 ***);
2. The gluten index parameter correlated insignificantly with the bread volume (r = 0.18 ns), but wet gluten content flours distinct correlated significantly (r = 0.62**) with bread volume;
3. The protein content of flours was not significantly correlated with bread volume (r = 0.35 ns);
4. The h/d ratio increased distinct significantly as the protein content of flours was higher (r = 0.66**) and significantly as the value of the gluten index parameter was higher. These data suggest that the ratio h/d is strongly dependent on the tenacity of gluten, being higher as the gluten is stronger.

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