EVALUATION OF FARINOGRAPH AND MIXOLAB FOR PREDICTION OF MIXING PROPERTIES OF INDUSTRIAL WHEAT FLOUR

— original paper —

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Abstract: Rheological properties of dough during mixing are very important in wheat flour processing. The evaluation of the farinograph and mixolab was performed by correlating the dough mixing parameters, (water absorption, dough development time and stability), of the flours obtained by grinding wheat on two laboratory mills (Quadromat Jr. and Chopin CD1) with industrial flours, and establish which of two instruments is more reliable to give information about mixing properties. Liniar correlation factors R^2 for the mixing parameters of flours provided by Quadromat Jr. were higher for farinograph and also for the flours provided by Chopin CD1 except for the dough development time for which the liniar correlation factor R^2 had a higher value for mixolab.

Keywords: wheat flour, mixing, rheology, farinograph, mixolab

INTRODUCTION

The rheological changes, which occur in gluten structure during mixing, greatly determine the final product quality (Dobraszczyk and Morgenstern, 2003). During this operation, hydration of flour particles and formation a gluten network from gliadin and glutenin with viscoelastic structure and specific properties occur. One of the most popular instruments used to evaluate the rheological properties of the dough is the Farinograph who gives information regarding the modifications that appear in the rheological properties of the dough during the kneading process allows the evaluation of the critical factors that influence these properties, such as flour quality and strength (Codina, 2010). The evaluation and interpretation of the Farinograph was reported by several researchers like (D'Appolonia, 1984; Mani, 1992). Mixolab is used to characterize the mechanical changes due to mixing and

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heating simulating the mechanical work as well as the thermal conditions that might be expected during the baking process (Rosell et al. 2006). Stage one (dough development) corresponds to the farinograph curve which determines the development time, stability and water absorption of the flour. The characteristics of a flour, such as how much water it absorbs to achieve optimum dough consistency, dough development time and dough stability, have been shown, by experience, to be good predictors of baking quality (Preston K.R. and Kilborn R.H.) So, this are important measures of flour's quality, both the bakers and millers. For this reason they want to evaluate this characteristics of wheat flour before purchase. For this purpose, ten samples of wheat were milled and the mixing properties of industrial flours determined with farinograph and mixolab were correlated with those derived by laboratory mills.

MATERIALS AND METHODS

White flour was obtained from 10 samples of common wheat from 2011 crop. The wheat samples of wheat were milled in an industrial roller mill with a capacity of 120t/24h, to an extraction rate of 79%, white flour (0.55% ash content) and black flour (1.25% ash content). Chemical characteristics of wheat samples (Table 1.) indicated a wide variation in the quality characteristics.

Table 1. Chemical characteristics of wheat samples

Parameters	1	2	3	4	5	6	7	8	9	10
Umidity, %	11.8	12	10.9	11.5	11.3	11.5	11.3	12	12	13.2
Ash, % s.u.	1.6	1.6	1.24	1.57	1.55	1.58	1.71	1.59	1.38	1.47
Wet gluten, %	21.7	21.9	28.4	23.2	20.1	24.1	18.9	24	25	21
Gluten index,%	83.6	90.7	86.8	81	88.5	69.6	75	60.8	79.4	90.6
Falling number, sec	370	218	476	370	149	394	297	390	414	272

The industrial roller mill consisted on five break rolls (B_{1-2}, B_3, B_{4g}, B_{4f} and B_{5f}), eleven reduction rolls (C_{1a}, C_{1b}, C_{2-3}, C_4, ...,C_{10}), one break reduced (Div), four bran finisher and one control sifter. The obtained wheat mill streams consisted of 4 break flours (B_{1-2}, B_3, B_4 and B_5), 14 reduction flour fraction (C_{1a}-1, C_{1a}-2, C_{1b}, C_{2-3}-1, C_{2-3}-2, C_4, C_5-1, C_5-2, C_7-1, C_7-2, C_9-1, C_9-2, C_{10}-1, C_{10}-2) 1 break reduced fraction (Div). For white flour (0.55% ash content) the mill streams were (B_3, B_5, Div, C_{1a}-1, C_{1a}-2, C_{1b}, C_{2-3}-1, C_5-1, C_{10}-1). The flours were sampled according to the standard SR EN ISO

24333:2010. The flour for laboratory tests was obtained by grinding wheat in two laboratory mills (Quadromat Jr. and Chopin CD1 test mill), according to the standard SR EN ISO 27971: 2009. List of methods and equipments used for qualifying wheat and flour samples is shown in Table 2. The rheological mixing characteristics were tested with the Chopin Mixolab using the standard ‘‘Chopin+’’ protocol and with Brabender Farinograph using ICC evaluation method.

Table 2. List of appropriate tests, methods and equipments

Quality parameter	Method	Equipment
Moisture, %	SR ISO 712:2010	Moisture Oven
Wet gluten , %	SR ISO 21415-1:2007	Manual
Falling number, sec	SR ISO 3093:2007	Falling Number
Gluten index, %	AACC Method 38-12	Glutomatic
Ash content, % s.u.	SR ISO 2171:2007	Ash Oven
Water absorption-14,0%, %	SR ISO 5530-1/2007	Farinograpf
Dough development time, min	SR ISO 5530-1/2007	Farinograpf
Stability, min	SR SO 5530-1/2007	Farinograpf
Water absorption- 14,0%, %	AACC Method 54-60.01	Mixolab
Dough Development time , min	AACC Method 54-60.01	Mixolab
Stability, min	AACC Method 54-60.01	Mixolab

RESULTS AND DISCUSSIONS

The mixing characteristics of the flours obtained with Farinograph and Mixolab are presented in Table 3.

Table 3. Mixing parameters of the flours

Device	Parameter	Industrial flour		Quadromat Jr. flour		Chopin CD1 flour	
		Min	Max	Min	Max	Min	Max
Farinograph	Water absorption-14,0%,	52.3	58.7	55.7	64.1	51.5	59.8
	Development time, min	1.3	3.5	1.5	5	1.5	3.8
	Stability, min	2.2	13.6	2	7.5	2.5	9.2
Mixolab	Water absorption- 14,0%, %	51.3	57	54.2	62.5	50.9	58.9
	Development time , min	1.32	4.43	1.05	4.42	1.32	3.75
	Stability, min	5.67	10.98	1.27	8.87	4.98	10.35

Water absorption: represents the quantity of water required to obtain 500-U.F±20 for farinograph and for mixolab the quantity of water required to obtain C_1=1.1Nm±0.05. Water-absorption gives an indication of the potential of the protein molecules to absorb the added water, and therefore is an indicator of baking quality (Van Lill et al., 1995). The major factors that contributing to farinograph and also the mixolab absorption include protein content, starch, damaged starch, pentosans and gluten strength. However, protein content and damage starch are the main factors that influence the water absorption capacity of the wheat flours (Farrand 1969).
The variation of the water absorption capacity values of the flours tested with the two devices is presented in Figure 1.

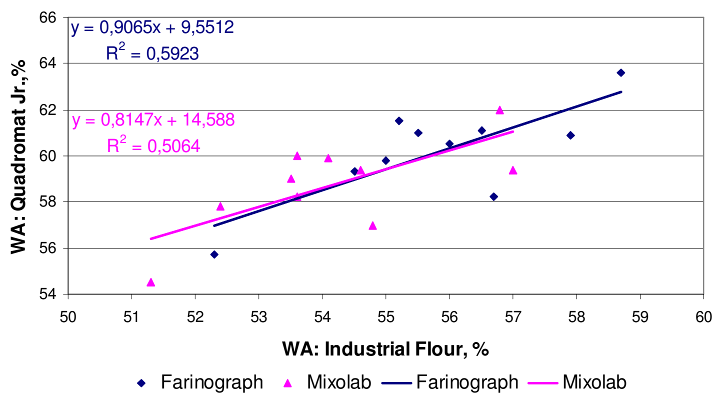

Figure 1. Variation of the water absorption (WA), of the flours obtained by Quadromat jr. according to the WA of industrial flours for farinograph (r-0.77) and for mixolab (r-0.71)

From the graphical representation of values it was concluded that for flours obtained with Quadromat Jr., and tested with farinograph the correlation R^2=0,5923 was higher than that obtained from mixolab R^2=0,5064.
For the flours provided by Chopin CD1 and corelated with industrial flours (Figure 2.) we obtained more better correlation than those provided by Quadromat Jr. and also higher for farinograph R^2=0.7314 than that for mixolab R^2= 0.6303.
The correlations obtained for water absorption capacity were higher for farinograph than those for mixolab for both laboratory milling devices.
From the graphical representation of values it was concluded that for flours obtained with Quadromat Jr., and tested with farinograph the correlation R^2=0,5923 was higher than that obtained from mixolab R^2=0,5064.

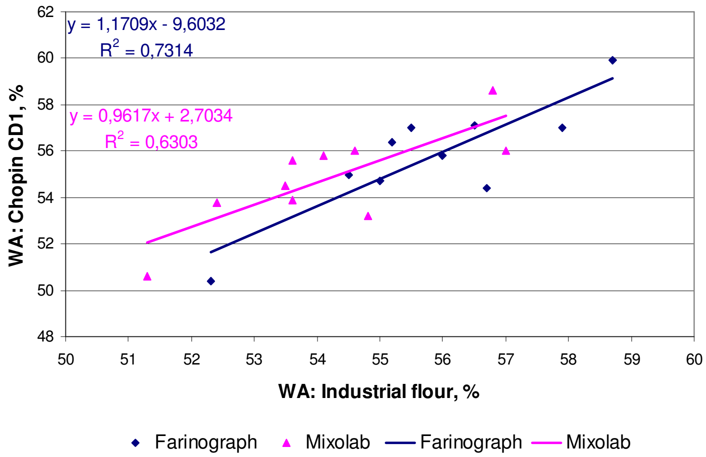

Figure 2. Variation of the water absorption (WA), of the flours obtained by Chopin CD1 according to the WA of industrial flours for farinograph (r-0.86) and for mixolab (r-0.79)

For the flours provided by Chopin CD1 and corelated with industrial flours (Figure 2.) we obtained more better correlation than those provided by Quadromat Jr. and also higher for farinograph R^2=0.7314 than that for mixolab R^2= 0.6303. The correlations obtained for water absorption capacity were higher for farinograph than those for mixolab for both laboratory milling devices.

Dough development time: is an important factor because it reflects the time between the first addition of water and the time when the dough seems to have optimum elastic and viscous properties for the retention of gas. Dough development time depends on the water absorption speed of flour constituents to form a smooth and homogenous appeareance.

The comparison of the dough development time values of the flours tested with the two devices is presented in Figure 3. For the flours milled with Quadromat Jr. , the correlation R^2=0.7261 was higher for farinograph compared to the correlation R^2=0.5472 obtained for mixolab.

Unlike the correlation obtained for flours milled with Quadromat Jr., for flours provided by Chopin CD1 (Figure 4.), the correlation R^2=0.52 for the flours tested with mixolab was higher than the correlation R^2=0.3645 obtained for farinograph.

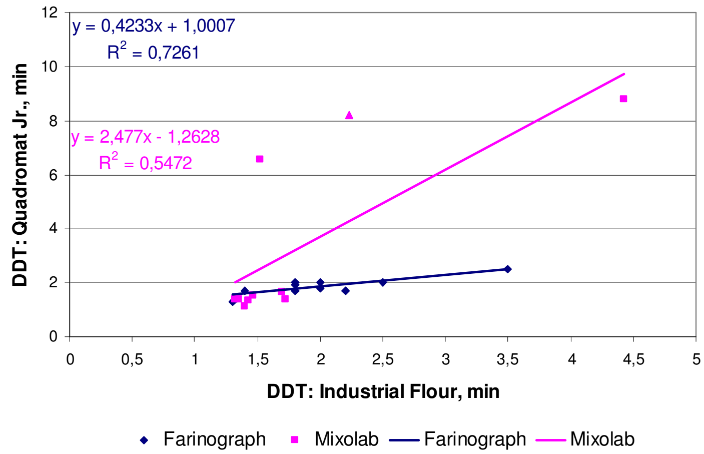

Figure 3. Variation of the time development time (DDT), of the flours obtained by Quadromat Jr. according to the DDT of industrial flours for farinograph (r-0.85) and for mixolab (r-0.74)

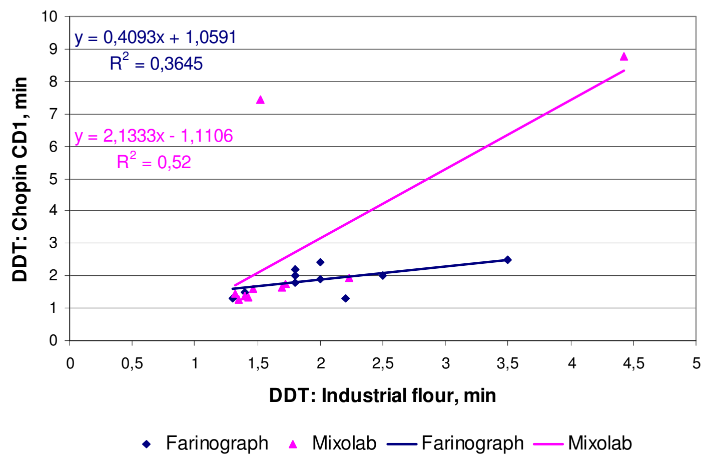

Figure 4. Variation of the time development time (DDT), of the flours obtained by Chopin CD1 according to the DDT of industrial flours for farinograph (r-0.6) and for mixolab (r-0.72)

Stability: represents the time during which the maximum dough consistency does not change or changes very little. Stability is an indication of the flour's tolerance to mixing and stronger flours tend to be more stable (Miralbés, 2004).The correlation obtained for flours milled with Quadromat Jr. (Figure 5.) was higher for Farinograph R^2=0.6897 than that obtained for mixolab R^2=0.5472. Same tendency we obtain for flours milled with Chopin CD1

(Figure 6.). For farinograph the correlation R^2= 0.6315 was higher than that obtained for mixolab device R^2=0.5472.

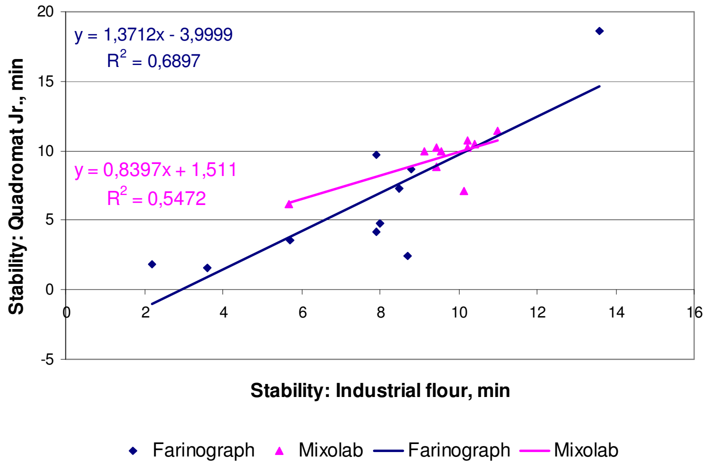

Figure 5. Variation of stability of the flours obtained by Quadromat Jr. according to the stability of industrial flours for farinograph (r-0.83) and for mixolab (r-0.74)

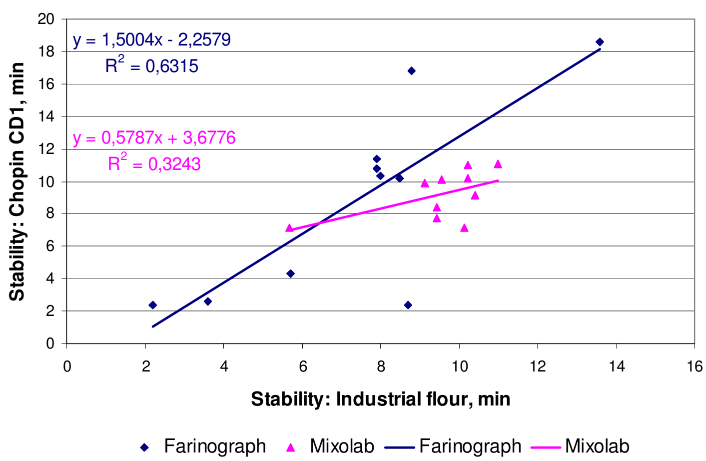

Figure 6. Variation of stability of the flours obtained by Chopin CD1 according to the stability of industrial flours for farinograph (r-0.79) and for mixolab (r-0.57)

CONCLUSIONS

In this study we evaluated the mixing properties determined with farinograph and with mixolab ($Chopin^+$ protocol) through the correlations of the wheat flours parameters provided by laboratory mills (Quadromat Jr. and Chopin

CD1) with industrial flours. For the flours milled in laboratory mill Quadromat Jr. the correlations of the mixing parameters with industrial flour were higher for farinograph than that for mixolab. Same results we obtained for the flours milled with Chopin CD1, except for the dough development time which had a higher correlation for mixolab.
Taking into account of the results obtained we may conclude that farinograph is a better predictor of mixing properties than mixolab.

ACKNOWLEDGEMENTS
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