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EVALUATION OF WHEAT FLOUR CHARACTERISTICS BY THE ALVEO-CONSISTOGRAPH

Marie Hruškova[1]*, Oldřich Faměra[2]

[1]*Institute of Chemical Technology, Prague, Czech Republic;*
[2]*Czech Agricultural University, Prague, Czech Republic*

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For assessing the alveo-consistograph (Chopin, France) use at the evaluation of wheat flour quality at industrial mills, eighty samples of fine flour from commercial wheat (harvest year 2001) were tested. Parallel to this measurement, the evaluation of dough properties was performed by means of the promylograph TS, the promylograph TS6 (both Egger, Austria) and the alveograph (Chopin, France). Relations between corresponding parameters were described by correlation analysis.

Water absorption evaluated at the alveo-consistograph (at both constant and adapted hydration) was found lower than at promylograph TS6. In regime at adapted hydration higher extensibility of dough was proved, P/L parameter dropped from 0.92 to 0.73. The results showed that the dough rheological characteristics depended on flour quality and the differences due to measure at alveo-consistograph and promylograps were important despite their correlation.

INTRODUCTION

Flour quality can be expressed by a variety of chemical and physical properties of dough, none of which serves as adequate by itself or is independent of others variables [Pyler, 1988]. According to Finney [1978] "a flour of good quality for bread-making should have high water absorption, a medium to medium-long mixing requirement, satisfactory mixing tolerance, and bread volume potential (considering protein content), and should yield a loaf with good internal grain and color". Tipples *et al*. [1982] identified the "ideal" bread flour as one that produces good bread over a wide range of processing conditions and yields dough with well-balanced handling properties.

The bread-making process can be divided into three stages: mixing, fermentation, and baking. The rheological properties of dough in these operations form a link between the composition and structure of its raw materials and functionality of the dough in the bakery. The chemical composition of flour, as a main dough recipe component, has a large influence on technological behaviour of dough, which can be predicted by many rheological instruments [Shuey, 1975; Walker & Hazelton, 1996].

The Chopin alveo-consistograph (France) can be described as a modern rheological equipment for the evaluation of wheat flour behaviour at a dough preparation with constant or adapted hydration levels and during its three-dimensional extension. Consequently, its function connects a farinograph and an alveograph measurement, the result of which (at adapted hydration) can be comparable with an extensigraph test.

The alveo-consistograph consists of three integrated parts: (i) the Consistograph mixer with a pressure sensor mounted in the mixing bowl wall, a double arm mixing blade and a fixed rod preventing balling of the dough, (ii) the Alveoling NC-recorder – a calculator and a printer used to record both mixing curve and alveogram in real time, (iii) the Alveograph for three-dimensional deformation of dough samples (flour + water + salt) under the effect of air pressure.

The objective of this short report was to determine the properties of various commercial flours by the Chopin alveo-consistograph and to compare their results with those performed at the Egger promylograph TS and TS6.

MATERIALS AND METHODS

Materials. Eighty samples of wheat fine flour (from wheat harvest of year 2001) produced at the industrial mill were evaluated by analytical characteristics, by means of the Chopin alveo-consistograph (France), the Egger promylograph TS and the Egger promylograph TS6 (both Austria).

Quality of wheat flour. Wheat flour quality is described by ash, wet gluten and protein content (measured at Inframatic 8620, Perten Sweden), Falling Number (according to ISO 3093) and Zeleny sedimentation value (according to ISO 5529).

Quality of dough. Dough behaviour during the mixing is measured at the Chopin alveo-consistograph at constant and adapted hydration regime according to ICC 171 and at the Egger promylograph TS, which is a recording mixer designed for determination of flour quality in relation to mixing, working similarly to Brabender farinograph. Both mixers function by measuring the resistance of dough against sigmoid-shaped paddles turning at a

*Author's address for correspondence: Marie Hruškova, Institute of Chemical Technology, Technicka 5, 166 28 Prague 6, Czech Republic; tel.: (420) 224 353 206; fax: (420) 233 339 990; e-mail: Marie.Hruskova@vscht.cz

differential speed (at farinograph 93 and 62 rpm, at promylograph TS 86 and 53 rpm). The paddles subject a flour-water dough to a prolonged, relatively gentle, kneading action, while it is held at a constant temperature. Mixing bowl is tempered by water (farinograph) or by air (promylograph TS). Flour sample at promylograph TS weighs only 100 g. From mixing curve measured at both apparatuses the same characteristics were obtained.

Viscoelastic behaviour of dough is tested at the Chopin alveo-consistograph at constant and adapted consistency according to ICC 171 and at the Egger promylograf TS6 worked at similar condition as Brabender extensigraph. The alveograph is designed to measure the resistence to three-axial extension of a thin sheet of flour-water-salt dough, generally at a constant hydration level. The extensigraph and promylograph TS6 also measure dough extensibility and resistance to extension, but piece of flour-water-salt dough is molded into a cylinder and a hook stretches it biaxial to rupture. Measurement at both apparatuses was slightly different (at dough weight and recommended resting time).

The results from Egger instruments were evaluated according to ISO 5530-1 (farinograph) and 5530-2 (extensigraph).

RESULTS AND DISCUSSION

The expression of the results

The proximate chemical composition, Zeleny value and Falling Number of wheat flour, the results of alveo-consistograph, promylograph TS and promylograph TS6 are presented by average value, minimum and maximum value of tested set of samples. The relation between alveo-consistograph and promylograph characteristics are expressed by means of the correlation analysis.

TABLE 1. Flour analytical parameters.

Parameter	Moisture (%)	Ash (%)	Gluten (%)	Protein (%)	Zel.value (mL)	FN (s)
Average	14.2	0.60	33.0	10.8	39	293
Min.	12.9	0.56	28.7	10.3	35	263
Max.	14.5	0.65	36.3	11.8	43	308

The analytical parameters of wheat flours

The range of analytical quality parameters shows that the set comprises different flour samples (protein 10.3–11.8%, Zeleny sedimentation value 35–43 mL, Falling Number 263–308 s) corresponding in medium to the Czech request for bakery flours (Table 1). For fermented dough a standard quality of fine flour is represented by protein content (min. 11%) and Falling Number (min. 180 s).

The evaluation of mixing characteristics

Water absorption evaluated at an alveo-consistograph (constant hydration) was found about 1.6% lower on aver-

TABLE 2. Flour promylograph characteristics.

Apparatus	Promylograph T6					Promylograph TS6									
						resting time-30min					resting time-60min				
Parameter	Absorption (%)	Stability (min)	Develop. (min)	Drop (PU)	Absorption (%)	R (PU)	L (mm)	R max. (PU)	E (cm^2)	R/L (PU//mm)	R (PU)	L (mm)	R max. (PU)	E (cm^2)	R/L (PU//mm)
Average	54.3	8.7	1.8	67	53.7	381	165	512	115	2.34	410	160	562	118	2.62
Min.	53.5	6.2	1.5	40	53.5	372	133	508	103	2.12	385	135	542	91	2.31
Max.	56.2	9.6	2.5	75	56.2	398	168	524	116	2.74	458	163	572	133	2.99

TABLE 3. Flour alveo-consistograph parameters.

Constant hydration

Apparatus	Alveograph							Consistograph		
Parameter	P (mmH_2O)	L (mm)	G ($mm^{1/2}$)	W (10^{-4}J)	P/L (mmH_2O//mm)	Ie (%)	W(40) (10^{-4}J)	PrMax (mb)	WA (%)	HYDHA (%)
Average	78	87	20.6	220	0.92	52.7	131	2492	56.0	52.5
Min.	58	71	19.1	161	0.60	45.9	97	2231	53.1	50.6
Max.	99	109	22.7	271	1.12	58.3	173	2909	56.2	54.3

Adapted hydration

Apparatus	Alveograph								Consistograph					
Parameter	HYDHA (%)	T (mmH_2O)	A (mm)	Ex ($mm^{1/2}$)	Fb (10^{-4}J)	T/A (mmH_2O//mm)	Iec (%)	Fb(40) (10^{-4}J)	PrMax (mb)	TPrMax (s)	Tol (s)	D250 (mb)	D450 (mb)	WAC (%)
Average	52.4	68	95	21.8	205	0.73	53.0	114	2173	109	193	468	932	54.9
Min.	50.6	56	69	18.5	167	0.49	46.2	91	2049	74	147	136	739	50.1
Max.	54.0	90	118	24.2	272	1.09	59.5	142	2327	150	287	641	1112	60.1

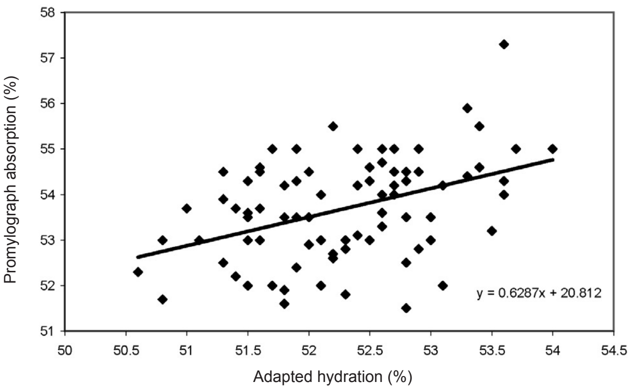


FIGURE 1. Correlation between promylograph and consistograph absorption (ro=0.3646).

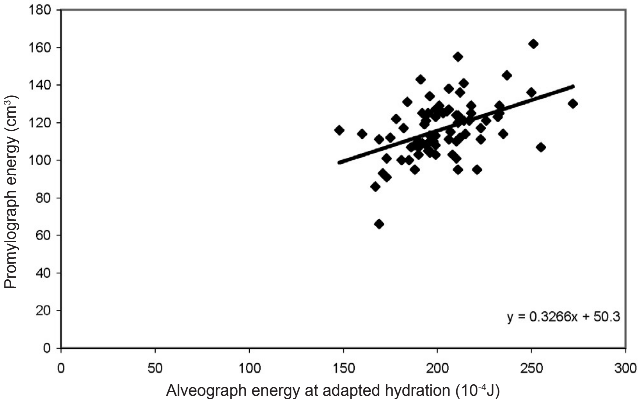
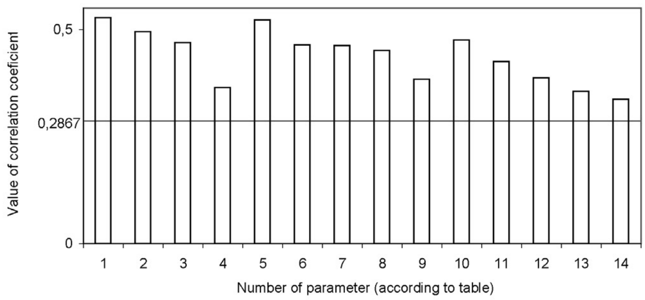


FIGURE 2. Correlation between promylograph and alveograph energy (ro=0.4249).

age than the results obtained at a promylograph TS (Table 2). Similar results were found with comparison to alveo-consistograph and farinograph absorption. In the case of second regime (adapted hydration), the average difference lowered at 0.6%, which was 1% of medium value. Figure 1 shows better relation between promylograph absorption and consistograph at adapted hydration. From comparison of other binary dough parameters (stability, dough development time and tolerance index) it is obvious that both can be used for description of individual flour samples but their numerical values were not identical.

The evaluation of viscoelastic characteristics

The commercial flours from the tested set were different in all alveograph parameters, which can suitably describe the range of P/L from 0.60 to 1.12 (Table 3). According to alveograph energy there are both weak ($W'=161.10^{-4}$J) and strong flours ($W=271.10^{-4}$ J). In regime at adapted hydration (dough consistence 500 BU), higher extensibility was measured of dough as a decrease in P/L (at average from 0.92 to 0.73) apparent describes. Alveograph energy decreased too and its value was comparable with promylograph energy (measured at TS6) after 30 min of the dough resting. The correlation between alveograph and promylograph energy was shown in Figure 2 and indicated that the dough characteristics depended on flour quality but not on the type of mixer used.



	Number, r_o		Parameter alveo-consistograph	promylograph
Alveograph and promylograph TS6	1	0.5280	P	maximum
	2	0.4953	P	elasticity
	3	0.4197	P/L	P/L
	4	0.3646	W	energy
Alveo-consistograph (adapted hydration) and promylogrph TS6	5	0.5225	T	elasticity
	6	0.4646	Fb	energy
	7	0.4629	T/A	P/L
	8	0.4514	T	maximum
	9	0.3838	A	extensibility
Alveo-consistograph (adapted hydration) and promylograph TS	10	0.4303	Tol	stability
	11	0. 4249	HYDHA	absorption TS6
	12	0.3870	HYDHA	absorption TS
	13	0.3559	D250	tolerance index
	14	0.3366	D450	tolerance index

r_o - correlation coefficient

FIGURE 3. Correlation between alveo-consistograph and promylographs parameters (level of 1%).

Correlation of dough parameters

The correlations between three sets of results (a consistograph at adapted hydration and a promylograph TS, an alveograph at constant hydration and a promylograph TS6, an alveograph at adapted hydration and a promylograph TS6) statistically significant at a probability level of 1% are summarized in Figure 3. Significant correlations were found between alveograph elasticity and promylograph resistance (r=0.495) and the maximum of promylograph curve (r=0.528), between alveograph and promylograph energy (r=0.365) and between both P/L value (r=0.469). Significant correlations between the same parameters measured at adapted hydration were proved with higher correlation coefficients and in this case the relation between dough extensibility at both tests was statistically significant. Replicate of viscoelastic behaviour measurement was confirmed despite the difference of deformation principal. The results of consistograph tests at adapted hydration correlate with absorption, dough stability and tolerance index taken at promylograph T6. The correlation between consistograph absorption at adapted hydration and promylograph TS6 absorption was found stronger (r=0.425) than between absorption measured at promylograph TS.

CONCLUSIONS

The Chopin alveo-consistograph spreads the evaluation of the wheat flour quality by means of rheological devices about the description of dough preparation and behaviour at constant and adapted hydration during three-dimensional deformation and its comparable using at industrial mills as Egger promylographs. The quality of commercial fine flours prepared from wheat of 2001 harvest has been successfully described by means of alveo-consistograph and the results obtained show significant correlations with some parallely measured parameters at Egger promylographs (TS and TS6) as was proved with its comparison in the case of farinograph and extensigraph measurements. The results of water absorption determined with all methods tested correlated strongly. This indicated that the alveo-consistograph is a well suited instrument for this type of determination which is in agreement with the previous studies of Dubat [1999]. Differences in dough deformation behaviour between both types of instruments and measurement regime are due to important influence of dough consistency and were found lower at alveograph tests at adapted hydration where all viscoelastic parameters correlated mutually at a probability level of 1%.

REFERENCES

1. Dubat A., Angepasste Wasserzugabe beim Alveographen. Getreide Mehl und Brot, 1999, 53, 30-31.
2. Finney K.F., Contribution of individual chemical constituents to the functional (breadmaking) properties of wheat. 1978, *In*: Cereals 78, American Association of Cereal Chemists, St. Paul, MN, pp. 250-264.
3. International Association of Cereal Science and Technology, ICC Method No. 171.
4. International Standards Organisation, ISO Methods No. 3093, No. 5529, No. 5530-1, No. 5530-2.
5. Pyler E.J., 1988, Baking Science and Technology, 3th.ed. Sosland Publ. Comp., Kansas City, Missouri, US, pp. 357-377.
6. Shuey W.C., Practical instruments for rheological measurements of wheat products. Cereal Chem., 1975, 52, 42r-81r.
7. Tipples K.H., Preston K.R., Kilborn R.H., Breadmaking properties of wheat flour. Bakers Digest, 1982, 56, 16-20.
8. Walker C.E., Hazelton J.L., Dough rheological tests. Cereal Foods World, 1996, 41, 23-28.