Solvent Retention Capacity for Different Wheats and Flours Evaluation

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Abstract

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The baking quality in the sets of both commercial and variety wheat samples (80 and 18 items) and wheat composite flour (standard and 25 blends) was evaluated in terms of the Solvent retention capacity method (AACC 56-11). Composites were prepared from a commercial fine wheat flour and commercial bio-wholemeal flour prepared by milling of common wheat, rye, oat, barleys and corn at substitution levels of 10, 20, 30, 40, and 50%. The commercial wheat quality testing ANOVA revealed the major effect of the sample tested form; the data measured for grain and flour proved to be correlated. Besides, the harvest year affected the baking quality to a greater degree than the growing locality. Within the variety wheat set, the harvest year factor dominated over that of the wheat cultivar one with the exception of the sodium carbonate retention capacity. In the case of the wheat flour substitution by bio-cereal flour types, the added amount of the alternative flour supported only the quantitative change caused by the incorporated cereal in all four retention capacities.

Keywords: commercial wheat; wheat variety; composite flour; SRC; Tukey's test

Soft wheat baking quality prediction according to the American Association of Cereal Chemists (AACC) method 56-11 (Gainer 2000), the SRC test, represents a complex approach in wheat industry, its values residing in the procedure simplicity and small amount of flour tested. The latest review of the method application to the wheat breeding and quality prediction of wheat based products (milling and baking features) was published by Kweon *et al.* (2011). The paper is a seminal work on SRC method, having been contributed by the author of the SRC method (L. Slade). Thus, other scientific works are derivatives of this work. The use of distilled water and 50% saccharose, 5% sodium carbonate, and 5% lactic acid water solutions, as well as the flour ability to retain these solvents corresponds with the overall quality, level of damaged starch, contents of pentosans and gliadins, and also with glutenin characteristics, respectively (Gaines 2000). Duyvejonck *et al.* (2011) verified the relations of the flour constituents and four retention capacities (RCs) in European commercial wheat flours. The above mentioned method was originally developed for the evaluation of the milling product end-use for pastry and long-life bakery products. Nowadays, its application field is broader – from breeding to quality assessment of wheat composite flour.

The application of this method for the breeding material selection was discussed by Guttieri *et al.* (2004), who also modified the method for wheat meal. For genotype and genotype × environment interactions, the sources of variation of inbred lines of some wheat varieties in the SRC profiles were evaluated by Guttieri and Souza (2003). Cereal research proved significant correlations between all four RCs and further internationally respected wheat quality traits such as SDS or Zeleny's sedimentation tests (Guttieri *et al.* 2004 and Hrušková *et al.* 2010, respectively), and flour extraction rate or protein content (Guttieri *et al.* 2002). Linear relation between the farinograph water absorption and single RCs was confirmed in articles e.g. by Ram *et al.* (2005) or Sedláček (2009). Also Hrušková *et al.* (2010) analysed the baking strength of 11 milling fractions by SRC when using the farinograph test. For five farinograph parameters, 12 significant correlations of the possible 20 were demonstrated; only sodium carbonate RC was found to be linked to all 5 farinograph characteristics. The cookie diameter and bread loaf volume were also found as dependent on RCs (Gaines 2006; Colombo *et al.* 2008).

Fortification of common wheat flour by 10 types of commercial fibres from different sources was performed by Rosell *et al.* (2009). Their impact on the flour quality was analysed by SRC method. All fibre groups influenced physico-chemical properties of the composites tested with the exception of lactic acid RC in the case of cereal fibres.

The aim of the presented paper is to verify the SRC method application for quality prediction of Czech commercial wheat and wheat varieties with regard to the harvest year, growing locality, and wheat variety statistical treatment. Within the commercial wheat set, both sample forms of wholemeal and flour were tested. A partially new point of view as far as SRC method use is concerned is to bring about an evaluation of wheat composite flour, mixed from standard commercial wheat bright flour and five wholemeal flour types composed of wheat, rye, oat, barley, and corn planted in a bio-regime. The relations of the grain and flour RCs to standard quality techniques and parameters are under study and our results will be published in the near future.

MATERIAL AND METHODS

Materials. The experiments were carried out on three sets of wheat material. Commercial wheat from two harvests (2009 and 2010 – 80 samples per year) was provided by the Prague commercial wheat mill, supported by four local farmers operating in Central Bohemia. In this case, the samples were analysed in the form of wheat grain (wholemeal groats from Retsch ZM 1000 (Retsch, Haan, Germany) and laboratory milled flour from FQC 109 (METEFÉM, Budapest, Hungary). Three winter and spring wheat varieties were planted in field trials in the east of the same region, and their quality in the form of fine flour obtained from WWGH mill was determined during the years 2008–2010. Industrially milled bright wheat flour of a common baking quality (protein content 14.1%, Zeleny's value 36 ml, Falling Number 396 s) was used as standard for its substitution by 5 other cereal wholemeal flours (bio-quality from wheat, rye, oat, barley and corn from a specialised shop) at levels of 10, 20, 30, 40, and 50%.

Methods. The baking quality of the standard flour for composites was analysed according to Czech standards: protein content (ČSN 560512-12:1995), Zeleny's sedimentation value (ČSN ISO 5529:2000) and Falling Number (ČSN ISO 3093:1993). Technological quality of the tested material was determined according to AACC method 56-11 Solvent retention capacity (SRC) profile, using flour samples of 5 g and the centrifuge Eppendorf 5702 (Eppendorf AG, Hamburg, Germany). Variance analysis (ANOVA) of harvest year, growing locality and wheat variety on one side and of the added flour type and substitution level on the other, was calculated using Statistica 7.1 software (StatSoft Inc., Tulsa, USA).

RESULTS AND DISCUSSION

Commercial wheat quality

Wheat samples SRC profiles differed in all four observed localities in both harvest years 2009–2010 (Table 1). The highest inter-crop difference was identified for its saccharose retention capacity (RC-SA) – the mean percentage decrease of one tenth was evaluated between the 2009 and 2010 averages of the four observed localities. Apart from the harvest year, the used form of the sample predetermined its SRC profile in flour, the variation between single RCs being higher. As expected, flour preparation using laboratory milling affects the final product composition and single flour component rates influence its physico-chemical behaviour. Owing to this influence, the water retention capacity (RC-WA) was higher in wheat (i.e. groat) than in flour, due to the presence of non-starch polysaccharides (independent of the growing locality). The positive effect of debran-

Table 1. Solvent retention capacity averages for groats and flour from commercial wheat (four localities, two harvest years)

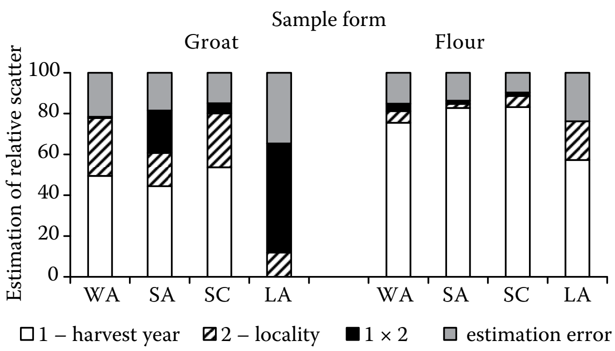
Locality	RC (%)							
	WA		SA		SC		LA	
	2009	2010	2009	2010	2009	2010	2009	2010
L1-g	73.4	69.6	94.1	78.9	90.3	82.0	76.0	72.0
L1-f	66.0	61.9	102.1	100.2	87.5	77.3	133.5	154.7
L2-g	76.5	70.6	95.4	85.8	95.2	85.1	79.1	75.7
L2-f	70.2	65.4	115.3	104.0	97.8	86.2	143.9	134.4
L3-g	74.6	69.7	93.8	81.1	92.5	82.8	77.0	73.2
L3-f	67.2	63.0	110.2	100.6	92.3	81.0	124.2	128.4
L4-g	72.8	69.5	94.6	82.7	90.1	83.5	76.3	73.3
L4-f	64.1	61.4	106.5	102.6	83.6	78.9	133.9	142.4
SD-g	2.1	1.2	4.3	3.4	3.2	1.9	2.0	2.0
SD-f	3.0	2.1	5.9	2.7	6.8	4.0	9.5	12.2

RC – retention capacity; solvents: WA – water, SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions; sample form: g – groat, f – flour; SD – standard deviation (40 samples)

ning could be also considered in approximately twofold lactic acid retention capacities of flour, for this treatment concentrated wheat proteins in disintegrated endosperm matter. The saccharose retention capacity (RC-SA) issues from arabinoxylans ("pentosans"), located in the kernel coating, their content being usually higher in wholemeal groats than in flour (Kweon *et al.* 2011). The tested commercial wheat set, RC-SAs, did not confirm these results probably owing to the regime of laboratory milling.

During different food fibres testing of the influence on SRC quality, Rosell *et al.* (2009) used Spanish commercial wheat flour, characterised by the proper RCs of 66.1, 101.7, 78.2, and 110.7%, respectively. For 19 European commercial flour samples, the SRC profiles were measured by Duyvejonck *et al.* (2011). Water, saccharose, sodium carbonate, and lactic acid RC average values of 61.5, 93.7 79.7, and 124.0, respectively, were by about 3, 11, 6, and 13 units lower than the proper values measured for the tested 80 Czech flours. Standard deviations within the European flour set were 2.5, 3.2, 3.8, and 9.3%, respectively, more or less corresponding with 'SC-f' (Table 1). Quite low variation coefficients (e.g. sample FS2: 0.6, 1.2, 0.6, and 3.8%, respectively) were published by Duyvejonck *et al.* (2011) for single flour samples water, saccharose, sodium carbonate and lactic acid RCs. The repeatability of the SRC method, as variation coefficients was determined in our Cereal laboratory was determined on levels of 0.8, 0.6, 0.9, and 0.8%, respectively. However, the repeatability of Zeleny's test (respected as standard procedure of wheat protein quality evaluation) was found to be somewhat higher (1.1%) in our laboratory.

The above mentioned effects were analysed statistically using MANOVA for comparison of both sample forms (Figure 1). In the case of wheat (and groats produced from it), the harvest year influence was above all reflected in the RCs of water, saccharose, and sodium carbonate. For groats RC-LA, the impact of the growing locality (perhaps as a result of the differences in the planted varieties portfolio) could not be omitted either. When the milling process was used, the harvest year effect was partially suppressed owing mainly to the yield gained from the growing locality. An extraordinary position was confirmed for RC-LA, which appears to be an independent and irreplaceable characteristic of the SRC test. The harvest year was surprisingly not directly observable in flour



Retention capacity solvents: WA – water, SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions

Figure 1. Harvest year and planting locality effect on solvent retention capacity profiles of commecial wheat and laboratory milled flour

RC-LA (zero at data relative scatter estimation; Figure 4). The interaction of both factors, however, has covered approximately 54% of its variability. As it will be further demonstrated, the smallest number of provable correlations was especially found in RC-LA (for grain: the correlations of 0.825, 0.774, and 0.851 with flour RCs of water, saccharose, and sodium carbonate, respectively; for flour: no correlation occurred with any other RCs of grain and flour; Table 4A).

Guttieri *et al.* (2002) determined the flour SRC profiles of two soft white spring wheat varieties planted in three localities within two years, subjected to a rainfed or an irrigated regime. Environmental (E) and genotype (G) variance analysis demonstrated the unprovable G × E interaction for all four RCs. Factor E affected all SRC test parameters as well, while the G factor was only reflected in RC-WA and RC-SC. In the case of RC-WA, G and E strengths were balanced together (*F*-values 31.9 and 35.6, respectively), while in the case of RC-SC, the effect of G was approximately twice the value of E (*F*-values 23.1 and 11.2, respectively). In our case when using commercial wheat flour, *F*-test results showed diverse dependencies. The harvest year × locality factors interaction did not affect RC-WA only. Further, both factors studied influenced considerably only RC-WA; to advantage of the harvest year (*F*-values 72.3 and 21.4, respectively), while RC-SC was attributed only to the crop years (*F*-value 34.2).

Wheat varieties quality

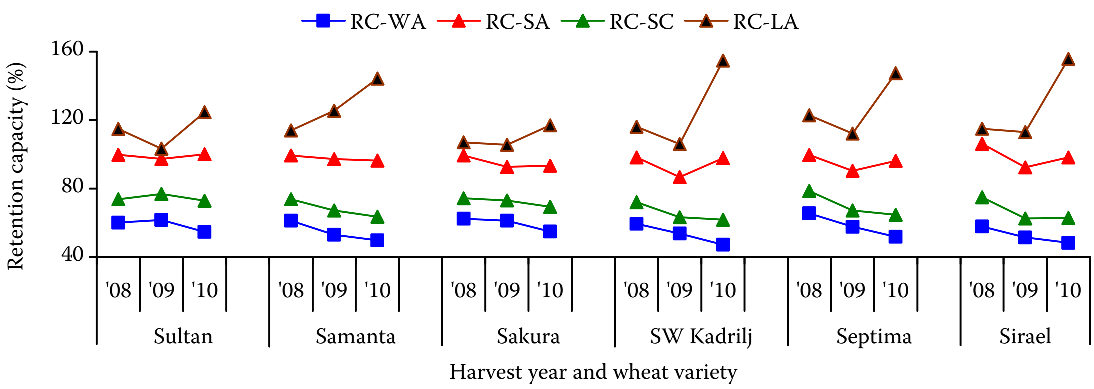
RCs profiles of the tested wheat varieties showed their quality dependence on the weather in the individually observed harvest years, enabling the use

Table 2. Solvent retention capacity averages for wheat varieties flour (% RC)

	WA-f	SA-f	SC-f	LA-f
A. Wheat cultivar effect 0150				
Sultan	58.8^{b}	99.0^{a}	74.4^{a}	114.2^{a}
Samanta	54.5^{ab}	97.6^{a}	68.1^{a}	127.9^{a}
Sakura	59.4^{b}	95.0^{a}	72.2^{a}	109.8^{a}
SW Kadrilj	53.3ab	94.2^{a}	65.6^{a}	125.6^{a}
Septima	58.3^{ab}	95.4^{a}	70.1^{a}	127.4^{a}
Sirael	52.4^{a}	98.8^{a}	66.7^{a}	127.9^{a}
B. Harvest year effect				
2008	61.0^{c}	100.4	74.6^{b}	114.9^{a}
2009	56.4^{b}	92.7^{a}	68.3^{a}	110.9^{a}
2010	51.0^{a}	96.9^{ab}	65.8^{a}	140.6^{b}

RC – retention capacity; solvents WA – water, SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions; sample form: g – groat, f – flour; $^{a-c}$average in columns tagged with the same letter are not significantly different (*P* = 95%)

of ANOVA on the main effects, without the calculation of mutual interactions. Wheat varieties could be, however, partially distinguished by RC-WA measurement (Table 2A). The significance of the harvest year influence is supported by differentiating at least one year from the others (Table 2B) in the case of all four RCs; in the case of RC-WA even all three monitored years. Figure 2 suggests the above given statistical findings, where the strongest impact of the variety and harvest year factors interaction was found for RC-SC (data not shown). Some additional information offers a comparison between winter (Sultan, Samanta, Sakura) and spring (Septima, Sirael, SW Kadrilj) varieties. In these variety groups, RC-LA manifested its value in distinguishing the harvest year influence on wheat quality, especially for spring wheat. In the



RC – retention capacity; solvents: WA – water; SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions

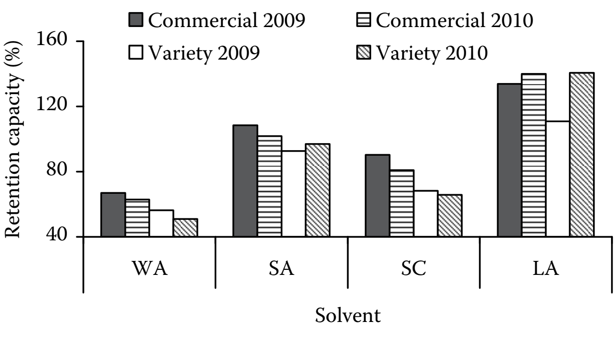
Figure 2. Harvest year and wheat wariety effect on solvent retention capacity profiles in wheat cultivars set

considered varieties tested belonging to different baking quality classes, (e.g. Sultan – A, good; SW Kadrilj – E, elite; Sirael – C, not suitable for fermented bakery products), the variety quality declaration was confirmed by RC-LA.

Guttieri *et al.* (2002), as mentioned above, measured SRC profiles across diverse environments for two spring wheat cultivars. The performed *F*-test recognised only the cultivar influence as significant. For the Czech winter and spring varieties of different baking qualities, RCs profiles were surprisingly affected by the harvest year only (*F*-values 24.8, 14.1, 10.2, and 16.9 for water, saccharose, sodium carbonate and lactic acid RCs, respectively; P = 99%). Wheat variety factor only influenced RC-WA, while *F*-value 5.5 was significant at P = 95%.

Comparison of commercial wheat and variety SRC profiles

As regards the commercial wheat sample quality, average SRC profiles of the varieties were proved to differ in years 2009 and 2010 (Figure 3). The median of RCs standard deviations through single harvest years in the commercial and variety wheat sets reached the level of 4.4%, with the broadest scatter having been recorded for RC-LA (8.1–16.2%). Two-way ANOVA of the wheat set and harvest year revealed a similar trend with RC-WA and RC-SC averages, strongly affected by both examined factors. Inter-variation between RC-LA means in commercial and variety wheat sets were directly dependent on both influences, as proven in separate wheat sets.



RC – retention capacity; solvents: WA – water; SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions

Figure 3. Comparison of the solvent retention capacity flour profiles for commercial and variety wheat (harvest years 2009, 2010)

In the harvest year of 2009, the medians of the four RCs of the tested varieties did not reach the values calculated for each of the localities of L1–L4. On the other hand, RC profiles of the winter varieties Sultan, Samanta, and Sakura resembled more those of the commercial wheat, mainly in terms of RC-WA and RC-SA. For example, the latter RC levels were 97.3% for the winter cultivar Sultan, and 86.7% for the spring SW Kadrilj vs. 101.2, 113.5, 110.0, and 106.8% for localities L1–L4, respectively. Only one exception was observed for RC-LA of the winter variety Samanta comparable to the L3 locality (125.5 and 121.6%, respectively).

In the following crop year, the RC profiles through both subsets were more levelled. The differences between the winter or spring varieties and commercial wheat saccharose RCs were approximately –5.1/–3.7 units, respectively. In the case of lactic acid RC, the differences between the winter and spring varieties were approximately –15.9/14.3 units. Compared to the harvest year of 2009, a positive shift was registered as a decrease of the given differences approximately by a half (RC-SA) and a 1/3 (RC-LA). The RC-SA levels were 100.0% for the winter cultivar Sultan and 97.7% for the spring cultivar SW Kadrilj vs. 100.1, 104.2, 100.3, and 102.6% for the locality L1–L4, respectively. Diverse protein quality between the winter and spring varieties, relating to commercial wheat, could be illustrated in the same samples sequence by the RC-LA 124.6% and 154.8 vs. 154.7, 135.9, 128.60, and 145.0%.

Wheat flour composite quality

A further possibility to change the wheat flour chemical composition is the addition of non-wheat cereals and other disintegrated plant materials. In this way, flour, dough, and final product properties or behaviour, as well as the appearance, are modified, being aimed in conclusion mainly at the nutritional benefits. For testing, five botanical species of common cereals wholemeal flour were chosen (wheat, rye, oat, barley, corn), and the nutritional enhancement mentioned was ensured by the declaration of the bio-planting regime of each sample.

The changes in standard wheat flour quality, caused by its substitution at diverse levels were described by means of Tukey's HSD test (ANOVA; Table 3). To consider the extent of the SRC profiles oscillation, a line with RCs values recorded for standard flour M (i.e. 0% of substitution) was also included in the table. As expected, the formula component type affected the composite SRC profiles more than the substitution levels for the solvents used, with the exception of that of lactic acid one (Table 3). Due to this, formula differences, from the viewpoint of the added component substitution level, were registered, however, they were not statistically significant according to the RC-SA and RC-SC. In the case of water RC, an increasing ratio of non-starch polysaccharides in the mixtures (at the basic flour replacement from 10% to 50%) resulted in a modest, but provable increase of this parameter value. For RC-LA, the impacts of both monitored factors were comparable. However, the column minima of 90.0 and 100.9% (as the corn and the 50% composites average, respectively) disclose the cereal type factor as prevailing (Table 3). Within the composite flour sets, some anomaly was registered for rye and oat mixtures (Figure 4). Compared to the standard M SRC profile, the range of the decrease or increase depended on the formula composition. An opposite trend in the RC-SA values signifies the opportunity to discriminate between both cereals tested.

Table 3. Solvent retention capacity averages for flour composites

	WA-f	SA-f	SC-f	LA-f
A. Recipe component effect (over five added amounts) – RC (%)				
M (standard)	70.6	116.5	89.9	136.7
P	71.5^{a}	112.0^{a}	91.4^{a}	120.9^{c}
Z	87.6^{c}	134.4^{b}	118.1^{b}	121.6^{c}
J	72.4^{ab}	109.7^{a}	92.5^{a}	102.6^{b}
O	79.5^{b}	110.4^{a}	110.0^{b}	115.5^{c}
K	70.6^{a}	105.1^{a}	83.4^{a}	90.0^{a}
B. Addition effect (over five added bio-cereal flours) – Substitution (%)				
0 (M)	70.6	116.5	89.9	136.7
10	72.6^{a}	115.5^{a}	93.6^{a}	125.7^{c}
20	73.5^{ab}	114.6^{a}	95.9^{a}	115.4b
30	76.2^{ab}	113.5^{a}	99.4^{a}	106.2^{a}
40	78.2^{ab}	113.9^{a}	101.1^{a}	102.4^{a}
50	81.0^{b}	114.2^{a}	105.3^{a}	100.9^{a}

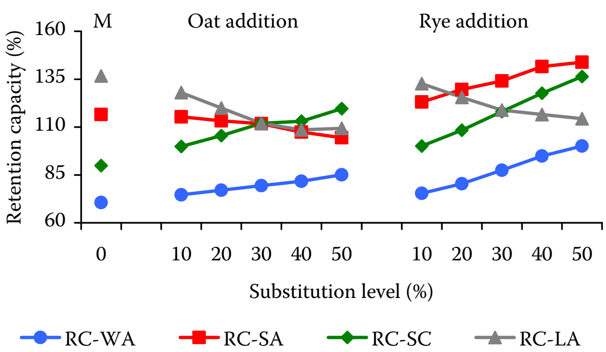
RC – retention capacity: solvents WA – water, SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions; sample form: g – groat, f – flour; wholemeal: P – wheat, Z – rye, J – barley, O – oat, K – corn; $^{a–c}$averages tagged by the same letter are not significantly different (P = 95%)

The dilution of gluten proteins achieved by a partial common wheat flour replacement, issues mostly in the RC-LA courses. Both the added cereal types and addition level partook in this characteristic decrease, owing mainly to different protein structures and properties (Figure 5). The strongest impact is illustrated for barley and corn composites.

Impact of sample sorts on correlation analysis results

Basically, the testing of linear inter-relations between the measured characteristics belongs to basic descriptive statistics. Thus, the potential of parameters exchangeability or uniqueness could be shown. Between the three analysed sets, only the commercial one and combination of all flour samples were used for RCs bind assessment, firstly due to a satisfying item number within them (160 and 124, respectively), and secondly for the consideration of the statistical error level of α = 0.01.

The results of the correlation analysis are summarised in Table 4; part A reflects the link closeness in the former sample set and part B in the latter. For commercial wheat, the verification of SRC method application to wholemeal was successful – all four RCs measured on groats described the wheat quality adequately to those obtained with flour. The only identified exception was flour RC-LA, which convincingly demonstrated the independence of gluten protein quality on the growing



Standard deviations for the M sample: 0.77, 0.85, 1.09, and 1.48% for the water, saccharose, sodium carbonate and lactic acid RC's, respectively

Figure 4. Influence of oat and rye addition on the composite flour solvent retention capacity profiles

Table 4. Analysis of the solvent retention capacity inter-relations (% RC)

	WA-g	SA-g	SC-g	LA-g	WA-f	SA-f	SC-f	LA-f
A. Commercial wheat set (groat and flour) – N = 160; $r_{0,01}$ = 0.203								
WA-g	1							
SA-g	0.846**	1						
SC-g	0.955**	0.886**	1					
LA-g	0.902**	0.828**	0.900**	1				
WA-f	0.841**	0.741**	0.829**	0.825**	1			
SA-f	0.798**	0.640**	0.817**	0.774**	0.799**	1		
SC-f	0.862**	0.746**	0.877**	0.851**	0.934**	0.850**	1	
LA-f	ns	ns	ns	ns	ns	ns	ns	1
B. All flour samples (commerical, variety, composites) – N = 124; $r_{0,01}$ = 0.231								
WA-f					1			
SA-f					0.829**		1	
SC-f					0.950**	1	0.862**	
LA-f					–0.304**	ns	ns	1

RC – retention capacity: solvents WA – water, SA – saccharose, SC – sodium carbonate, LA – lactic acid solutions; sample form: g – groat, f – flour; **correlations provable at P = 99%; ns – non-significant

locality. In the flour set, RC-WA correlated with all others RCs; at the smallest rate also with RC-LA (Table 4B). In conclusion, the retention capacities of water, saccharose, and sodium carbonate could be alternated together in the tested set, but lactic acid retention capacity could not be replaced by any of the three others.

Generally, wheat quality evaluation is performed from several points of view (as genotype, environment, baking quality prediction, etc.), and the correlation analysis is usually added. The wheat origin or winter/spring type, growing locality and other environmental factors play a more or less important role in SRC scores. Guttieri *et al.* (2004) compared the RCs of wheat meal and flour, and found the meal RC-SC prediction ability of RC-SC and RC-SA from flour in three tested wheat populations. On the other hand, appropriate fitting between RC-LAs of the meal and the flour was found only in one of the three cases. Duyvejonck *et al.* (2011) did not prove any link either between RC-LA and other RCs in a group of 19 European commercial wheat flours. Similar results were published by Guttieri *et al.* (2002) for the variety Pomerelle – RC-LA correlated only with RC-SA (r = 0.78).

Ram and Singh (2004) in the quality treatment of 92 Indian wheat genotypes confirmed inversely the closeness between the retention capacities, when the correlation between RC-LA and saccharose and sodium carbonate RCs reached 0.59 and 0.47, respectively (P = 99.9%). The water RC was substituted by alkaline water RC, and the correlation coefficient equalled 0.51 at the same probability level.

Pasha *et al.* (2009) compared the flour SRC profiles of 50 both old and contemporary spring wheat varieties (released between 1933 and 2004), grown in Pakistan during 2003 and 2004, in terms of the variety and harvest year influence. In agreement with our results, the highest variance was signified by the harvest year, and reversely, no serious impact of the variety × year interaction was identified. Further, lactic acid has also a dominant role within the foursome of solvents, due to the correlation with RC-SA only (0.43, P = 99%). In addition, RC-LA determined in 18 Argentinean wheat cultivars was also independent as far as other RCs were concerned (Colombo *et al.* 2008).

The changes in the flour chemical composition due to the three types of cereal fibres used (two oat samples and one wheat) and the consequence of their addition to commercial Spanish wheat flour was analysed by Rosell *et al.* (2009). The SRC profile of their standard flour were provably lower compared to pure Czech wheat flour used for fortification (differences of –5, –15, –12, and –26 points for RC-WA, RC-SA, and RC-SC, respectively). A 10% substitution level, the highest

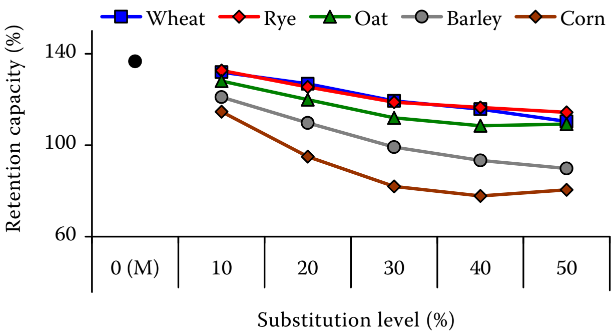


Figure 5. The lactic acid solvent retention capacity profiles as influenced by composite flour recipe (standard deviations for the M sample of 1.48%)

standard-to-composite differences for the RC-SA (approx. increase by about 18 points) regardless of the fibre type were measured by Rosell's team. In our case, 10% replacement by oat and wheat wholemeal was manifested by a minimal change (decrease of 1 and 2 units, respectively). Although both compared standard SRC profiles were in contrast, to each other, in terms of the RC-LA values, the changes caused by 10% fortification were adequate to expectations. In our case, 10% wholemeal oat and wheat composite proved a decrease of 9 and 5 units, while in Rosell's research only oat fibre lowered the RC-LA value ("oat 401" by about 4%, and "oat 600" by about 9%).

CONCLUSIONS

In the three qualitatively diverse subsets tested, the solvent retention capacity method (SRC, AACC 56-11) confirmed its potential to describe wheat flour quality. Commercial wheat SRC profiles were primarily dependent on the harvest year, with both wholemeal groats and laboratory prepared flour. The application of SRC method directly on disintegrated grain brings about some novelty, and the capability of the method to classify food wheat quality was precisely confirmed. Correlation analysis of 160 samples verified the interrelation between the retention capacity four somes determined for groats and flour. An exception was revealed for flour lactic acid RC, demonstrating its non-exchangeability in the SRC method. The importance of our finding lies in the possibility of the gluten protein quality prediction.

Wheat varieties quality was also influenced by the harvest year, mainly affecting the water RC. Issuing from this, three observed years and partially six tested varieties could be precisely distinguished. Lactic acid RC in the variety set (mostly in the case of the tested spring cultivars) was also dependent to a greater extent on the harvest year.

The substitution of standard wheat flour by wholemeal wheat, rye, oat, barley and corn flours in levels of 10–50% significantly influenced SRC profiles. Recorded change considerably increased in the tested composites due to the rate of non-starch polysaccharides and non-gluten protein. An extraordinary behaviour was identified for the samples involving rye and oat wholemeal, while the plants mentioned could be distinguished on the base of saccharose RC. In all five cereal types, lactic acid RC was the most sensitive characteristic due to the weak or even fatal dilution of gluten proteins. Notably, due to different protein structures, corn flour addition resulted in a decreasing trend.

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