

Dedicated to the anniversary of Prof. Ing. Jiří Petr, DrSc., Dr.h.c.

TECHNOLOGICAL QUALITY OF SPELT (*TRITICUM SPELTA* L.) FROM ECOLOGICAL GROWING SYSTEM

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Milling and baking quality of a set of varieties of spelt (*T. spelta* L.) from ecological growing system in a fertile sugar beet growing region of Central Bohemia was evaluated in three-year trials (1996–1998). The applied spelt varieties included Rouquin (Belgium, 1979), Oberkulmer Rotkorn (Switzerland, 1948), Schwabenkorn (Germany, 1978), Steiners roter Tiroler (Germany, 1916), Altgold (Switzerland, 1952). The high-quality Czech breadmaking variety of common wheat (*T. aestivum* L.) Hana (1985, quality group A) was used as the check variety. In comparison with the check variety Hana the evaluated spelt varieties showed a higher value of thousand kernels grains (TKW), ash content and protein content (13–15% against 11–12.9% of the check variety Hana). Steiners roter Tiroler and Rouquin of spelt varieties had the highest and the lowest protein content in all three years, respectively. The wet gluten content in spelt varieties was also high (about 40%), considerably exceeding that in the check variety Hana (27–31%). In comparison with the common wheat Hana the quality of gluten in spelt varieties was lower the evidence of which were the low values of gluten index and SDS-test, with the exception of the spelt variety Rouquin whose values were close to that of the check variety Hana. The total yield of flours in spelt varieties, determined by milling test with the use of laboratory mill Bühler, moved around 70% at a level comparable with Hana. Like in grain evaluation high values of the protein content and wet gluten content were found in the evaluated spelt flours. Like the quality of gluten in meals the quality of gluten in flours was lower in comparison with Hana (low values of gluten index and Zeleny sedimentation test). The best variety in rheological evaluation of flours using farinograph was Rouquin with a satisfactory value of water absorption (about 60%), dough development time (above 3 minutes), a favourable value of dough stability time (3.5–4.5 minutes) and degree of softening (80–100 B.U.). These values were close to those of the check variety Hana. The values of farinographic indicators of the other spelt varieties were less favourable and characteristic of weaker doughs less resistant to mechanical stress. The results of baking test

well correspond with farinographic evaluation. The varieties which achieved favourable farinographic evaluation were the best in baking test (Hana, Rouquin) while those varieties which achieved less favourable values of farinographic indicators were worse also in baking test (Steiners roter Tiroler, Oberkulmer Rotkorn, Altgold). In general, it is possible to say that the evaluated spelt varieties confirmed a considerable variability on the level of evaluated quality indicators; in particular, the quality of the newer variety Rouquin moves this variety to a level comparable with the check variety of the common wheat Hana, further from the old, classical spelt varieties which achieved worse results in this evaluation but maintained their original properties of this type of wheat. At the same time, this evaluation confirmed that in comparison with the check variety of common wheat the evaluated spelt varieties maintained their typical character of quality indicators, in particular a high protein content, gluten and ash content, when grown in ecological system (without mineral fertilizers, pesticides and growth regulators).

spelt; varieties; ecological growing system; milling and baking quality

INTRODUCTION

Spelt (*T. spelta* L.) is an old European wheat cultivar the evidence of which are archeological findings in many countries, in particular German speaking countries. Since the Bronze Age the expansion of spelt in the so-called allmande territory was fast at the detriment of one- and two-grained wheat. It was in fact the widest spread variety of wheat through the historic ages until the late 19th century when common wheat (*T. aestivum* L.) with higher yields prevailed (Schwanitz, 1967).

The total area of spelt (špalda in Czech, samopše in Old Slavic, dinkel in German) in Europe is currently approx. 14 to 18 thousand ha. It is also a traditional crop grown mainly in harsher, more extensive conditions in Austria, Switzerland, Germany, Belgium and North Spain.

Today's new interest in spelt is mainly due to its specific sensoric properties (potential use of spelt for production of special types of pastry, wholemeal bread, as basis or additives in pastries and other foodstuffs recommended as healthy food). In comparison with common wheat spelt contains more proteins, gluten, vitamins (B1, B2) and minerals (iron, copper and zinc) appreciated in human food. Also the content of some essential amino acids is higher (Chrenková et al., 2000; Moudrý, Dvořáček, 1999).

Although the growing principles for spelt are similar to those for common wheat, a growing of spelt is more modest, less demanding, more resistant,

more able to achieve an acceptable yield in less favourable or unfavourable conditions, more able to use nutrients than common wheat. It particularly suits ecological farming and low input growing systems (Kling, 1988; Eusterschulte, Kahnt, 1995). However it is difficult to thresh (about 80 per cent of grains remain in hulls and has to be hulled); this disadvantage prevents spelt from further expansion.

In the Czech Republic a number of spelt genotypes has been tested since 1990 in growing regions, mainly ecological farms, exceeding 600 ha. Consumers and producers are mostly interested in ecologically grown spelt untreated with mineral fertilizers, pesticides and growth regulators. Such spelt is greatly demanded on foreign markets. This is why spelt varieties from ecological farming in comparison with standard breadmaking variety of common wheat were evaluated in our tests.

MATERIAL AND METHODS

The spelt tests were established in the years 1996 to 1998 at the Uhříněves trial station of the Czech University of Agriculture Prague. The Uhříněves trial station is certified for test establishment in ecological farming (4 years after conversion). It is located in a sugar beet growing region with clay brown soils of the production potential of 84 points. The annual mean temperature is 8.3 °C, the annual mean precipitation is 575 mm. Table I shows the weather pattern in the trial years.

I. Weather pattern (Prague-Uhříněves) in the vegetation period from 1996 to 1998 and long-time mean values

Month	Long-time mean values		1996		1997		1998	
	mean temperature (°C)	mean precipitation (mm)	mean temperature (°C)	mean precipitation (mm)	mean temperature (°C)	mean precipitation (mm)	mean temperature (°C)	mean precipitation (mm)
4	8.2	46	9.5	23.4	6.3	35.1	8.4	28.4
5	13.4	65	12.4	169.7	14.6	25.7	12.9	71.2
6	16.3	74	16.8	110.6	17.0	84.1	16.9	95.7
7	18.2	74	16.6	105.7	17.0	110.2	17.1	96.1
8	17.5	72	17.5	57.5	19.5	60.5	18.2	58.9
9	14.0	49	10.7	48.9	12.8	48.0	12.2	35.6

The trials were established by using the randomised block method in four repeats, trial plot area 15 m², seeding rate 250 germinating grains per m². The forecrop was manured potatoes. No mineral fertilizers, pesticides and growth regulators were used in the trials established in ecological growing system according to the IFOAM regulations and the Methodological Directive for Ecological Farming issued by the Czech Ministry of Agriculture.

Applied spelt varieties: Rouquin (Belgium, 1979), Oberkulmer Rotkorn (Switzerland, 1948), Schwabenkorn (Germany, 1978), Steiners roter Tiroler Dinkel (Germany, 1916), Altgold (Switzerland, 1952). The Czechoslovak variety of common wheat Hana (1985, quality group A) was used as the check variety.

Grain samples after harvest of trial varieties were used for evaluation of milling and baking quality. The evaluation of technological quality included grain analyses, milling test (laboratory mill Bühler), analyses of laboratory produced flours, rheological test of flours in farinograph, test baking and evaluation of made pastry.

Applied methods:

- Grain evaluation: test weight ČSN 46 1010, falling number ČSN ISO 3093 (46 1018), ash content in grain ČSN ISO 2171 (46 1019), protein content ČSN ISO 1871 (56 0020), SDS-test ČSN 46 1021, wet gluten content ČSN 56 0512-10;
- Grain preparation for milling and test milling in laboratory mill Bühler: methodologies of the former Research Institute of Milling and Baking Industry Prague;
- Analyses of flours: ČSN 56 0512;
- Rheological test in farinograph: ICC Standard No. 115;
- Test baking: automatic baking machine HB-021 3, applied formula: 300 g of flour, 10 g of sugar, 5 g of salt, 3 g of dried yeast, 10 g of fat, 190 ml of water.

One-way variance analysis was used for statistical evaluation of grain quality indicators, with statistically evident difference between individual varieties verified by means of Scheffe's test.

RESULTS AND DISCUSSION

Although special literature contains a number of information about agronomical properties of hulled wheat including spelt (Eusterschulte, Kahnt, 1995; Jorgensen et al., 1996; Rügger, Winzeler, 1993) there is no detailed information about milling and baking characteristics of such wheat, in particular from ecological growing system. There is also a considerable variability between quality indicators of individual spelt genotypes.

The authors therefore aimed at quality evaluation of a set of spelt varieties which includes both the old, classical varieties (Steiners roter Tiroler Dinkel, Oberkulmer Rotkorn and the most spread post-war Swiss variety Altgold) and more new and modern ones (the most spread German variety Schwabenkorn and, in particular, the Belgian variety Rouquin of a character already close to common wheat).

Grain quality evaluation

Table II shows the results of grain quality evaluation. Grain test weight of spelt varieties was relatively low in all three years of trial (720–740 g.l⁻¹), lower than the value of the check variety of winter wheat Hana and in all cases below the requirement on breadmaking wheat (780 g.l⁻¹). On the other hand, it was close to the values published for spelt in West Europe (740–760 g.l⁻¹).

Thousand kernels weight (TKW) of the evaluated varieties of spelt were higher than the value of Hana. In the years 1996 and 1998 it exceeded 50 g in all spelt varieties while in 1997 it was lower by about 3 g. The values of TKW in Hana moved between 43.6 g (1998) and 47.1 g (1996). Based on the results of their trials of select spelt varieties Moudrý (1998) and Vlasák (1994) published similar data about relatively high TKW in spelt varieties.

The falling number values in spelt varieties were comparable with those of Hana, with the exception of Steiners roter Tiroler and Oberkulmer Rotkorn with a lower falling number values. In spite of this the values of all spelt varieties in all years exceed the commercial requirement on falling number value of 220 s.

Typically for spelt, ash content in grain in all three years of trial with values above 2 per cent exceeded the value of the common wheat Hana.

The published interval of protein content in grain is rather large in case of spelt (12–20%) (Cubadda, Marconi, 1995). According to Grella (1996), Hein (1997), Jorgensen, Olsen (1997) as well as other authors the protein content in grain shows a considerable variability in spelt according to variety and weather pattern in the year although it tends to be higher in spelt than in common wheat.

The interval of protein content in the evaluated spelt varieties was 13–15% in all three years (Hana 11% in 1996 and 1998, 12.9% in 1997) with a statistically evident difference between the spelt varieties and the check variety of winter wheat Hana. Steiners roter Tiroler, Schwabenkorn and Oberkulmer Rotkorn of spelt varieties showed the highest and Rouquin the lowest protein content in all three years of trials.

The wet gluten content in dry matter is high in spelt varieties (approx. 40%); this value complies with consumer's requirements (40–42%) and con-

siderably exceeds that of the check variety Hana (27 and 28% in 1996 and 1997, 30.7% in 1998). Like in case of protein content all spelt varieties and the check variety of common wheat show a statistically evident difference in wet gluten content in all three years of trial. Steiners roter Tiroler, Schwabenkorn and Oberkulmer Rotkorn of spelt varieties showed again the highest and Rouquin the lowest wet gluten content like in case of protein content. However, the quality of gluten in spelt varieties was lower than in the winter wheat variety Hana, the evidence of which are the low values of gluten index (50–60% of Hana on the average) and SDS-test (70–80% of Hana on the average) in spelt varieties, with the exception of Rouquin whose values are close to those of the check variety Hana.

Results of test milling in laboratory mill Bühler

According to Vlasák (1994) the long, deep groove in spelt grain will reduce milling yield so that spelt will be more suitable for wholemeal pastry. The yield of break flours and reduction flours as well as total yield of flours is comparable in the evaluated spelt varieties and the check variety Hana (total yield of flours about 70%).

The yield of semolinas in spelt varieties which is about 60% exceeds the value of the check variety Hana (103–109% of Hana). The peelability of semolinas in spelt varieties of 80–93% is comparable with that of the check variety of common wheat Hana (Table IV).

Quality evaluation of flours

The content of ash in flours is lower than in grain (meals). Unlike grain evaluation, the evaluation of flours shows less difference between spelt varieties and the check variety Hana – the content of ash in spelt varieties and in Hana is 0.5–0.7% and 0.4–0.5%, respectively.

The protein content in flour is higher than in meals by approx. 0.5–1.0%. Like in grain evaluation the highest protein content is in the spelt varieties Steiners roter Tiroler, Schwabenkorn and Oberkulmer Rotkorn (15–16%), with a lower content measured in Rouquin (about 14%) and the check variety Hana (12.1–12.8%). The wet gluten content is very high in spelt varieties (45–50%) and, except for Rouquin (about 40%), clearly exceeds the same value in Hana (32–36%). Like in meals the quality of gluten in spelt flours is lower than in Hana the evidence of which are the low values of gluten index (50–60% of Hana) and Zeleny sedimentation test (60–74% of Hana); nevertheless, they still exceed 20 ml which is the minimum requirement of customers. Falling number both in spelt varieties and Hana is even too high (above 300 s) in the years 1996 and 1998, with a reduction in 1997 (Table V).

Results of farinographic evaluation of flours and test baking

The following indicators were determined from farinogram: farinographic water absorption, dough development time, dough stability time and degree of softening. It is likely in evaluation of technological baking wheat quality that wheats with a higher-quality protein will have a higher value of water absorption, longer development and stability time and a lower value of degree of softening. Table 6 shows the results of farinographic evaluation of flours.

The values of water absorption are most frequently between 53–65% in European wheats and up to 70% in high-quality American ones. Both the evaluated spelt varieties and the check variety Hana achieved the average level of flour extraction (54–60% for spelt varieties, 62–65% for Hana).

Dough development time in the evaluated varieties makes 2–3.5 minutes, with the longest values found in Rouquin and Hana. Dough stability time in the evaluated spelt varieties makes 2–3 minutes (3–3.5 minutes in Rouquin as well as Hana). The values of degree of softening in the evaluated varieties are more different. The lowest and therefore the best ones were found in the check variety Hana (70–80 B.U.) and in Rouquin (80–100 B.U.) of spelt varieties. The other spelt varieties showed higher values of degree of softening (110–160 B.U.) characteristic of weaker doughs less resistant to mechanical stress. The overall evaluation of farinographic test results allows the statement that the check variety Hana has the best results, namely satisfactory (above 60%) water absorption, the longest (3.5 minutes) dough development time of all evaluated varieties, favourable (4.5–5 minutes) dough stability time, the lowest (70–80 B.U.) degree of softening of all evaluated varieties. Rouquin may also get a positive evaluation. High values of Rouquin dough indicators, in particular long stability time and low degree of softening, are also mentioned by Macháň et al. (1996) on the basis of their trials in spelt varieties in potato and sugar beet growing region. The spelt variety Steiners roter Tiroler with short dough development and stability time and fast and sharp degree of softening may be described as the worst variety in general.

The key indicator for baking test evaluation is specific volume of bread. The evaluated set of varieties showed considerable differences in this indicator (Table VI). The highest specific volume of bread was found in the check variety Hana (1890–1930 cm³) and the spelt variety Rouquin (1810–1940 cm³), the lowest one in Steiners roter Tiroler. Another part of baking test evaluation is sensoric evaluation of taste sensation, flexibility and porosity of crumb, crust parcelling and overall appearance of bread. Hana and Rouquin again achieved the highest total scores, with Steiners roter Tiroler receiving the worst evaluation.

Year	Variety	Test weight (g.l ⁻¹)	Thousands kernels weight (g)	Ash content in grain (%)	Falling number value (s)	Protein content in grain (%)	Wet gluten content (%)	Gluten index	SDS-test (ml)
1996	Rouquin (a)	758	54.7	2.13	295	13.3	36.7	68	50
	Schwabenkorn (b)	742	52.6	2.17	284	14.3	43.9	45	39
	Steiners roter Tiroler (c)	729	53.1	2.14	281	14.0	38.5	29	38
	Altgold (d)	731	52.4	2.21	292	13.4	37.8	27	30
	Oberkulmer Rotkorn (e)	742	54.9	2.15	278	14.2	41.6	47	38
	spelt varieties average	740	53.5	2.16	286	13.8	39.7	43	39
	Hana (f) (<i>T. aestivum</i>)	788	47.1	1.72	281	11.0	27.1	72	52
	% of spelt varieties average to Hana	93.9	113.6	125.6	102.0	138.0	146.5	59.7	75.0
	Rouquin (a)	729	50.5	2.08	234	13.0	38.8	55	49
	Schwabenkorn (b)	723	48.6	2.17	262	14.5	44.4	39	40
1997	Steiners roter Tiroler (c)	706	48.2	2.10	238	14.7	47.9	32	35
	Altgold (d)	727	49.1	2.14	262	13.9	41.5	29	33
	Oberkulmer Rotkorn (e)	722	49.3	2.06	239	14.5	43.9	41	42
	spelt varieties average	721	49.1	2.11	247	14.1	42.7	39	40
	Hana (f) (<i>T. aestivum</i>)	770	43.8	1.83	251	11.2	28.0	74	57
	% of spelt varieties average to Hana	93.6	112.1	115.3	93.2	125.9	152.5	52.7	70.2
	Rouquin (a)	738	52.1	2.17	254	13.6	38.3	59	47
	Schwabenkorn (b)	731	50.4	2.20	249	14.3	42.7	48	43
	Steiners roter Tiroler (c)	716	52.3	2.12	266	15.1	45.1	26	38
	Altgold (d)	730	52.9	2.18	272	14.7	43.9	34	32
1998	Oberkulmer Rotkorn (e)	728	51.8	2.22	261	14.5	41.8	33	45
	spelt varieties average	729	51.9	2.18	260	14.4	42.4	40	41
	Hana (f) (<i>T. aestivum</i>)	781	43.6	1.83	269	12.9	30.7	68	50
	% of spelt varieties average to Hana	93.3	119.0	119.1	96.7	111.6	138.1	58.8	82.0

III. One-way analysis of variance and homogenous groups in the choiced grain quality indicators among varieties (Scheffe, $\alpha = 0.05$)

Year	Variety	Protein content in grain (%)	Mean square - between groups - within groups	F-ratio	Homogenous groups	Wet gluten content (%)	Mean square - between groups - within groups	F-ratio	Homogenous groups
1996	Rouquin	13.3			A	36.7			A
	Schwabenkorn	14.3			B	43.9			B
	Steiners roter Tiroler	14.0	10.89	278.56	C	38.5	282.24	999.99	C
	Altgold	13.4	0.02		A	37.8	0.04		A
	Oberkulmer Rotkorn	14.2			B	41.6			D
	Hana (<i>T. aestivum</i>)	11.0			D	27.1			E
1997	Rouquin	13.0			A	38.8			A
	Schwabenkorn	14.5			B	44.4			B
	Steiners roter Tiroler	14.7	12.25	364.98	B	47.9	396.01	999.99	C
	Altgold	13.9	0.02		C	41.5	0.03		D
	Oberkulmer Rotkorn	14.5			B	43.9			B
	Hana (<i>T. aestivum</i>)	11.2			D	28.0			E
1998	Rouquin	13.6			A	38.3			A
	Schwabenkorn	14.3			B	42.7			B
	Steiners roter Tiroler	15.1	4.84	151.65	C	45.1	207.36	999.99	C
	Altgold	14.7	0.02		D	43.9	0.04		B
	Oberkulmer Rotkorn	14.5			B	41.8			B
	Hana (<i>T. aestivum</i>)	12.9			E	30.7			D

Year	Variety	Protein content in grain (%)	Mean square - between groups - within groups	F-ratio	Homogenous groups	Wet gluten content (%)	Mean square - between groups - within groups	F-ratio	Homogenous groups
1996	Rouquin	50			A	295			A
	Schwabenkorn	39			B	284			B
	Steiners roter Tiroler	38	196.00	999.99	B	281	289.00	999.99	B
	Altgold	30	1.00		C	292	9.00		A
	Oberkulmer Rotkorn	38			B	278			C
	Hana (<i>T. aestivum</i>)	52			A	281			B
1997	Rouquin	49			A	234			A
	Schwabenkorn	40			B	262			B
	Steiners roter Tiroler	35	576.00	999.99	C	238	784.00	999.99	A
	Altgold	33	1.00		C	262	4.00		B
	Oberkulmer Rotkorn	42			B	239			A
	Hana (<i>T. aestivum</i>)	57			D	251			C
1998	Rouquin	47			A	254			A
	Schwabenkorn	43			B	249			B
	Steiners roter Tiroler	38	324.00	999.99	C	266	529.00	999.99	C
	Altgold	32	4.00		D	272	9.00		D
	Oberkulmer Rotkorn	45			A B	261			E
	Hana (<i>T. aestivum</i>)	50			E	269			C

IV. Milling test results

Year	Variety	Yield of break flours (%)	Yield of reduction flours (%)	Yield of flours total (%)	Yield of break bran (%)	Yield of reduction bran (%)	Yield of bran total (%)	Yield of semolinassemolinas (%)	Peelability of semolinassemolinas (%)	Yield acc. to Mohse (%)
1996	Rouquin	17.5	53.6	71.1	20.7	3.9	24.6	57.5	93.2	1.3
	Schwabenkorn	15.3	54.6	69.9	20.7	5.2	25.9	59.8	91.3	3.6
	Steiners roter Tiroler	15.9	55.1	71.0	19.9	6.3	26.2	61.4	89.7	1.2
	Altgold	17.2	56.4	73.6	18.3	5.3	23.6	61.7	90.0	0.3
	Oberkulmer Rotkorn	17.2	54.1	71.3	18.9	6.8	25.7	60.9	88.8	1.8
	spelt varieties average	16.6	54.8	71.4	19.7	5.5	25.2	60.3	90.0	1.6
	Hana (<i>T. aestivum</i>)	17.6	52.7	70.3	18.1	5.8	23.9	58.5	90.1	4.0
	% of spelt varieties average to Hana	94.3	104.0	101.6	108.8	94.8	105.4	103.1	99.9	41.0
	Rouquin	15.3	53.0	68.3	19.3	8.3	27.6	61.3	86.5	0.2
	Schwabenkorn	15.8	54.8	70.6	18.8	6.7	25.5	61.5	89.1	5.0
1997	Steiners roter Tiroler	13.3	55.3	68.6	19.0	8.3	27.3	63.6	86.9	1.5
	Altgold	13.8	56.8	70.6	18.0	9.3	27.3	66.1	85.9	4.5
	Oberkulmer Rotkorn	15.5	52.3	67.8	19.3	10.8	30.1	63.1	82.9	3.5
	spelt varieties average	14.7	54.4	69.1	18.9	8.7	27.6	63.1	86.2	2.9
	Hana (<i>T. aestivum</i>)	15.5	49.8	70.0	18.0	7.8	25.8	57.6	86.5	5.3
	% of spelt varieties average to Hana	94.8	109.2	98.7	105.0	111.5	107.0	109.5	99.7	55.5
	Rouquin	20.2	50.0	70.2	18.5	10.8	29.3	60.8	82.2	1.1
	Schwabenkorn	16.9	48.3	65.2	20.1	14.3	34.4	62.6	77.2	3.2
	Steiners roter Tiroler	19.2	51.1	70.3	19.8	8.5	28.3	59.6	85.7	2.4
	Altgold	18.8	52.1	70.9	19.0	8.7	27.7	60.8	85.7	0.8
1998	Oberkulmer Rotkorn	18.3	51.9	70.2	18.2	10.1	28.3	62.0	83.7	0.9
	spelt varieties average	18.7	50.7	69.4	19.1	10.5	29.6	61.2	82.8	1.7
	Hana (<i>T. aestivum</i>)	15.5	49.8	65.3	18.0	7.8	25.8	57.6	86.5	5.3
	% of spelt varieties average to Hana	120.6	101.8	106.3	106.1	134.6	119.7	106.3	95.7	31.7

Year	Variety	Moisture content (%)	Ash content (%)	Protein content (%)	Wet gluten content (%)	Gluten index	Sedimentation value by Zeleny (ml)	Falling number value (s)
1996	Rouquin	12.9	0.64	13.9	42.7	69	31	296
	Schwabenkorn	13.0	0.67	15.2	47.5	52	21	319
	Steiners roter Tiroler	13.0	0.63	15.2	47.2	35	19	322
	Altgold	12.5	0.68	14.9	45.8	37	23	335
	Oberkulmer Rotkorn	12.3	0.58	14.6	46.3	52	25	287
1997	spelt varieties average	12.7	0.64	14.8	45.9	49.0	23.8	312.0
	Hana (<i>T. aestivum</i>)	12.1	0.43	12.1	32.6	78	32	289
	% of spelt varieties average to Hana	105.0	148.8	122.3	140.8	62.8	74.4	107.9
	Rouquin	11.6	0.57	14.1	43.3	62	33	234
	Schwabenkorn	12.5	0.52	15.2	49.3	48	20	262
1998	Steiners roter Tiroler	11.6	0.54	15.5	50.3	42	20	195
	Altgold	12.0	0.53	15.0	48.1	40	20	196
	Oberkulmer Rotkorn	12.1	0.51	15.9	52.7	58	30	219
	spelt varieties average	12.0	0.53	15.1	48.7	50.0	24.6	211.2
	Hana (<i>T. aestivum</i>)	11.1	0.45	12.5	32.8	80	38	242
1998	% of spelt varieties average to Hana	108.1	117.8	120.8	148.5	62.5	64.7	91.4
	Rouquin	11.8	0.58	13.7	40.6	70	31	293
	Schwabenkorn	12.1	0.56	15.2	49.7	55	20	334
	Steiners roter Tiroler	10.9	0.70	16.3	53.9	38	19	323
	Altgold	10.8	0.67	15.8	50.1	39	18	340
1998	Oberkulmer Rotkorn	11.1	0.62	15.0	49.6	47	20	318
	spelt varieties average	11.3	0.63	15.2	48.8	36.0	21.6	321.6
	Hana (<i>T. aestivum</i>)	10.9	0.48	12.8	36.8	73	36	297
	% of spelt varieties average to Hana	103.7	131.3	118.8	132.6	49.3	60.0	108.3

VI. Farinographic evaluation of flours and baking test

Year	Variety	Farinograph water absorption (%)	Dough development time (min)	Dough stability time (min)	Degree of softening (Brabender units B.U.)	Specific volume of bread (cm ³)	Sensory evaluation total (maximum 10 scores)
1996	Rouquin	59.8	3.5	4.5	90	1900	9
	Schwabenkorn	56.7	2.5	3.0	110	1690	7
	Steiners roter Tiroler	54.2	2.0	2.0	150	1570	5
	Altgold	55.9	2.0	2.5	120	1590	6
	Oberkulmer Rotkorn	56.6	2.5	3.0	110	1610	7
1996	spelt varieties average	56.6	2.5	3.0	116	1672	6.8
	Hana (<i>T. aestivum</i>)	62.1	3.5	5.0	70	1890	9
	% of spelt varieties average to Hana	91.1	71.4	60.0	165.7	88.5	75.6
	Rouquin	60.7	3.0	4.0	100	1810	9
	Schwabenkorn	54.5	2.0	2.5	120	1700	6
1997	Steiners roter Tiroler	54.6	2.0	2.0	160	1530	5
	Altgold	58.9	2.0	2.0	130	1610	5
	Oberkulmer Rotkorn	60.2	3.0	2.5	130	1670	7
	spelt varieties average	54.8	2.4	2.6	128	1664	6.4
	Hana (<i>T. aestivum</i>)	65.1	3.5	4.0	80	1950	10
1997	% of spelt varieties average to Hana	88.8	68.6	65.0	160.0	85.3	64.0
	Rouquin	58.4	3.5	3.5	80	1940	10
	Schwabenkorn	56.9	2.5	2.0	110	1710	8
	Steiners roter Tiroler	55.8	2.0	2.0	130	1610	6
	Altgold	56.5	2.5	2.0	130	1650	5
1998	Oberkulmer Rotkorn	59.7	2.5	2.5	120	1660	7
	spelt varieties average	57.5	2.6	2.4	114	1714	7.2
	Hana (<i>T. aestivum</i>)	62.3	3.0	4.5	80	1930	10
	% of spelt varieties average to Hana	92.3	86.7	53.3	142.5	88.8	72.0

It is therefore possible to say that the overall evaluation of baking test well corresponds with the farinographic evaluation. The varieties which achieved favourable farinographic evaluation were also the best in the baking test (Hana, Rouquin), while those whose values of farinographic indicators were unfavourable were worse also in baking test (Steiners roter Tiroler, Oberkullmer Rotkorn).

Finally, it is possible to say that the above mentioned results of milling and baking quality evaluation proved a good quality of spelt from ecological growing system. In comparison with the check variety of winter wheat the evaluated spelt varieties maintained their typical character of quality indicators, particularly a high protein content, wet gluten and ash content, even without mineral fertilizers, pesticides and growth regulators.

The evaluated spelt varieties also confirmed a considerable variability on the level of evaluated quality indicators; in particular, the quality of the newer variety Rouquin (mainly the results of sedimentation tests but also farinographic and baking test evaluation) moves this variety nearer to common wheat, rather than the old, classical spelt varieties which achieved worse results in this evaluation but maintained the original properties of this type of wheat. However, one should bear in mind that in the above mentioned period of time the check variety Hana belonged to the best-quality bread-making varieties of Czech crop production.

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Received for publication on October 30, 2000
Accepted for publication on June 26, 2001

CAPOUCHOVÁ, I. (Česká zemědělská univerzita, katedra rostlinné výroby, Praha, Česká republika):

Technologická jakost pšenice špaldy (*Triticum spelta* L.) z ekologického způsobu pěstování.

Scientia Agric. Bohem., 32, 2001: 307–322.

V tříletých pokusech (1996–1998) byla hodnocena mlynářská a pekařská jakost souboru odrůd pšenice špaldy (*T. spelta* L.) z ekologického systému pěstování v úrodné řepářské oblasti středních Čech. Použité odrůdy špaldy: Rouquin (Belgie, 1979), Oberkullmer Rotkorn (Švýcarsko, 1948), Schwabekorn (Německo, 1978), Steiners roter Tiroler (Německo, 1916), Altgold (Švýcarsko, 1952). Jako kontrola byla použita kvalitní česká potravinářská odrůda pšenice obecné (*T. aestivum* L.) Hana (1985, jakostní skupina A).

Hodnocené odrůdy špaldy se ve srovnání s kontrolní odrůdou Hana vyznačovaly vyšší hmotností tisíce zrn (HTZ) a vyšším obsahem popelovin. Pro zrno špaldy je typický relativně vysoký obsah N-látek – u hodnocených odrůd špaldy se v našich pokusech pohyboval ve všech třech letech mezi 13 až 15 % (kontrolní odrůda Hana 11–12,9 %). Ve všech třech pokusných letech byla zjištěna statisticky průkazná diference mezi odrůdami špaldy a odrůdou Hana. Nejvyšší obsah N-látek byl ve všech třech letech zaznamenán u odrůdy Steiners roter Tiroler, nejnižší z odrůd špaldy u odrůdy Rouquin.

Obsah mokrého lepku v sušině byl rovněž u odrůd špaldy vysoký (kolem 40 %) a převyšoval značně kontrolní odrůdu Hana (27–31 %). I zde byla ve všech sledovaných letech zjištěna statisticky průkazná diference mezi všemi odrůdami špaldy a kontrolní odrůdou. Ve srovnání s pšenicí obecnou Hana byl lepek odrůd špaldy méně kvalitní, o čemž svědčí nízké hodnoty Gluten Indexu, dosahující v průměru u odrůd špaldy 50–

60 % odrůdy Hana, a SDS-testu (70–80 % odrůdy Hana). Výjimku tvořila odrůda špalda Rouquin, která se v těchto ukazatelích blížila kontrolní odrůdě Hana.

Celková výtěžnost mouk, zjištěná při mlecím pokusu na laboratorním mlýnu Bühler, se pohybovala u odrůd špalda kolem 70 % a byla na úrovni srovnatelné s odrůdou Hana.

Pro jakostní hodnocení mouk byla použita mouka odpovídající granulaci běžné pekařské mouce T 530. U hodnocených špaldových mouk byl zjištěn, stejně jako při hodnocení zrna, vysoký obsah N-látek a mokrého lepku, nejvyšší opět u odrůdy Steiners roter Tiroler, nejnižší z odrůd špalda u odrůdy Rouquin. Obdobně jako lepek šrotů byl i lepek mouk ve srovnání s kontrolní odrůdou Hana méně kvalitní (hodnoty Gluten Indexu 50–60 % odrůdy Hana, hodnoty Zeleného sedimentačního testu 60–74 % odrůdy Hana).

Z reologického hodnocení mouk na farinografu vyšla z odrůd špalda nejlépe odrůda Rouquin, která dosáhla uspokojivé vaznosti (kolem 60 %), doby vývinu těsta nad 3 minuty, příznivé doby stability těsta (3,5–4,5 minuty) a poklesu konzistence (80–100 B. J.). Těmito hodnotami se blížila kontrolní odrůdě Hana. Ostatní odrůdy špalda dosáhly méně příznivých hodnot farinografických ukazatelů, charakteristických pro slabší těsta s menší odolností vůči mechanickému namáhání.

Výsledky pekařského pokusu dobře korespondují s farinografickým hodnocením. Odrůdy, které dosáhly příznivého hodnocení na farinografu, obstály nejlépe i při pokusném pečení (Hana, Rouquin) a naopak odrůdy, které dosáhly méně příznivých hodnot farinografických ukazatelů, skončily i v pekařském pokusu hůře (Steiners roter Tiroler, Oberkulmer Rotkorn, Altgold).

Celkově lze konstatovat, že mezi sledovanými odrůdami špalda se potvrdila značná variabilita v úrovni hodnocených jakostních ukazatelů, kdy zejména novější odrůda Rouquin se svou kvalitou (zejména výsledky sedimentačních testů, ale i farinografickým hodnocením a výsledky pekařského pokusu) ukázala na úrovni srovnatelné s kontrolní odrůdou pšenice obecné Hana, ale vzdaluje se starým, klasickým odrůdám špalda, které dosáhly při tomto hodnocení sice horších výsledků, ale podržují si původní vlastnosti tohoto druhu pšenice.

Naše hodnocení současně potvrdilo, že při pěstování v ekologickém systému (bez hnojení průmyslovými hnojivy a bez použití pesticidů a regulátorů růstu) si hodnocené odrůdy špalda podržely svůj typický charakter jakostních ukazatelů – zejména vysoký obsah N-látek, lepku a popelovin ve srovnání s kontrolní odrůdou pšenice obecné.

pšenice špalda; odrůdy; ekologický systém pěstování; technologická jakost

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