

Table S1 Quality parameters of SHWSD

Year / location	Material	Zeleny-sedimentation value (ZSV)	Protein content (%)		Dough development time (DDT)	Dough stability time (DST)	Farinograph quality number (FQN)	Gluten index (%)	Wet gluten (g)	Dry gluten (g)
			Flour	Grain						
2015 CZ	STD1	8.00 ± 1.00 c	14.40 ± 0.15 e	16.49 ± 0.12 e	0.70 ± 0.20 bc	0.73 ± 0.15 b	11.00 ± 3.00 bc	0.94 ± 0.23 c	27.98 ± 6.50 c	11.90 ± 2.83 c
2015 CZ	STD2	14.67 ± 0.58 b	15.59 ± 0.06 d	17.11 ± 0.09 d	0.57 ± 0.23 c	1.00 ± 0.10 b	9.67 ± 5.77 c	11.61 ± 2.11 b	45.02 ± 2.03 a	17.65 ± 1.17 ab
2015 CZ	STD3	15.33 ± 0.58 a	16.25 ± 0.11 b	18.02 ± 0.10 b	0.90 ± 0.36 bc	0.87 ± 0.29 b	16.33 ± 5.69 b	21.73 ± 13.64 a	45.99 ± 2.16 a	18.20 ± 0.89 a
2015 CZ	STD4	15.00 ± 1.00 ab	15.82 ± 0.13 c	17.67 ± 0.15 c	1.00 ± 0.44 bc	1.17 ± 0.12 b	12.67 ± 2.89 bc	10.63 ± 7.11 b	42.31 ± 2.62 ab	17.74 ± 1.87 a
2015 CZ	STD5	14.67 ± 0.58 b	13.86 ± 0.11 f	15.43 ± 0.07 f	1.00 ± 0 bc	1.03 ± 0.12 b	15.67 ± 3.06 bc	11.33 ± 4.46 b	43.72 ± 3.48 a	18.41 ± 2.39 a
2015 CZ	STD6	14.67 ± 0.58 b	13.64 ± 0.06 g	15.33 ± 0.08 f	0.93 ± 0.06 bc	1.03 ± 0.42 b	11.67 ± 1.15 bc	13.25 ± 4.63 ab	37.92 ± 1.97 b	15.04 ± 1.51 b
2015 CZ	STD7	14.00 ± 0 b	17.38 ± 0.07 a	19.78 ± 0.13 a	0.95 ± 0.07 bc	0.80*	9.50 ± 0.71 c	8.95 ± 1.74 b	43.72 ± 3.48 a	19.99 ± 0.85 a
2015 CZ	CN16	—**	—**	—**	1.77 ± 0.12 a	2.13 ± 0.23 a	—**	—**	—**	—**
2015 WJ	STD2	16.67 ± 1.15 a	17.76 ± 0.05 b	19.52 ± 0.08 b	1.50*	1.80*	27.00*	19.18 ± 8.08 a	55.07 ± 5.37 a	18.92 ± 1.68 b
2015 WJ	STD3	17.67 ± 0.58 a	18.21 ± 0.16 a	20.31 ± 0.07 a	1.07 ± 0.29 a	1.40 ± 0.17 b	17.00 ± 1.00 b	11.30 ± 3.05 a	45.40 ± 3.04 b	23.06 ± 3.52 a
2015 WJ	STD5	14.67 ± 0.58 b	14.04 ± 0.06 c	14.69 ± 0.09 c	0.83 ± 0.49 a	1.73 ± 0.21 ab	10.00 ± 8.66 b	8.81 ± 4.20 a	39.24 ± 0.96 c	17.52 ± 2.38 b
2015 WJ	CN16	12.33 ± 0.58 c	8.65 ± 0.02 d	10.51 ± 0.04 d	1.50 ± 0.42 a	2.15 ± 0.21 a	27.50 ± 0.71 a	33.25 ± 3.5 a	22.34 ± 2.11 d	7.83 ± 0.59 c
2016 CZ	STD1	12.33 ± 0.58 c	16.18 ± 0.05 c	18.02 ± 0.02 c	0.70*	1.00*	10.00*	4.93 ± 3.90 c	42.36 ± 4.45 b	18.42 ± 2.33 ab
2016 CZ	STD2	15.67 ± 0.58 b	17.72 ± 0.10 a	19.37 ± 0.07 a	0.83 ± 0.12 b	1.50 ± 0.20 b	11.67 ± 1.15 b	15.60 ± 2.16 bc	52.28 ± 0.95 a	21.89 ± 2.74 a
2016 CZ	STD4	16.17 ± 1.26 b	16.93 ± 0.04 b	18.62 ± 0.19 b	0.77 ± 0.12 b	1.10 ± 0.17 c	12.00 ± 2.65 b	11.07 ± 5.92 bc	48.94 ± 4.86 a	21.02 ± 2.98 a
2016 CZ	STD5	13.67 ± 0.58 c	14.57 ± 0.05 e	16.12 ± 0.09 e	0.70 ± 0 b	0.75 ± 0.07 d	10.50 ± 0.71 b	11.74 ± 2.44 bc	45.62 ± 1.00 b	17.94 ± 1.33 bc
2016 CZ	STD6	15.33 ± 0.58 b	15.14 ± 0.07 d	16.99 ± 0.09 d	0.80 ± 0.26 b	1.03 ± 0.15 cd	11.67 ± 1.53 b	18.97 ± 6.86 b	46.15 ± 2.35 a	20.62 ± 0.80 a
2016 CZ	CN16	24.33 ± 1.15 a	11.10 ± 0.05 f	13.09 ± 0.03 f	2.73 ± 0.21 a	4.00 ± 0.10 a	49.33 ± 2.52 a	56.84 ± 3.94 a	31.33 ± 0.85 c	11.97 ± 0.61 c
2016 WJ	STD1	11.33 ± 1.15 d	12.81 ± 0.02 e	14.37 ± 0.03 d	0.70*	0.80*	10.00*	1.57 ± 0.66 d	25.15 ± 2.96 c	12.15 ± 2.34 b
2016 WJ	STD2	15.67 ± 0.58 b	13.78 ± 0.07 b	15.41 ± 0.06 c	—**	—**	—**	14.83 ± 3.98 c	41.00 ± 4.43 ab	17.29 ± 3.18 a
2016 WJ	STD3	15.00 ± 0.00 b	13.12 ± 0.03 c	14.36 ± 0.10 de	1.03 ± 0.32 b	1.20 ± 0.53 b	13.00 ± 2.65 b	24.52 ± 3.10 b	38.27 ± 3.01 bc	16.68 ± 1.37 a
2016 WJ	STD4	13.33 ± 0.58 c	15.14 ± 0.04 a	16.77 ± 0.05 a	0.77 ± 0.12 b	1.27 ± 0.31 b	16.67 ± 5.51 b	15.44 ± 4.11 bc	44.47 ± 3.38 a	17.62 ± 0.97 a
2016 WJ	STD6	11.33 ± 0.58 d	13.03 ± 0.10 d	14.20 ± 0.11 f	0.80 ± 0.10 b	0.87 ± 0.06 b	11.00 ± 1.00 b	11.08 ± 1.03 c	37.01 ± 3.07 bc	14.86 ± 1.31 ab
2016 WJ	STD7	13.00 ± 1.00 c	15.18 ± 0.03 a	16.64 ± 0.06 b	0.77 ± 0.12 b	1.03 ± 0.21 b	10.33 ± 0.58 b	6.98 ± 4.33 cd	43.31 ± 2.94 a	17.29 ± 1.60 a
2016 WJ	CN16	28.67 ± 1.15 a	11.71 ± 0.02 f	14.23 ± 0.06 ef	2.73 ± 0.46 a	3.23 ± 0.29 a	46.00 ± 5.29 a	52.38 ± 1.08 a	35.42 ± 0.57 c	12.92 ± 0.40 b

Note: *and** indicate that these parameters were tested without replication or were not tested due to shortage of seeds. Different lowercase letters indicate significance at $P < 0.05$.

Table S2 Glutenins and gliadins of SHWSD as revealed by RP-HPLC

Year / Location	Material	HMW-GS (mAU × min)	LMW-GS (mAU × min)	Glutenin (mAU × min)	HMW-GS/ Glutenin	LMW-GS/ Glutenin	ω-gliadin (mAU × min)	α,β-gliadin (mAU × min)
2015 CZ	STD1	9375.93 ± 160.86 cd	42524.82 ± 371.97 g	51900.75 ± 494.49 g	0.18 ± 0.002 c	0.82 ± 0.002 c	13734.51 ± 117.2 c	42687.26 ± 96.79 d
2015 CZ	STD2	12788.91 ± 525.88 b	67942.54 ± 633.37 a	80731.45 ± 1130.29 a	0.16 ± 0.004 e	0.84 ± 0.004 a	13809.57 ± 92.0 c	43773.25 ± 238.45 d
2015 CZ	STD3	12765.68 ± 45.16 b	59243.24 ± 585.27 d	72008.92 ± 628.31 d	0.18 ± 0.001 c	0.82 ± 0.001 c	16394.56 ± 1267.4 a	48856.43 ± 381.70 b
2015 CZ	STD4	9021.33 ± 615.36 d	44983.01 ± 181.93 f	54004.34 ± 797.29 f	0.17 ± 0.009 d	0.83 ± 0.009 b	16430.34 ± 198.16 a	46926.92 ± 1889.93 c
2015 CZ	STD5	15005.22 ± 109.86 a	64462.55 ± 726.10 b	79467.77 ± 801.74 b	0.19 ± 0.001 b	0.81 ± 0.001 d	13985.80 ± 581.33 bc	40491.73 ± 361.71 e
2015 CZ	STD6	9722.14 ± 145.67 c	51760.58 ± 422.21 e	61482.72 ± 446.91 e	0.16 ± 0.002 e	0.84 ± 0.002 a	13794.42 ± 245.49 c	39621.70 ± 133.68 e
2015 CZ	STD7	13072.79 ± 185.92 b	62760.83 ± 544.82 c	75833.62 ± 365.92 c	0.17 ± 0.003 d	0.83 ± 0.003 b	14813.59 ± 506.48 b	50586.67 ± 173.55 a
2015 CZ	CN16	15432.17 ± 83.08 a	18235.79 ± 338.97 h	33667.96 ± 324.47 h	0.46 ± 0.005 a	0.54 ± 0.005 e	11911.45 ± 181.41 d	21572.41 ± 113.72 f
2015 WJ	STD2	10911.01 ± 212.02 b	35764.64 ± 1296.15 a	46675.64 ± 1205.81 a	0.23 ± 0.009 b	0.77 ± 0.009 b	12013.50 ± 511.42 a	48677.67 ± 620.18 a
2015 WJ	STD3	9143.79 ± 257.68 c	34896.41 ± 214.93 a	44040.21 ± 313.89 b	0.21 ± 0.005 c	0.79 ± 0.005 a	11624.82 ± 159.21 a	47145.82 ± 369.89 b
2015 WJ	STD5	7139.08 ± 95.99 d	25599.57 ± 270.56 b	32738.64 ± 210.68 c	0.22 ± 0.004 c	0.78 ± 0.004 a	10943.35 ± 130.19 b	36552.45 ± 406.78 c
2015 WJ	CN16	13877.96 ± 38.50 a	16874.50 ± 286.07 c	30752.45 ± 322.17 d	0.45 ± 0.004 a	0.55 ± 0.004 c	10024.32 ± 192.38 c	17930.72 ± 101.22 d
2016 CZ	STD1	6242.98 ± 109.53 f	25606.42 ± 250.35 d	31849.40 ± 296.10 e	0.20 ± 0.003 c	0.80 ± 0.003 a	16063.36 ± 378.82 a	44819.31 ± 452.43 c
2016 CZ	STD2	9373.78 ± 124.67 d	38458.55 ± 504.46 a	47832.34 ± 621.62 b	0.20 ± 0.001 c	0.80 ± 0.001 a	12400.81 ± 467.02 c	47834.96 ± 94.01 a
2016 CZ	STD4	14227.46 ± 34.30 b	58486.86 ± 636.14 a	72714.32 ± 606.78 a	0.20 ± 0.002 c	0.80 ± 0.002 a	12817.83 ± 612.04 c	46625.20 ± 273.74 b
2016 CZ	STD5	9891.91 ± 393.13 c	37077.94 ± 278.32 b	46969.86 ± 646.66 b	0.21 ± 0.006 b	0.79 ± 0.006 b	12051.31 ± 472.81 c	39717.20 ± 157.37 d
2016 CZ	STD6	6930.12 ± 122.43 e	27547.91 ± 217.13 c	34478.02 ± 119.15 d	0.20 ± 0.004 c	0.80 ± 0.004 a	10776.53 ± 414.82 d	38520.50 ± 205.20 e
2016 CZ	CN16	19306.55 ± 227.79 a	22418.93 ± 253.26 f	41725.48 ± 371.24 c	0.46 ± 0.004 a	0.54 ± 0.004 c	14536.92 ± 136.48 b	24461.62 ± 92.97 f
2016 WJ	STD1	7800.77 ± 71.10 f	31278.47 ± 275.00 d	39079.24 ± 327.25 e	0.20 ± 0.001 d	0.80 ± 0.001 c	10514.58 ± 231.03 b	33264.86 ± 252.20 c
2016 WJ	STD2	11828.28 ± 134.8 b	47310.97 ± 785.64 b	59139.25 ± 918.40 b	0.20 ± 0.001 d	0.80 ± 0.001 c	10000.24 ± 176.88 c	34572.76 ± 232.90 b
2016 WJ	STD3	11545.96 ± 214.14 b	39120.59 ± 417.37 c	50666.56 ± 617.52 c	0.23 ± 0.002 b	0.77 ± 0.002 e	7564.00 ± 105.15 f	32377.56 ± 149.07 d
2016 WJ	STD4	8315.77 ± 241.26 e	31425.66 ± 446.68 d	39741.42 ± 567.11 e	0.21 ± 0.005 c	0.79 ± 0.005 d	9205.52 ± 416.94 d	38770.96 ± 225.59 a
2016 WJ	STD6	8982.32 ± 176.79 d	40166.44 ± 360.89 c	49148.76 ± 492.23 d	0.18 ± 0.002 e	0.82 ± 0.002 b	8479.92 ± 206.41 e	30487.05 ± 216.50 e
2016 WJ	STD7	10923.20 ± 499.09 c	51713.80 ± 1195.44 a	62637.01 ± 1496.27 a	0.17 ± 0.006 f	0.83 ± 0.006 a	10523.76 ± 137.23 b	38740.71 ± 114.37 a
2016 WJ	CN16	19083.41 ± 249.02 a	21239.91 ± 312.41 e	40323.32 ± 555.17 e	0.47 ± 0.001 a	0.53 ± 0.001 f	15554.36 ± 193.57 a	28127.59 ± 221.39 f

Table 2 continued

Year and location	Material	γ -gliadin (mAU \times min)	Gliadin (mAU \times min)	ω -gliadin/ Gliadin	α , β / Gliadin	γ -gliadin/ Gliadin	Gluten (Glutenin + Gliadin, mAU \times min)	Gliadin/ Glutenin
2015 CZ	STD1	39537.07 \pm 189.77 e	95958.85 \pm 310.23 d	0.14 \pm 0.001 b	0.45 \pm 0.001 a	0.41 \pm 0.001 c	147859.59 \pm 804.47 f	1.85 \pm 0.01 b
2015 CZ	STD2	47157.65 \pm 636.22 c	104740.47 \pm 757.86c	0.13 \pm 0.001 c	0.42 \pm 0.003 c	0.45 \pm 0.003 a	185471.92 \pm 437.48 b	1.30 \pm 0.03 e
2015 CZ	STD3	51838.34 \pm 449.68 a	117089.33 \pm 1996.1a	0.14 \pm 0.008 b	0.42 \pm 0.005 c	0.44 \pm 0.004 b	189098.25 \pm 2535.94 a	1.63 \pm 0.02 c
2015 CZ	STD4	49941.57 \pm 1886.02 b	113298.82 \pm 3886.81b	0.15 \pm 0.004 b	0.41 \pm 0.003 cd	0.44 \pm 0.002 b	167303.16 \pm 3693.53 d	2.10 \pm 0.09 a
2015 CZ	STD5	43568.01 \pm 514.97 d	98045.54 \pm 1403.87d	0.14 \pm 0.004 b	0.41 \pm 0.003 cd	0.44 \pm 0.002 b	177513.31 \pm 1592.64 c	1.23 \pm 0.02 f
2015 CZ	STD6	43564.53 \pm 238.34 d	96980.65 \pm 424.69 d	0.14 \pm 0.002 b	0.41 \pm 0.001 d	0.45 \pm 0.002 a	158463.37 \pm 864.42 e	1.58 \pm 0.01 d
2015 CZ	STD7	50311.49 \pm 329.97 b	115711.75 \pm 853.92 ab	0.13 \pm 0.003 c	0.44 \pm 0.002 b	0.44 \pm 0.002 b	191545.37 \pm 1060.74 a	1.53 \pm 0.01 d
2015 CZ	CN16	18045.50 \pm 36.50 f	51529.36 \pm 276.1 9 e	0.23 \pm 0.002 a	0.42 \pm 0.001 c	0.35 \pm 0.002 d	85197.32 \pm 330.78 g	1.53 \pm 0.02 d
2015 WJ	STD2	51225.19 \pm 580.32 b	111916.36 \pm 962.77a	0.11 \pm 0.004 c	0.44 \pm 0.005 a	0.46 \pm 0.006 c	158592.01 \pm 2062.78 a	2.40 \pm 0.05 c
2015 WJ	STD3	53809.91 \pm 316.46 a	112580.55 \pm 684.82 a	0.10 \pm 0.001 c	0.42 \pm 0.001 c	0.48 \pm 0.002 a	156620.76 \pm 598.04 a	2.56 \pm 0.03 b
2015 WJ	STD5	41999.52 \pm 235.28 c	89495.31 \pm 367.14 b	0.12 \pm 0.002 b	0.41 \pm 0.003 d	0.47 \pm 0.002 b	122233.96 \pm 157.17 b	2.73 \pm 0.03 a
2015 WJ	CN16	14134.45 \pm 121.51 d	42089.49 \pm 287.32 c	0.24 \pm 0.003 a	0.43 \pm 0.003 b	0.34 \pm 0.003 d	72841.94 \pm 226.24 c	1.37 \pm 0.02 d
2016 CZ	STD1	45160.01 \pm 441.00 c	106042.68 \pm 521.0 c	0.15 \pm 0.004 b	0.42 \pm 0.005 b	0.43 \pm 0.002 c	137892.08 \pm 805.35 d	3.33 \pm 0.02 a
2016 CZ	STD2	50356.16 \pm 1082.76 a	110591.92 \pm 808.72 a	0.11 \pm 0.004 d	0.43 \pm 0.004 a	0.46 \pm 0.007 b	158424.26 \pm 1106.66 b	2.31 \pm 0.03 c
2016 CZ	STD4	49008.22 \pm 140.10 b	108451.24 \pm 937.27 b	0.12 \pm 0.005 d	0.43 \pm 0.002 a	0.45 \pm 0.003 b	181165.56 \pm 666.19 a	1.49 \pm 0.02 e
2016 CZ	STD5	43727.48 \pm 456.18 d	95495.99 \pm 943.10 d	0.13 \pm 0.004 c	0.42 \pm 0.002 c	0.46 \pm 0.003 ab	142465.85 \pm 1193.63 c	2.03 \pm 0.03 d
2016 CZ	STD6	42905.89 \pm 371.01 d	92202.91 \pm 392.60 e	0.12 \pm 0.004 d	0.42 \pm 0.003 bc	0.47 \pm 0.003 a	126680.94 \pm 511.47 e	2.67 \pm 0.002 b
2016 CZ	CN16	20220.70 \pm 574.03 e	59219.23 \pm 555.84 f	0.25 \pm 0.002 a	0.41 \pm 0.005 c	0.34 \pm 0.006 d	100944.71 \pm 823.38 f	1.42 \pm 0.01 f
2016 WJ	STD1	33330.08 \pm 354.69 d	77109.53 \pm 135.59 d	0.14 \pm 0.003 b	0.43 \pm 0.003 bc	0.43 \pm 0.005 d	116188.77 \pm 265.49 d	1.97 \pm 0.02 b
2016 WJ	STD2	36218.20 \pm 600.09 c	80791.20 \pm 208.92 c	0.12 \pm 0.003 c	0.43 \pm 0.004 c	0.45 \pm 0.006 c	139930.45 \pm 1088.58 b	1.37 \pm 0.02 f
2016 WJ	STD3	33322.47 \pm 875.62 d	73264.03 \pm 898.68 e	0.10 \pm 0.002 e	0.44 \pm 0.005 a	0.46 \pm 0.006 c	123930.59 \pm 1425.87 c	1.45 \pm 0.01 e
2016 WJ	STD4	44140.24 \pm 185.75 a	92116.73 \pm 804.83 b	0.10 \pm 0.004 e	0.42 \pm 0.001 d	0.48 \pm 0.003 b	131858.15 \pm 1246.98 c	2.32 \pm 0.03 a
2016 WJ	STD6	37509.28 \pm 338.11 b	76476.25 \pm 558.74 d	0.11 \pm 0.003 d	0.40 \pm 0.001 f	0.49 \pm 0.002 a	125625.01 \pm 845.72 d	1.56 \pm 0.02 c
2016 WJ	STD7	44181.39 \pm 361.53 a	93445.87 \pm 332.36 a	0.11 \pm 0.001 d	0.42 \pm 0.002 e	0.47 \pm 0.003 b	156082.87 \pm 1443.31 a	1.49 \pm 0.04 d
2016 WJ	CN16	20343.60 \pm 467.84 e	64025.56 \pm 785.38 f	0.24 \pm 0.003 a	0.44 \pm 0.003 ab	0.32 \pm 0.003 e	104348.88 \pm 1125.14 e	1.59 \pm 0.02 c

Note: Different lowercase letters indicate significance at $P < 0.05$.