Predicting Cookie Wheat Germplasm Performance

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Abstract: Compared to the large effort spent developing Brazilian bread wheat cultivars, relatively few soft wheat cultivars for cookie flour were released in this country in the recent years. The objective of this study is to propose a model to predict wheat cultivars with improved manufacturing quality for the cookie industry while maintaining production for the growers. A database was compiled originally with 1674 entries with field, milling and flour quality parameters from the year 2000 to 2008 crop seasons. The critical specifications of 14 commercial cookie flours were compared and it was determined that the variables farinograph water absorption appeared in 14 out of 41 specifications (34.1%), alveograph strength appeared in 13 out of 41 specifications (31.7%), wet gluten appeared in 11 out of 41 specifications (26.8%), alveograph tenacity appeared in two out of 41 specifications (4.9%), and alveograph dough extensibility appeared in one out of 41 specifications (2.5%). Using frequency percentages as model coefficients a Brazilian Cookie Wheat Score Model was proposed: BCWS =ABS × 0.341 + W × 0.317 + WG × 0.268 + P × 0.049 + L × 0.025. The ideal score for a wheat genotype to be classified as cookie wheat for the Brazilian market is within the optimum interval from 56.1 to 81.2. To validate this model and its proposed interval, 277 wheat entries from the 2008 crop year were tested under the following conditions: first, wheat genotypes that yielded less than the average of bread wheat genotypes were discharged; second, wheat genotypes without the full set of values for the model variables were discharged. Twenty wheat genotypes, out of 277, were within the optimum interval and were proposed as wheat genotypes to produce cookie flour. The validation results indicated that, using the BCWS Model, along with the established conditions, a wheat breeder will have 75% chance of finding a potential cultivar with acceptable cookie functionality from a set of experimental lines.

Keywords: Brazilian wheat market; cookie flour specifications; soft wheat breeding; soft wheat cultivars; cookie wheat cultivars

Wheat in Brazil is essentially a spring wheat type, planted in the fall (mid March through July) and harvested in the spring (mid September through late November). The Brazilian wheat is divided into five classes based on alveograph strength (W) and falling number (FN). Table 1 shows the technological classification of wheat in Brazil. De Almeida *et al.* (2008) suggested that soft wheat genotypes with acceptable cookie functionality were available within the Brando wheat class in Brazilian germplasm. The challenge was to identify them in a classification system based on alveograph W and farinhograph water absorption. However, compared to the large effort spent developing Brazilian bread wheat cultivars, relatively few soft wheat cultivars for cookie flour were released in this country in the recent years. The main reason for this is the low participation of the cookie flour, which constituted only 11.2% of the Brazilian wheat flour market share in the year 2009 (Table 2). Nevertheless, the Brazilian cookie industry is expanding. The cookie production growth rate increased at an average annual rate of 2.5% from

Table 1. Wheat classification, according to the Brazilian Department of Agriculture Resolutions

Class	Alveograph strength (× 10^{-4} J)	Falling number (s)
	minimal value	
Brando wheat	50	200
Bread wheat	180	200
Extra-strong wheat	300	250
Other uses wheat	any value	< 200
Durum wheat	–	250

2002 to 2008, and 4.1% in 2008 alone. In addition, whereas Brazilians consumed 5.6 kg of cookies per person in 2002, by 2008 that figure rose to 6.1 kg. Considering the consistent growth in the cookie market, some wheat growers and soft wheat millers are demanding soft wheat cultivars with acceptable cookie making quality. The objective of this study is to propose a model to predict wheat cultivars with improved cookie quality while maintaining high production for the growers.

MATERIAL AND METHODS

A database originally with 1674 entries with field and milling quality lab parameters from the year 2000 to 2008 crop seasons were compiled. The field data were obtained from trials that were established at the Fundação Agrária de Pesquisa Agropecuária in Guarapuava, Paraná, Brazil. The soil at the site was a Humic Xanthic Hapludox. Grains representing each plot (for the solvent retention capacity – SRC) and each cultivar (for other analyses) were tempered (AACC method 26-10, AACC 1995) and milled to straight-grade flour on an Agromatic AG AQC 109 Mill, from 2000 to 2005 and on a Laboratory Mill Quadrumat Senior – Brabender, from 2006 to 2008. Falling number (FN) was measured using a Falling Number 1800 Perten (AACC method 56-81B). Alvegraph analysis (Chopin MA95, AACC method 54-30) was used to determine strength (W), tenacity (P), dough extensibility (L) and P/L ratio. Gluten analysis (Glutomatic Perten, Centrifuge

Table 2. Brazilian wheat consumption and wheat flour products market share from 2005 to 2009

Wheat products	2005	2006	2007	2008	2009	Wheat flour market share 2009 (%)
	(thousand tons)					
Wheat grain	9500	9842	9449	9036	9351	–
Wheat bran	2375	2461	2362	2259	2338	–
Total flour (75%)	7125	7382	7087	6777	7013	–
Imported flour	367	453	630	682	644	–
Total flour for the market	7492	7835	7717	7459	7657	–
Domestic use	1349	1238	1050	1002	960	12.5
Pasta	1064	1301	1270	1274	1293	16.9
Cookies	832 (11.1%)	830 (10.6%)	790 (10.2%)	831 (11.1%)	856	11.2
Bread	4097	4309	4195	4102	4211	55.0
Cakes, pizza, panettone and others	150	157	413	250	337	4.4

Source: ABITRIGO/ABIMA/ANIB/ABIP (April 2010)

2015 Perten, and Glutork 2020 Perten, AACC method 38-12) was used to determine wet (WG) and dry gluten (DG) content. Farinograph analysis (Farinograph-E Brabender, AACC method 54-21) was used to determine water absorption (ABS), dough development time (DDT), stability (STA), tolerance index (TIN). Solvent retention capacity – SRC of flour was measured according to the AACC method 56-11, modified by Guttieri *et al.* (2001) and by Haynes *et al.* (2009) using four solvents: water SRC (WAT); sodium carbonate SRC (SOC); sucrose SRC (SUC) and latic acid SRC (LAc). The first issue faced in building a model was the field yield limitations of the Brazilian soft wheat genotypes. All the entries that yielded (produced) less than the average of bread wheat genotypes were discharged from the data base. A total of 920 wheat genotypes were discharged because they yielded less than the bread wheat genotypes (4390 kg/ha). 751 wheat genotypes remained to build the model. Considering that the field problems were solved, the second issue was to select variables that were important for the cookie industry. The critical specifications of 14 commercial cookie flours were compared and it was determined that the variable ABS appeared in 14 out of 41 specifications (34.1%), W appeared in 13 out of 41 specifications (31.7%), WG appeared in 11 out of 41 specifications (26.8%), P appeared in two out of 41 specifications (4.9%) and finally L appeared in one out of 41 specifications (2.5%). Using frequency percentages as model coefficients

Table 3. Brazilian cookie wheat score (BCWS), farinograph water absorption, wet gluten content, alveograph results (W – strength; P – tenacity; L – dough extensibility) and class of Brazilian Wheat Cultivars at the Fundação Agrária de Pesquisa Agropecuária (FAPA) at Guarapuava, Paraná, Brazil, 2008

Cultivar	BCWS	Farinograph absorption (%)	W ($\times 10^{-4}$ J)	Wet gluten content (%)	P (mm)	L (mm)	Class*
CD 105	59.2	54.8	86	30.6	31.0	142.0	Brando
CD 120	61.6	52.6	95	34.5	33.0	108.0	Brando
PF 040310	62.0	56.4	96	26.7	36.0	135.0	Brando
Fundacep 40	64.7	54.2	103	32.6	34.0	125.0	Brando
CD 115	67.5	54.6	110	30.9	37.0	155.0	Brando
Campeiro	67.6	50.8	118	28.0	27.0	160.0	Brando
BRS Timbauva	68.9	62.9	102	38.9	53.0	86.0	Bread
IPR 129	70.6	61.8	109	37.5	38.0	123.0	Bread
IPR 118	70.9	60.2	111	38.7	36.0	121.0	Bread
BRS 179	71.2	53.4	116	38.7	34.0	168.0	Brando
Mirante	71.4	55.5	128	25.2	45.0	117.0	Bread
CD 115	72.2	53.7	126	32.2	43.0	128.0	Brando
Fundacep 47	73.0	54.0	124	36.8	34.0	151.0	Brando
BRS Umbu	73.2	55.3	122	37.0	34.0	163.0	Brando
Vaqueano	73.2	56.7	127	30.9	44.0	127.0	Brando
Fundacep Nova Era	74.6	60.0	128	31.6	64.0	80.0	Brando
Campeiro	75.3	49.3	148	27.2	57.0	59.0	Brando
CD 105	76.2	54.1	141	28.3	34.0	154.0	Brando
BRS Umbu	77.0	51.3	149	27.4	38.0	123.0	Brando
Supera	79.3	52.8	155	29.1	43.0	91.0	Bread

*Commercial class furnished by the breeders based in the Brazilian Department of Agriculture resolutions a Brazilian Cookie Wheat Score Model (BCWS Model) was proposed: BCWS = ABS × 0.341 + W × 0.317 + WG × 0.268 + P × 0.049 + L × 0.025. However, not all wheat genotypes (entries) have the full set of values for the model variables and they were discharged. From the 751 wheat entries, only 309 had the full set of data for the selected variables with critical specifications. In order to propose a solid score interval, soft wheat entries which had an ABS, W and WG values out of the critical specification were discharged to avoid wheat genotypes without cookie manufacturing properties. The maximum specification superior limit (SSLmax) for ABS was 61%; 231 entries had lower ABS values and remained in the model. For the W variable the specification inferior limit (SIL) was 80 joules ($\times 10^{-4}$) and the specification superior limit (SSL) was 160 joules ($\times 10^{-4}$); 63 wheat entries were within this interval and they stayed in the model. Finally for WG content (%) the SIL was 26% and the SSL was 33%. An additional 28 wheat entries were discharged and 35 remained to run the model. The BCWS Model was finally run using these 35 wheat entries. The ideal score, proposed by this model, for a wheat genotype to be classified as cookie wheat for the Brazilian market is within the optimum interval from 56.1 to 81.2.

RESULTS AND DISCUSSION

To validate this model and its proposed interval, 277 wheat entries from the 2008 crop year were tested, under the following conditions: First, wheat genotypes that yielded less than the average of bread wheat genotypes were discharged; second, wheat genotypes without the full set of values for the model variables were discharged. Table 3 shows 20 wheat entries, out of 277, that were within the optimum interval and were proposed as wheat genotypes to produce cookie flour. 75% of the selected genotypes were known soft wheat cultivars and 25% were weak bread wheat cultivars.

CONCLUSIONS

The validation results indicated that, using the BCWS Model, along with the established management conditions, a wheat breeder will have 75% chance of finding a potential cultivar with acceptable cookie functionality from a set of experimental lines. The current challenge is to run the proposed model with the coming year's data in order to find a more robust interval that can improve the prediction.

References

American Association of Cereal Chemists (1995): Approved Methods. 9th Ed. Saint Paul.

De Almeida J.L., Souza E., Guttieri M.J. (2008): Searching Brazilian cookie wheat cultivars. In: Proc. Annual Meeting of AACC International. Honolulu.

Guttieri M.J., Bowen D., Gannon D., O'Brien K., Souza E.J. (2001): Solvent retention capacities of irrigated soft white spring wheat flours. Crop Science, **41**: 1054–1061.

Haynes L.C., Bettge A.D., Slade L. (2009): Soft wheat and flour products methods review: Solvent retention capacity equation correction. AACC International Report, **54**: 174–175.