Wheat Quality Council

January 11, 2012

Our Mission is to advocate the development of new wheat varieties that improve the value of wheat to all parties in the U.S. supply chain.

Our Goal is to improve the value of all U.S. wheat classes for producers, millers, and processors of wheat.

Membership in the Wheat Quality Council is a wise investment if wheat or flour quality has any influence on your business.

Uniform Grow Outs are an extremely important part of the Wheat Quality Council efforts to improve wheat & flour quality.

Ben Hancock

Executive Vice President

Wheat Quality Council

P.O. Box 966

Pierre, South Dakota 57501-0966

Scott E. Beil

USDA-ARS Soft Wheat Quality Laboratory

OARDC-OSU

1680 Madison Avenue

Wooster, Ohio 44691

Scott.Beil@ars.usda.gov

Acknowledgments

We thank the Wheat Quality Council for providing this forum to improve the quality of wheat. Thank you to the Soft Wheat Quality Lab and the collaborators in industry for their professional analysis and suggestions. Also, we are thankful for the cooperation from all the wheat breeding programs involved with this year's project. Great communication among the breeding programs, growers, and the different labs in industry have made this project a continued success.

Soft Wheat Quality Council

Mission, Policy, and Operating Procedure

The Soft Wheat Quality Council (SWQC) will provide an organizational structure to evaluate the quality of soft wheat experimental lines and variety varieties that may be grown in the traditional growing regions of the United States. The SWQC also will establish other activities as requested by the membership. The SWQC operates under the direction and supervision of the Wheat Quality Council (WQC). The mission of the SWQC is to provide a forum for leadership and communication in promoting continuous quality improvement among the various elements of the community of soft wheat interests.

Objectives

- Encourage wide participation by all members of the soft wheat industry.
- Determine, through technical consulting expertise, the parameters which adequately describe the performance characteristics which members seek in new varieties.
- Promote the enhancement of soft wheat quality in new varieties.
- Emphasize the importance of communication across all sectors and provide resources for education on the continuous improvement of soft wheat quality.
- Encourage the organizations vital to soft wheat quality enhancement to continue to make positive contributions through research and communications.
- Offer advice and support for the U.S.D.A. - A.R.S. Soft Wheat Quality Laboratory in Wooster, Ohio.

Membership

- The membership of the SWQC will consist of members of the WQC.

SWQC Technical Board

- The Technical Board shall be the administrative unit responsible for managing the functions of the council.
- The Technical Board shall consist of three officers elected from the membership.
- Officers of the Technical Board shall consist of a chair, vice-chair, and secretary.
- Each officer serves one year in his/her office.
- Terms start the day after the annual meeting of the SWQC
- The vice-chair replaces the chair at the conclusion of the chair's term and the secretary replaces the vice-chair at the conclusion of the vice-chair's term.

- Officers (normally only the secretary) shall be elected annually at the annual meeting of the SWQC by nomination and majority vote.
- Any eligible member may be reelected after being out of office for one year.
- Vacancies that occur during the term of office of the members of the Technical Board shall be filled by nomination and majority vote of the remaining members of the board and the WQC Executive Vice President. The appointee will serve the remaining term of the vacancy (up to 3 years).
- Exceptions to the above may be granted if voted on by Technical Board or by majority vote of the SWQC at the annual meeting.

Duties of the Technical Board

- The chair shall be responsible to establish a meeting place and preside at all meetings of the Technical Board and SWQC (selected elements of the General Meeting WQC).
- The vice-chair shall preside at meetings in absence of the chair and assume such duties as may be assigned by the chair of the Technical Board.
- The secretary shall be responsible for taking minutes of the Technical Board and the SWQC meetings.
- The Technical Board will direct the Executive Vice President of the WQC on disbursement of allocated funds.
- The chair shall be responsible for communicating budget needs to the Executive Vice President.
- The Technical Board is responsible for presenting budget updates to the general membership at the annual meeting.

Compensation

- Technical Board members shall serve without compensation.

Expenses

- Certain paid expenses may be authorized for some technical board functions.

Quality Evaluation Committee of the SWQC

Committee Purpose

A technical committee entitled "Quality Evaluation Committee" shall be established and consist of the three Technical Board officers and other key members working on soft wheat. Those other key members should include, but are not limited to:

- The research leader of the USDA Soft Wheat Quality Laboratory, Wooster, OH.
- A grow out coordinator who is a soft wheat breeder.
- Technical collaborators from Soft Wheat Milling and Baking Laboratories.
- Collaborating soft wheat breeders.

Evaluation and Responsibilities

- Establish procedures and requirements for the annual grow out, handling, evaluation and reporting of the experimental test line quality evaluation program.
- Annual approval of the samples and check varieties submitted by soft wheat breeders.
- Milling of the experimental and check samples.
- Distribution of samples to collaborators (member companies willing to conduct testing and baking evaluations on the samples prepared).
- Preparation of a quality report.

Sample/Locations

- Each breeder entity shall have the privilege of submitting experimental test lines and a check variety each year for evaluation. (up to a maximum of 10 samples annually

Annual Meeting

- The annual meeting of the SWQC shall coincide with the annual meeting of the WQC. If for some reason the WQC annual meeting is not held, it shall be the duty of the Technical Board chair to establish an annual meeting time and place.
- The purpose of the meeting shall be to discuss the results of the test line quality testing program, elect board members and carry on other business as required by the SWQC.
- Other meetings determined to be necessary may be established by the Technical Board.

Finances and Budget

- The finances required to meet the operating expenses of the council shall be designated by the Executive Board of the WQC.
- The budget shall be presented for membership approval at the annual meeting.

Amendments

- Amendments to the policy and operation procedure of the SWQC can be made by majority vote of the council members present.
- The proposed changes must be submitted in writing and must be in the hands of the membership two weeks prior to voting on the change.

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Entry Descriptions

5187J, tested as VA05W-151

The soft red winter wheat cultivar 5187J, tested as VA05W-151, was derived from the cross Pioneer Brand '26R24' (PI 614110 PVPO) / 'McCormick' (PI 632691). Prior to its release, 5187J was evaluated in seven environments over three years (2008-2010) in Virginia's State Variety Trials. It also was evaluated throughout the soft red winter (SRW) wheat region in the USDA-ARS Uniform Eastern SRW Wheat Nurseries (UESRWWN) in 2009 and 2010 and in the Uniform Southern SRW Wheat Nursery (USSRWWN) in 2011. Cultivar 5187J is widely adapted, early heading, and has high grain yield potential and high test weight. It has expressed moderate levels of resistance to the most prevalent wheat diseases in the eastern U.S. with the exception of stripe rust and Hessian fly. An initial seed purification of 5187J was sown on five acres at the VCIA Foundation seed farm during fall 2010 and produced 400 bu of Foundation seed. Breeder seed also was planted on 1 acre during fall 2010 and produced 60 bu of Foundation seed. Most of this seed was provided to seedsmen in fall 2011, and 5187J will be marketed by Growmark-East and Seedway.

Cultivar 5187J is a broadly adapted, high yielding, early maturing, short height semi-dwarf (gene Rht2). In the eastern SRW wheat region, average head emergence of 5187J (129 – 135 d) has been similar to 'Branson' (129 – 134 d) and 2 to 3 d earlier than 'Shirley' and 'Roane'. Mature plant height of 5187J is 33 to 34 inches and on average is similar to Branson, 1 to 2 inches taller than Roane and Shirley, and 2.5 inches shorter than 'Bess'. On average, straw strength (0=erect to 9=completely lodged) of 5187J (2.6 – 3.4) is most similar to that of 'Featherstone 176' (3.1) and Roane (3.2), but weaker than that of Branson (1.3 – 2.0). Cultivar 5187J was evaluated at 27 locations in the 2009-10 UESRWWN, and produced the highest mean grain yield (72.9 Bu/ac) and second highest test weight (59.4 Lb/Bu) among 46 entries. Grain yields of 5187J were significantly ($P < 0.05$) higher than the test averages at 11 of the 27 locations and ranked among the top ten entries at 20 locations. Cultivar 5187J was evaluated at 28 locations in the 2008-09 UESRWWN, and ranked first among 42 entries for grain yield (83.2 Bu/ac) and second for test weight (59.1 Lb/Bu). Grain yields of 5187J were significantly ($P < 0.05$) higher than the test averages at 9 of the 28 locations and ranked among the top ten entries at 20 locations. In the 2010-11 USSRWWN, 5187J ranked first in grain yield (79.7 Bu/ac) among 28 entries evaluated at 26 locations. On the basis of winter kill ratings (0 = no injury to 9 = complete kill) reported at 5 of 28 locations in the 2008-09 UESRWWN, winter hardiness of 5187J (2.1) was similar to that (2.2 – 2.4) of the check cultivars INW0411, Branson and Bess.

Grain samples of 5187J produced in four crop environments (2008 and 2009) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. Cultivar 5187J has exhibited milling and baking qualities that are most similar to those of the strong gluten cultivars Pioneer 26R12, USG 3315, and Tribute; although, 5187J has notably higher gluten strength than these cultivars. Mean comparisons of milling and baking quality attributes of 5187J versus Tribute over two years (2008-2009) include: milling quality score (69.3 vs. 69.6), baking quality score (59.0 vs. 54.4), softness equivalent score (70.3 vs. 65.9), flour yield (70.4% vs. 70.2%), flour protein (7.9% vs. 7.4%), gluten strength (lactic acid retention capacity 120.2 vs. 107.3), and cookie spread diameter (18.64 vs. 18.50 cm). On the basis of quality evaluations conducted on entries in the 2010 and 2009 UESRWWN, 5187J had milling quality scores (69.6 and 64.1) that were similar to those of check cultivars Bess, INW0411, and Shirley (60.1 – 65.5) and higher than that of Roane (57.3). Baking quality scores of 5187J (61.3 and 45.7) were similar to Shirley and better than INW0411 in 2010, but were lower than those of the check cultivars (52.6 – 79.8) in 2009. Softness equivalent scores of 5187J (62.6 and 59.0) were most similar to those of Bess (65.5 and 57.3). Flour yields of 5187J (71.0% and 70.4%) were higher than those of Bess (68.9% and 69.5%) and Roane (68.8%). Flour protein concentration of 5187J (8.5% and 8.8%) was most similar to that of INW0411 (8.6% and 8.9%). Protein gluten strength of 5187J estimated by lactic acid solvent retention capacity (112.8% and 114.7%) was consistently higher than that of INW0411, Branson, Bess, and Shirley (85.4% – 109.5%). Cookie spread diameters of 5187J (18.6 and 18.4 cm) were similar to those of INW0411.

12V51, tested as VA05W-251

The soft red winter wheat cultivar 12V51, tested as VA05W-251, was derived from the cross VA98W-130 // VA96W-348 / Pioneer Brand '26R61' (PI 612153 PVPO). Parentage of VA98W-130 is 'Savannah' (PI559929) / VA87-54-558 // VA88-54-328 / 'GA-Gore' (PI 561842). Parentage of VA87-54-558 is 'Massey' (CItr 17953) / 'Holley' (CItr 14579) and parentage of VA88-54-328 is 'Lovrin 29' (PI 519144) / 'Tyler' (CItr 17899) // 'Redcoat' (CItr 13170) 2 / 'Gaines' (CItr 13448). Parentage of VA96W-348 is IN81401A1-32-2 / 'FFR555W' (PI 560318 PVPO), and parentage of IN81401A1-32-2 is 'Arthur 71' (CItr 15282) / 'Caldwell' (CItr 17897) /4/ Arthur 71 /3/ 'Benhur' (CItr 14054) // 'Riley' (CItr 13702) 2 / W62-63-119A.

Prior to its release, 12V51 was evaluated in seven environments over three years (2008 – 2010) in Virginia's State Variety Trials. It also was evaluated throughout the soft red winter (SRW) wheat region in the USDA-ARS Uniform Southern SRW Wheat Nurseries (USSRWWN) in 2009 and 2010, and in the Uniform Eastern SRW Wheat Nursery (UESRWWN) in 2011. Cultivar 12V51 is widely adapted, has short plant height, high grain yield potential, and good milling and pastry baking quality. It has expressed moderate to high levels of resistance to the most prevalent wheat diseases in the eastern U.S. with the exception of stripe rust and stem rust. Most notably, 12V51 provides producers in the eastern U.S. with a cultivar having resistance to leaf rust and glume blotch. Breeder seed of 12V51 was planted on 8 acres during fall 2010 and produced 480 Bu of Foundation seed in 2011, which was distributed to seedsmen. Cultivar 12V51 will be marketed by seed companies working in collaboration with Maryland Crop Improvement Association.

Cultivar 12V51 is a short height semi-dwarf (gene Rht2) that is mid-season maturity, broadly adapted, and high yielding. In the southern SRW wheat region, average head emergence of 12V51 (114 – 118 d) is similar to that of Pioneer Brand 26R61 and one day later than 'AGS 2000'. Mature plant height of 12V51 (31 – 34 inches) is similar to that of 'USG 3555' and 4 to 5 inches shorter than Pioneer Brand 26R61. Straw strength (0=erect to 9=completely lodged) of 12V51 (1.7 – 3.4) is equal to or slightly less than average. In Virginia's State Variety Trials, 12V51 had a three year (2008-2010) average grain yield (84 Bu/ac) similar ($P < 0.05$) to that of the highest yielding cultivar Shirley. Cultivar 12V51 had a three year average test weight (58.0 Lb/Bu) that was significantly ($P < 0.05$) higher than Shirley (57.0 Lb/Bu). Cultivar 12V51 was evaluated at 26 locations in the 2009-2010 USSRWWN, and produced a grain yield (61.8 Bu/ac) that was similar to the nursery average. Cultivar 12V51 ranked among the top ten entries for grain yield at 11 of the 26 locations. In the 2008-09 USSRWWN, 12V51 was evaluated at 25 locations, and ranked seventh among 40 entries for grain yield (67.1 Bu/ac). It ranked among the top ten entries at 13 of the 25 locations. Test weight of 12V51 has been most similar to that of USG 3555. In the 2010-11 UESRWWN, 12V51 was evaluated at 28 locations, and ranked eighth among 38 entries for grain yield (73.3 Bu/ac). On the basis of winter kill ratings (0 = no injury to 9 = complete kill) reported at 3 of 25 locations in the 2008-09 USSRWWN, winter hardiness of 12V51 (4.2) was similar to that of USG 3555 (4.3) and 'Coker 9553' (4.0).

Grain samples of 12V51 produced in six crop environments (2008 – 2010) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. Cultivar 12V51 has exhibited good milling and pastry baking qualities and overall has superior quality compared to USG 3555. Mean comparisons of milling and baking quality attributes of 12V51 versus USG 3555 include: milling quality score (68.3 vs. 65.7), baking quality score (61.0 vs. 47.4), softness equivalent score (58.3 vs. 62.1), flour yield (69.7% vs. 69.0%), and flour protein (8.2% vs. 8.7%). Gluten strength of 12V51 as predicted by lactic acid solvent retention capacity has been consistently lower (mean of 100.7%) than that of USG 3555 (116.1%). Cultivar 12V51 has consistently produced cookies of larger diameter (mean of 18.76 cm) than USG 3555 (18.30 cm).

SY 1526

SY 1526 is a soft red winter wheat bred and developed by Syngenta Seeds, Inc. SY 1526 was selected for height, maturity, appearance, and kernel soundness using a modified bulk breeding method that originated with a single cross made in December of 1998. SY 1526 is a medium tall semidwarf variety and has white chaff at maturity. It has medium early maturity and its heading is less than a day later than Branson's. SY 1526 has shown best adaptation to the area south of Interstate 70 in the states of Illinois, Indiana, Ohio, and Kentucky. It has shown moderate resistance to the races of leaf rust in this area, and moderate susceptibility to soil borne mosaic virus. Based on observations and data from southern Illinois in 2009, it may be resistant to wheat spindle streak mosaic virus.

Juvenile growth habit is semi-erect. Plant color at boot stage is green. Anther color is yellow. Auricle anthocyanin is absent and auricle hairs are present. Flag leaf at boot stage is recurved and twisted. Head shape is tapering and apically awnletted. Glumes are midlong in length and midwide in width. Glume shoulder shape is square with an obtuse beak. Chaff color is white at maturity. Seed shape is ovate. Brush hairs on the seed are long in length and occupy a medium area of the seed tip. Seed depth is shallow and width is narrow. Seed cheeks are rounded.

SY 1526 has been uniform and stable since 2009. Approximately 0.8% of the plants were rogued from the Breeder's seed increase in 2009. Approximately 95% of the rogued variant plants were taller height wheat plants (8 to 15 cm) and 5% were awned. Up to 1.0% variant plants may be encountered in subsequent generations.

Syngenta Seeds, Inc. maintains seed stock and certified classes of Foundation, Registered and Certified. Certified seed stocks of SY 1526 will be available in the fall of 2012. Certified acreage is not to be published by AOSCA and certifying agencies and SY 1526 may only be sold as a class of certified seed and all seed sales are royalty bearing.

IL00-8061

IL00-8061 is a very high yielding soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2006 for brand labeling. Yield of IL00-8061 has been about 12 bu/A greater than Kaskaskia in 12 tests in Illinois. Yield of IL00-8061was also quite high in the 2005 Wisconsin variety trial. IL00-8061 has excellent test weight (similar to Kaskaskia), and IL00-8061 is early with heading date similar to Caldwell. It is similar in height to Kaskaskia. IL00-8061 is not awned and has tan chaff at maturity. IL00-8061 has yellow-green heads after flowering, and there is no bloom on the peduncles. Flag leaf color of IL00-8061 is green and most closely matches RHS color sample 137B. IL00-8061 is resistant to Fusarium head blight (caused primarily by Fusarium graminearum), moderately resistant to soil borne mosaic virus, and resistant or moderately resistant to leaf rust (caused by Puccinia recondita). IL00-8061 is susceptible to biotype L of the Hessian fly (Mayetiola destructor) and susceptible or moderately susceptible to powdery mildew (caused by Erysiphe graminis f. sp. tritici). IL00-8061 is resistant to moderately resistant to Septoria leaf blotch (caused by Septoria tritici), and moderately resistant to stripe rust (caused by Puccinia striiformis). IL00-8061 has excellent milling and baking quality. Up to 0.5% other types are allowed in IL00-8061. PVP for IL00-8061 will not be applied for.

IL00-8530

IL00-8530 is a very high yielding soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2008 for brand labeling. Yield of IL00-8530 has been about 6 bu/A greater than Kaskaskia in 20 tests in Illinois. IL00-8530 has excellent test weight (equal to or better than Kaskaskia), and IL00-8530 is early with heading date 3- 4 days earlier than Kaskaksia and about 2 days earlier than Foster. The height of ILL00-8530 is about 15 cm shorter than Kaskaskia and about 5 cm taller than Roane. IL00-8530 is not awned and has tan chaff at maturity. IL00-8530 is moderately resistant to Fusarium head blight (caused primarily by Fusarium graminearum), moderately susceptible to soil borne mosaic virus, and moderately susceptible to susceptible to leaf rust (caused by Puccinia recondita). IL00-8530 is susceptible to biotype L of the Hessian fly (Mayetiola destructor) and susceptible or moderately susceptible to powdery mildew (caused by Erysiphe graminis f. sp. tritici). IL00-8530 has excellent milling and baking quality. Up to 0.5% other types are allowed in IL00-8530. PVP for IL00-8530 will not be applied for.

IL00-8633

IL00-8633 is a high yielding soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2006 for brand labeling. Yield of IL00-8633 has been about 5 bu/A greater than Kaskaskia in 12 tests in Illinois. Heading date of IL00-8633 is similar to Roane. It is similar in height to Kaskaskia. IL00-8633 is not awned (short tip awns are present) and has tan chaff at maturity. IL00-8633 has yellow-green heads after flowering, and there is no bloom on the peduncles. Flag leaf color of IL00-8633 is green and most closely matches RHS color sample 137B. IL00-8633 is somewhat more susceptible to lodging than Kaskaskia. IL00-8633 is moderately resistant to Fusarium head blight (caused primarily by Fusarium graminearum), and moderately susceptible to soil borne mosaic virus and stripe rust (caused by Puccinia striiformis). It is moderately resistant to moderately susceptible to Septoria leaf blotch (caused by Septoria tritici). IL00-8633 has excellent milling and baking quality. Up to 0.5% other types are allowed in IL00-8633. PVP for IL00-8633 will not be applied for.

IL01-11934

IL01-11934 is an awnless soft red winter wheat with tan chaff at maturity. Foliage color has not been determined. IL01-11934 heads about two days later than Roane. It is about 1 day earlier heading than Kaskaskia, two days earlier heading than Excel 307, and three days later than IL00-8530. IL01-11934 is 2.5 cm taller than Roane, 5 cm shorter than Excel 307, similar in height to Il00-8530 and about 13 cm shorter than Kaskaskia. IL01-11934 is moderately resistance to powdery mildew and Fusarium head blight and is susceptible to Hessian Fly Biotypes B,C, D and L. Plant Variety Protection has not been applied for. Since it was released for licensing PVP cannot be obtained.

IL01-16170

IL01-16170 is a an early soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2008 for brand labeling. Yield of IL01-16170 has been about 3 bu/A greater than Kaskaskia in 16 tests in Illinois. IL01-16170 has high test weight (about 1 lb/bu less than Kaskaskia), and heading date for IL01-16170 is three days earlier than Kaskaskia. It is 15 cm shorter than Kaskaskia and 1 cm shorter than Roane. IL01-16170 is not awned and has tan chaff at maturity. IL01-16170 is moderately resistant to Fusarium head blight (caused primarily by Fusarium graminearum), moderately resistant to soil borne mosaic virus, and is moderately susceptible to leaf rust (caused by Puccinia recondita). IL01-16170 is susceptible to biotype L of the Hessian fly (Mayetiola destructor) and susceptible or moderately susceptible to powdery mildew (caused by Erysiphe graminis f. sp. tritici). IL01-16170 is moderately susceptible to Septoria leaf blotch (caused by Septoria tritici). IL01-16170 has acceptable to good milling and baking quality. Up to 0.5% other types are allowed in IL01-16170. PVP for IL01-16170 will not be applied for.

IL02-18228

IL02-18228 is a high yielding Fusarium head blight resistant soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2010 for brand labeling. Yield of IL02-18228 has been about 7 bu/A greater than Bess in 12 tests in Illinois and about 6 bu/A less than Pioneer brand 25R47. IL02-18228 has excellent test weight (about 1 lb/bu higher than Kaskaskia and 2.5 lb/bu higher than Bess). IL02-18228 is quite early with heading date about 4 days earlier than Kaskaskia and about 3 days earlier than Bess. IL02-18228 is about 8 cm shorter than Kaskaskia and about 4 cm taller than Bess. IL02-18228 is not awned and has tan chaff at maturity. IL02-18228 is resistant to Fusarium head blight (caused primarily by Fusarium graminearum). IL02-18228 is one of the most Fusarium head blight resistant adapted lines identified in the University of Illinois wheat breeding program to date. IL02-18228 is resistant to soil borne mosaic virus, and moderately resistant to moderately susceptible to leaf rust (caused by Puccinia recondita). IL02-18228 is susceptible to biotype L of the Hessian fly (Mayetiola destructor) and susceptible to powdery mildew (caused by Erysiphe graminis f. sp. tritici). IL02-18228 is moderately susceptible to Septoria leaf blotch (caused by Septoria tritici), and susceptible to stripe rust (caused by Puccinia striiformis). IL02-18228 has acceptable milling and baking quality, but is harder than optimal for a soft red winter wheat. Up to 0.5% other types are allowed in IL02-18228. PVP for IL02-18228 will not be applied for.

IL02-19463

IL02-19463 is a very early, awned soft red winter wheat with tan chaff at maturity. Foliage color has not been determined. It is about 5 days earlier heading than Kaskaskia, 3-4 days earlier heading than Excel 307 and Bess. IL02-19463 is about 14 cm shorter than Kaskaskia, 3-4 cm shorter than Excel 307, and about 3-5 cm shorter than Bess. IL02-19463 is moderately resistant to Fusarium head blight (caused primarily by Fusarium graminearum). It is about equal to Bess for Fusarium head blight resistance and usually has lower deoxynivalenol levels than Bess. IL02-19463 is moderately tolerant to barley yellow dwarf virus. IL02-19463 is susceptible to leaf rust (caused by Puccinia triticina). IL02-19463 has acceptable milling and baking quality. Up to 1.0 % other types are allowed in IL02-19463. Plant Variety Protection will not be applied for.

IL99-26442

IL99-26442 is a very high yielding soft red winter wheat cultivar (Triticum aestivum L.) released by the Illinois Agricultural Experiment Station in 2006 for brand labeling. Yield of IL99-26442 has been about 11 bu/A greater than Kaskaskia in 16 tests in Illinois. Heading date of IL99-26442 is similar to Roane. It is similar in height to Kaskaskia. IL99-26442 is awned and has tan chaff at maturity. IL99-12976 has yellow-green heads after flowering, and there is no bloom on the peduncles. Flag leaf color of IL99-12976 is green and most closely matches RHS color sample 137B. IL99-26442 is moderately susceptible to Fusarium head blight (caused primarily by Fusarium graminearum), and resistant to moderately resistant to soil borne mosaic virus. It is resistant to stripe rust (caused by Puccinia striiformis) and moderately susceptible to leaf rust (caused by Puccinia recondita). IL99-26442 is susceptible to biotype L of the Hessian fly (Mayetiola destructor). It is resistant to moderately resistant to soil borne mosaic virus, and resistant to Septoria leaf blotch (caused by Septoria tritici). IL99-26442 has acceptable milling and baking quality. Up to 0.5% other types are allowed in IL99-26442. PVP for IL99-26442 will not be applied for.

GA001138-8E36

GA 001138-8E36 is a high grain yielding, awned, medium late maturing, good test weight, medium-tall height line with moderate straw strength. It was derived from the cross of GA 961581 / PIO26R61. Its maturity averages about 4 days later than AGS 2000 in Georgia. Juvenile plant growth is semi-erect. At the boot stage, it is blue-green plant color with waxy stems and flag leaves are erect and not twisted. It is resistant to races of leaf rust and stripe rust in Georgia and the Southeast, current biotypes of Hessian fly in Georgia, wheat soil-borne mosaic virus, moderate-resistant to glume blotch, moderate susceptible to fusarium head blight (scab), good milling and baking quality as a soft red winter wheat.

E6012

MSU E6012 is a soft white wheat cultivar developed at Michigan State University from the cross 'Caledonia'/ '25W33' made in 2001. MSU E6012 is awned and white chaffed, has an average height and flowering date, matures early in Michigan, and is average for FHB, powdery mildew, leaf blotch and stripe rust. MSU E6012 shows susceptibility to leaf and stem rusts.

Milling Analysis: Ash and Protein Curves

Miag Multomat Mill

The Miag Multomat Mill is a pneumatic conveyance system consisting of eight pair of 254 mm diameter x 102 mm wide rolls, and ten sifting passages. Three pair are corrugated break rolls and five reduction passes. Each sifting passage contains six separate sieves. The two top sieves for each of the break bolls are intended to be used as scalp screens for the bran. The third break sieving unit of the Soft Wheat Quality Laboratory (SWQL) Miag Multomat Mill was modified so that the top four sieves better sift bran.

All SRW varieties are tempered to 14.5% moisture. The tempered wheat is held for 24 hours prior to milling. Wheat is introduced into the first break rolls at a rate of approximately 80 lb/hr. First break roll gap is adjusted to allow 47% through a #28 SSBC; 716μm. Straight grade flour is a blend of the three Break flour streams including the Grader flour and the five Reduction streams including the Duster flour. The straight grade flour mean volume diameter will be about 100 microns with a flour ash content usually between 0.38% and 0.50%. Bran, head shorts, tail shorts and red dog are by-products which are not included with the flour. Flour yields will vary between 70% and 78% which is variety dependent due to heritable milling quality differences and/or grain condition; environmental. Sprouted and/or shriveled kernels will negatively impact flour production. Recovery of all mill products will usually be about 98%.

Table 1: Miag Multomat Millstream Percentages for the 2011 Wheat Quality Council Entries.

	VA05W-151	VA05W-251	Merl	SY 1526	Branson	IL00-8061	IL00-8530	IL00-8633	IL01-11934	IL01-16170	IL02-18228	IL02-19463	IL99-26442	GA001138AGS 8E36	GA001138AGS 2035	E6012	Ambassador
1st Break:	11.3	14.0	16.7	17.1	14.4	9.2	12.4	10.8	13.4	20.9	9.6	15.3	10.8	11.1	12.6	12.6	12.7
2nd Break:	2.7	2.9	2.9	6.7	4.7	2.8	3.1	3.9	3.3	5.7	2.7	3.4	2.9	2.7	3.0	3.1	2.7
Grader:	3.2	3.6	3.8	4.9	4.2	2.8	3.4	3.6	3.5	5.0	3.0	3.9	3.2	3.6	3.7	3.8	4.4
3rd Break:	5.4	5.0	5.3	2.4	5.2	6.4	5.9	5.4	5.4	2.6	6.3	5.8	5.5	3.8	5.8	5.2	4.7
Total Break:	22.6	25.5	28.6	31.1	28.5	21.2	24.9	23.7	25.6	34.2	21.5	28.3	22.5	21.3	25.1	24.7	24.6
1st Reduction:	12.7	12.8	12.6	11.1	11.3	12.4	12.2	11.9	10.9	9.8	12.7	12.8	12.8	12.6	12.2	12.0	10.5
2nd Reduction:	11.3	8.5	8.2	13.7	9.4	11.1	10.1	9.2	8.8	12.7	11.7	7.0	10.6	10.6	9.7	8.6	9.3
3rd Reduction:	15.1	14.2	13.0	6.1	12.3	15.2	15.8	14.2	15.4	5.6	15.6	13.9	15.3	12.7	15.0	14.5	14.7
Duster:	7.0	6.0	5.4	7.4	6.1	6.9	6.9	6.9	5.6	6.2	7.0	6.0	7.0	8.2	6.8	6.6	7.2
4th Reduction:	3.9	3.6	3.3	1.9	2.8	3.4	3.8	3.3	4.0	1.6	4.4	3.3	3.9	3.6	3.9	4.0	4.4
5th Reduction:	1.4	1.5	1.4	1.0	1.1	5.3	1.6	1.5	1.8	0.9	1.9	1.4	1.4	1.3	1.4	1.4	1.5
Total Reduction:	51.3	46.5	44.0	41.2	43.0	54.4	50.5	47.0	46.4	36.9	53.2	44.4	51.1	49.1	49.0	47.1	47.7
Straight Grade:	73.9	72.1	72.6	72.2	71.5	75.6	75.4	70.8	72.0	71.0	74.7	72.8	73.5	70.4	74.1	71.7	72.3
Head Shorts:	10.4	12.8	12.1	7.5	10.2	10.1	11.1	11.6	11.7	7.0	12.3	11.4	11.8	8.7	8.1	10.0	9.6
Red Dog:	1.0	1.0	1.0	0.7	0.7	0.8	1.1	0.9	1.2	0.5	1.4	1.0	0.9	0.7	0.6	0.7	0.6
Tail Shorts:	0.6	0.6	0.7	0.3	0.3	0.5	0.7	0.6	0.5	0.3	0.9	0.5	0.6	0.4	0.2	0.5	0.3
Bran:	13.7	13.2	13.1	19.2	16.8	12.5	11.1	14.0	13.8	21.0	10.1	13.3	12.5	19.3	16.5	16.4	16.3
Total Byproduct:	25.6	27.6	27.0	27.7	28.1	23.9	24.0	27.2	27.2	28.8	24.8	26.1	25.9	29.1	25.4	27.5	26.8

Ash Curves

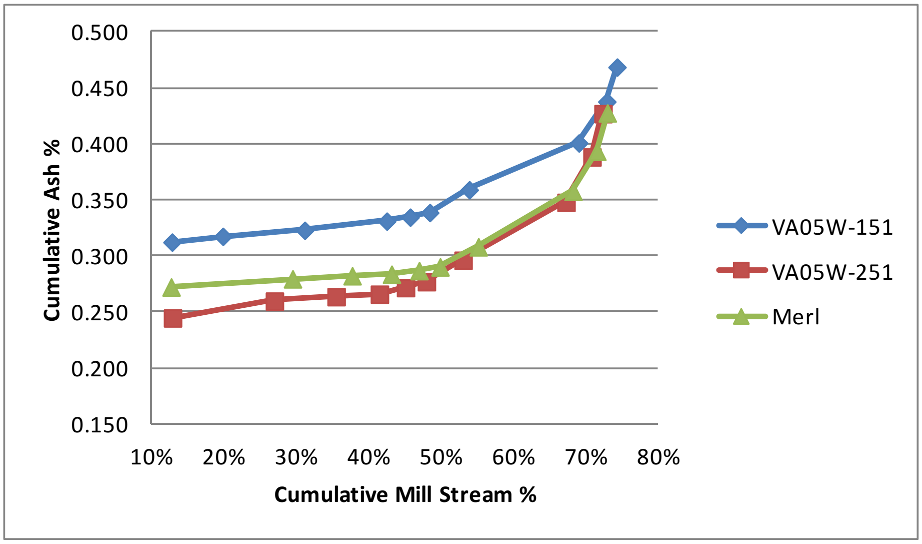


Table 2: Mill Stream Ash: VA05W-151, VA05W-251, and Merl

VA05W-151			VA05W-251			Merl		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	13%	0.312	1 Mids	13%	0.245	1 Mids	13%	0.272
Duster	20%	0.317	Duster	27%	0.260	1 Brk	29%	0.280
2 Mids	31%	0.323	2 Mids	35%	0.264	2 Mids	38%	0.282
1 Brk	42%	0.331	Duster	41%	0.266	Duster	43%	0.284
Grader	46%	0.335	Grader	45%	0.272	Grader	47%	0.287
2 Brk	48%	0.339	2 Brk	48%	0.277	2 Brk	50%	0.290
3 Brk	54%	0.359	3 Brk	53%	0.296	3 Brk	55%	0.308
3 Mids	69%	0.401	3 Mids	67%	0.348	3 Mids	68%	0.358
4 Mids	73%	0.438	4 Mids	71%	0.388	4 Mids	71%	0.393
5 Mids	74%	0.468	5 Mids	72%	0.427	5 Mids	73%	0.428
Red Dog	75%	0.502	Red Dog	73%	0.462	Tail Shorts	74%	0.454
Tail Shorts	76%	0.521	Tail Shorts	74%	0.483	Red Dog	75%	0.492
Brk Shorts	86%	0.925	Brk Shorts	87%	0.967	Brk Shorts	87%	0.963
Bran	100%	1.473	Bran	100%	1.443	Bran	100%	1.441

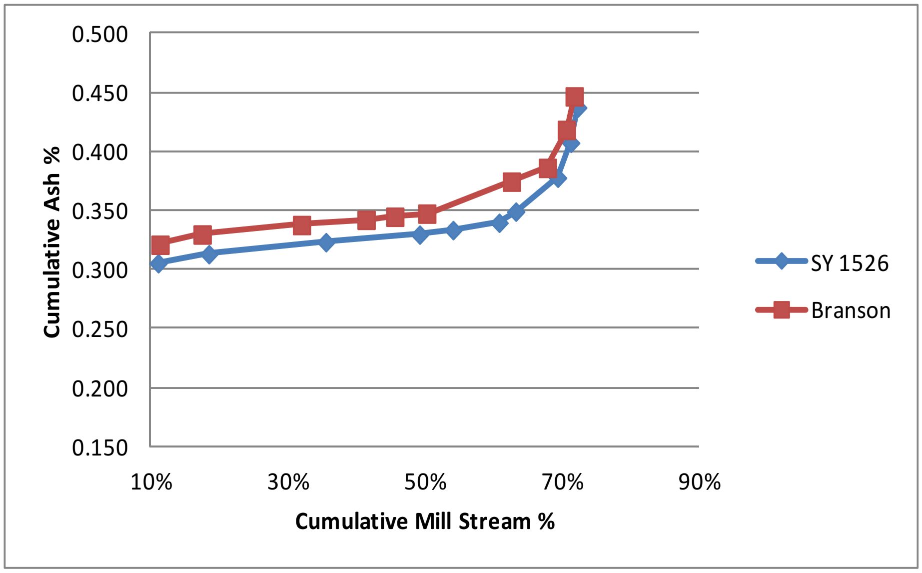


Table 3: Mill Stream Ash: SY 1526 and Branson

SY 1526			Branson		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	11%	0.305	1 Mids	11%	0.321
Duster	18%	0.313	Duster	18%	0.330
1 Brk	36%	0.323	1 Brk	32%	0.338
2 Mids	49%	0.330	2 Mids	41%	0.342
Grader	54%	0.333	Grader	46%	0.345
2 Brk	61%	0.340	2 Brk	50%	0.347
3 Brk	63%	0.349	3 Mids	63%	0.374
3 Mids	69%	0.378	3 Brk	68%	0.386
4 Mids	71%	0.407	4 Mids	71%	0.418
5 Mids	72%	0.437	5 Mids	72%	0.447
Red Dog	73%	0.462	Red Dog	72%	0.472
Tail Shorts	73%	0.475	Tail Shorts	73%	0.486
Brk Shorts	81%	0.813	Brk Shorts	83%	0.904
Bran	100%	1.765	Bran	100%	1.622

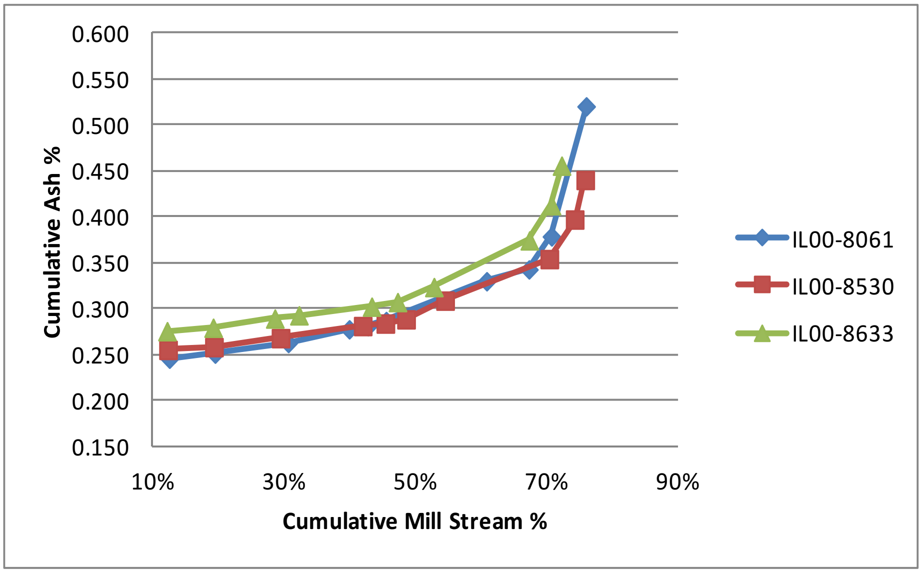


Table 4: Mill Stream Ash: IL00-8061, IL00-8530, and IL00-8633

IL00-8061			IL00-8530			IL00-8633		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	13%	0.246	1 Mids	12%	0.255	1 Mids	12%	0.276
Duster	19%	0.251	Duster	19%	0.259	Duster	19%	0.280
2 Mids	31%	0.263	2 Mids	29%	0.268	2 Mids	29%	0.290
1 Brk	40%	0.278	1 Brk	42%	0.281	Grader	32%	0.293
Grader	43%	0.281	Grader	45%	0.284	1 Brk	43%	0.302
2 Brk	46%	0.287	2 Brk	49%	0.289	2 Brk	47%	0.307
3 Mids	61%	0.330	3 Brk	55%	0.309	3 Brk	53%	0.324
3 Brk	67%	0.343	3 Mids	70%	0.354	3 Mids	67%	0.375
4 Mids	71%	0.379	4 Mids	74%	0.397	4 Mids	71%	0.413
5 Mids	76%	0.520	5 Mids	76%	0.440	5 Mids	72%	0.456
Red Dog	77%	0.549	Red Dog	77%	0.480	Red Dog	73%	0.492
Tail Shorts	77%	0.567	Tail Shorts	78%	0.507	Tail Shorts	74%	0.516
Brk Shorts	87%	1.046	Brk Shorts	89%	0.991	Brk Shorts	86%	1.064
Bran	100%	1.685	Bran	100%	1.539	Bran	100%	1.714

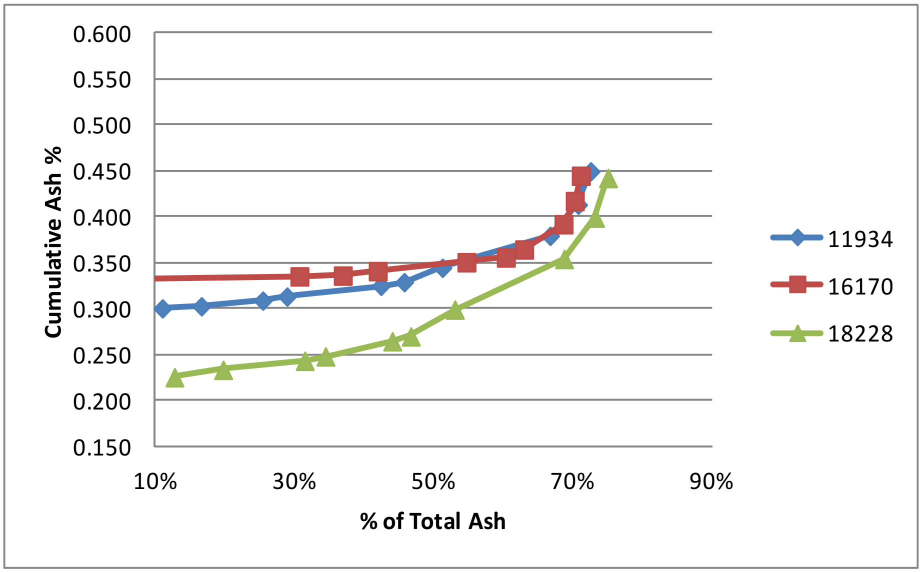


Table 5: Mill Stream Ash: IL01-11934, IL01-16170, and IL02-18228

IL01-11934			IL01-16170			IL01-18228		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	11%	0.301	1 Mids	10%	0.333	1 Mids	13%	0.226
Duster	17%	0.303	1 Brk	31%	0.335	Duster	20%	0.234
2 Mids	25%	0.309	Duster	37%	0.336	2 Mids	31%	0.244
Grader	29%	0.313	Grader	42%	0.341	Grader	34%	0.248
1 Brk	42%	0.325	2 Mids	55%	0.351	1 Brk	44%	0.265
2 Brk	46%	0.329	2 Brk	60%	0.356	2 Brk	47%	0.270
3 Brk	51%	0.345	3 Brk	63%	0.365	3 Brk	53%	0.299
3 Mids	67%	0.380	3 Mids	69%	0.392	3 Mids	69%	0.354
4 Mids	71%	0.413	4 Mids	70%	0.417	4 Mids	73%	0.399
5 Mids	73%	0.450	5 Mids	71%	0.445	5 Mids	75%	0.442
Red Dog	74%	0.490	Red Dog	72%	0.464	Red Dog	77%	0.492
Tail Shorts	74%	0.511	Tail Shorts	72%	0.479	Tail Shorts	77%	0.527
Brk Shorts	86%	1.037	Brk Shorts	79%	0.788	Brk Shorts	90%	1.116
Bran	100%	1.676	Bran	100%	1.800	Bran	100%	1.599

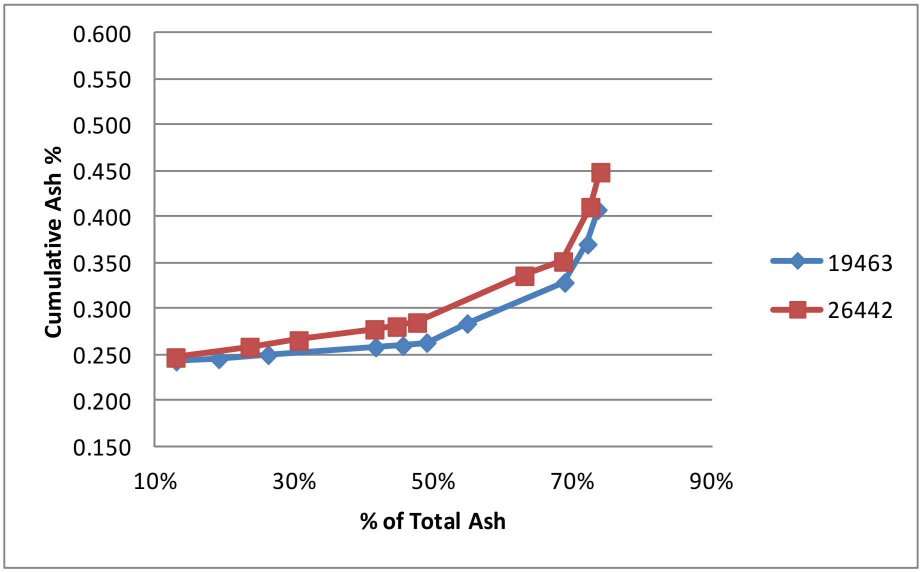


Table 6: Mill Stream Ash: IL02-19463 and IL99-26442

IL02-19463			IL99-26442		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	13%	0.243	1 Mids	13%	0.247
Duster	19%	0.246	2 Mids	24%	0.259
2 Mids	26%	0.250	Duster	31%	0.266
1 Brk	42%	0.258	1 Brk	41%	0.278
Grader	46%	0.260	Grader	45%	0.281
2 Brk	49%	0.263	2 Brk	48%	0.285
3 Brk	55%	0.284	3 Mids	63%	0.336
3 Mids	69%	0.329	3 Brk	69%	0.352
4 Mids	72%	0.370	4 Mids	73%	0.411
5 Mids	74%	0.408	5 Mids	74%	0.449
Red Dog	75%	0.442	Red Dog	75%	0.487
Tail Shorts	75%	0.460	Tail Shorts	76%	0.514
Brk Shorts	87%	1.006	Brk Shorts	87%	1.089
Bran	100%	1.602	Bran	100%	1.709

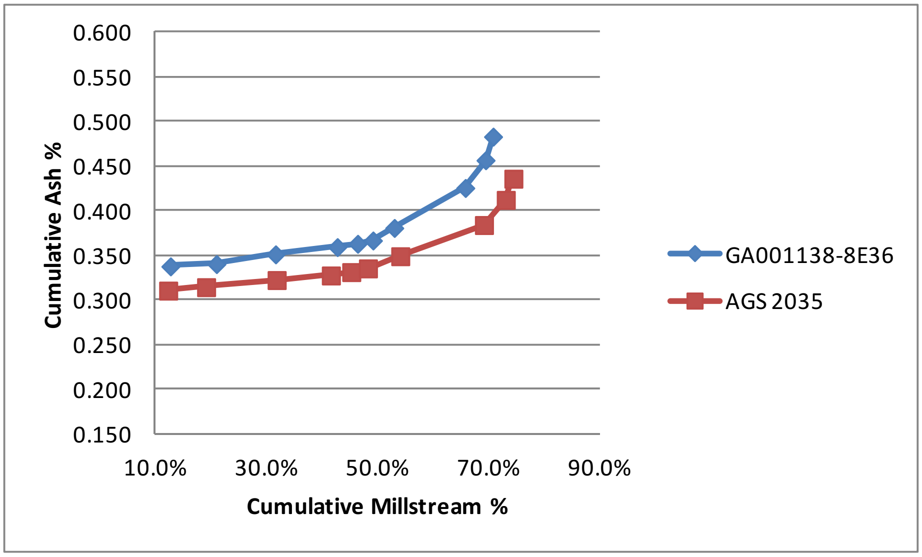


Table 7: Mill Stream Ash: GA001138-8E36 and AGS 2035

GA001138-8E36			AGS 2035		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill Stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	12.7%	0.338	1 Mids	12%	0.311
Duster	21.0%	0.340	Duster	19%	0.315
2 Mids	31.6%	0.351	1 Brk	32%	0.323
1 Brk	42.7%	0.359	2 Mids	42%	0.328
Grader	46.4%	0.363	Grader	45%	0.332
2 Brk	49.2%	0.367	2 Brk	48%	0.336
3 Brk	53.0%	0.381	3 Brk	54%	0.349
3 Mids	65.8%	0.426	3 Mids	69%	0.384
4 Mids	69.4%	0.457	4 Mids	73%	0.412
5 Mids	70.8%	0.483	5 Mids	74%	0.436
Tail Shorts	71.2%	0.496	Red Dog	75%	0.454
Red Dog	71.8%	0.518	Tail Shorts	75%	0.462
Brk Shorts	80.6%	0.853	Brk Shorts	83%	0.785
Bran	100.0%	1.606	Bran	100%	1.472

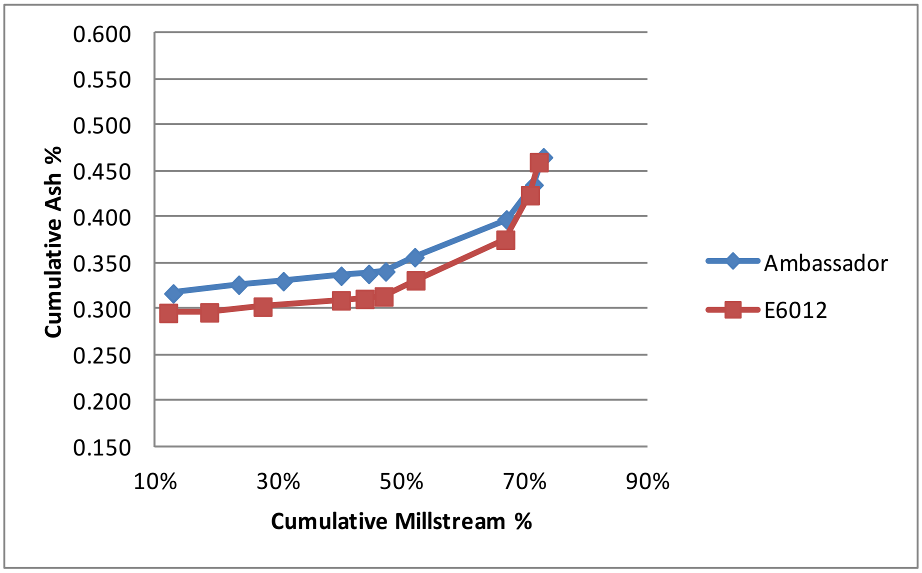


Table 8: Mill Stream Ash: E6012 and Ambassador

E6012			Ambassador		
Mill Stream	Cumulative Mill Stream %	Cumulative Ash %	Mill stream	Cumulative Mill Stream %	Cumulative Ash %
1 Mids	12%	0.296	1 Brk	13%	0.317
Duster	19%	0.296	1 Mids	24%	0.326
2 Mids	27%	0.302	Duster	31%	0.330
1 Brk	40%	0.309	2 Mids	40%	0.336
Grader	44%	0.311	Grader	45%	0.338
2 Brk	47%	0.314	2 Brk	47%	0.341
3 Brk	52%	0.331	3 Brk	52%	0.356
3 Mids	67%	0.375	3 Mids	67%	0.397
4 Mids	71%	0.424	4 Mids	71%	0.435
5 Mids	72%	0.460	5 Mids	73%	0.465
Tail Shorts	73%	0.477	Red Dog	74%	0.483
Red Dog	73%	0.501	Tail Shorts	74%	0.494
Brk Shorts	84%	0.943	Brk Shorts	84%	0.930
Bran	100%	1.699	Bran	100%	1.685

Protein Curves

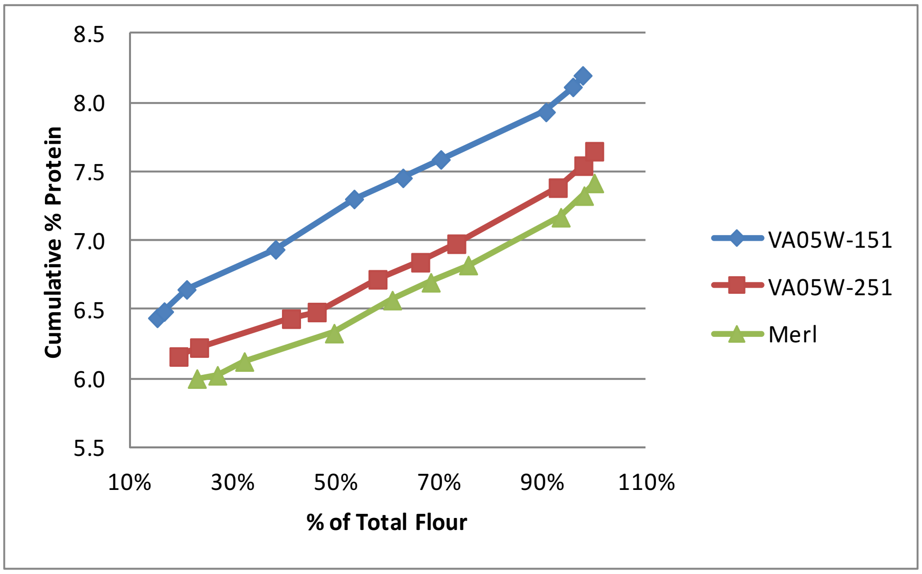


Table 9: Mill Stream Protein: VA05W-151, VA05W-251, and Merl

VA05W-151			VA05W-251			Merl		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	15%	6.4	1 Brk	19%	6.2	1 Brk	23%	6.0
1 Mids	17%	6.5	1 Mids	23%	6.2	1 Mids	27%	6.0
2 Brk	21%	6.6	2 Brk	41%	6.4	2 Brk	32%	6.1
Grader	38%	6.9	Grader	46%	6.5	Grader	50%	6.3
Duster	53%	7.3	Duster	58%	6.7	Duster	61%	6.6
2 Mids	63%	7.5	2 Mids	66%	6.8	2 Mids	68%	6.7
3 Brk	70%	7.6	3 Brk	73%	7.0	3 Brk	76%	6.8
3 Mids	91%	7.9	3 Mids	93%	7.4	3 Mids	94%	7.2
4 Mids	96%	8.1	4 Mids	98%	7.5	4 Mids	98%	7.3
5 Mids	98%	8.2	5 Mids	100%	7.6	5 Mids	100%	7.4

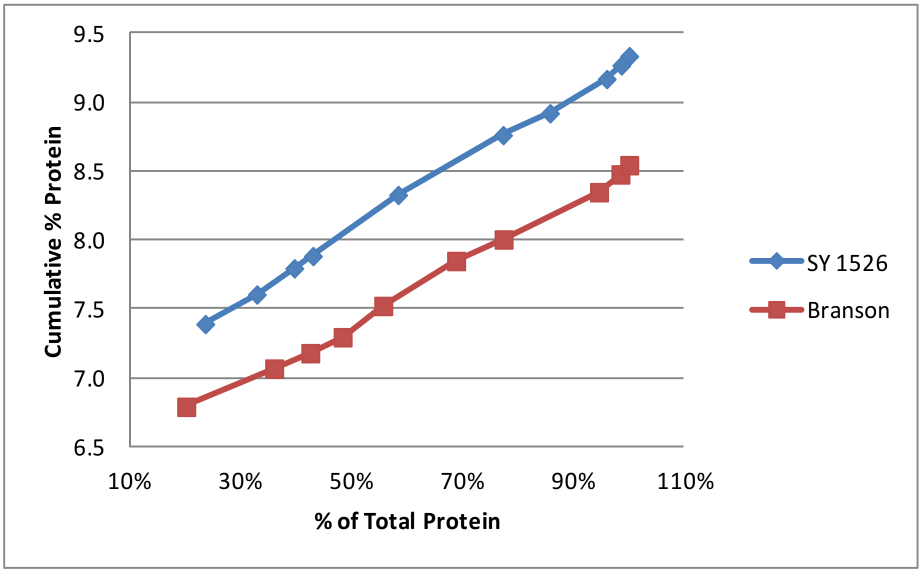


Table 10: Mill Stream Protein: SY 1526 and Branson

SY 1526			Branson		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	24%	7.4	1 Brk	20%	6.8
1 Mids	33%	7.6	1 Mids	36%	7.1
2 Brk	40%	7.8	2 Brk	43%	7.2
Grader	43%	7.9	Grader	48%	7.3
Duster	58%	8.3	Duster	56%	7.5
2 Mids	77%	8.8	2 Mids	69%	7.8
3 Brk	86%	8.9	3 Brk	77%	8.0
3 Mids	96%	9.2	3 Mids	95%	8.3
4 Mids	99%	9.3	4 Mids	98%	8.5
5 Mids	100%	9.3	5 Mids	100%	8.5

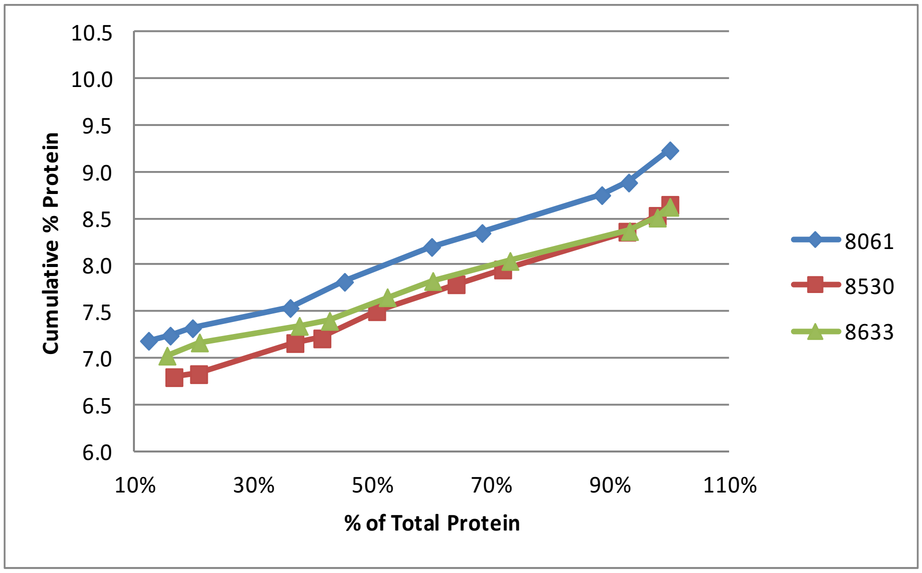


Table 11: Mill Stream Protein: IL00-8061, IL00-8530, and IL11-8633.

IL00-8061			IL00-8530			IL00-8633		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	12%	7.2	1 Brk	17%	6.8	1 Brk	15%	7.0
2 Brk	16%	7.2	2 Brk	21%	6.8	2 Brk	21%	7.2
Grader	20%	7.3	1 Mids	37%	7.2	1 Mids	38%	7.3
1 Mids	36%	7.5	Grader	41%	7.2	Grader	43%	7.4
Duster	45%	7.8	Duster	51%	7.5	Duster	52%	7.7
2 Mids	60%	8.2	2 Mids	64%	7.8	3 Brk	60%	7.8
3 Brk	68%	8.3	3 Brk	72%	8.0	2 Mids	73%	8.0
3 Mids	89%	8.8	3 Mids	93%	8.4	3 Mids	93%	8.4
4 Mids	93%	8.9	4 Mids	98%	8.5	4 Mids	98%	8.5
5 Mids	100%	9.2	5 Mids	100%	8.6	5 Mids	100%	8.6

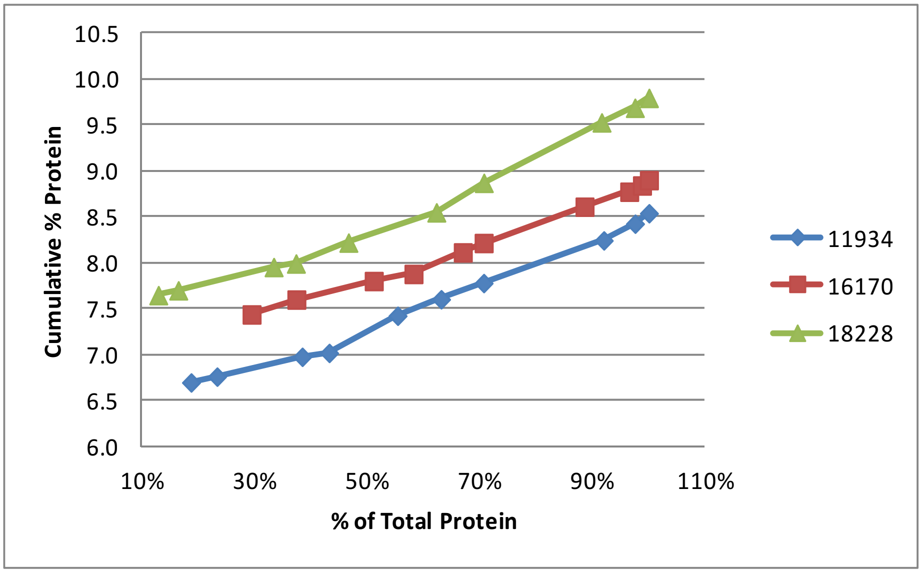


Table 12: Mill Stream Protein: IL01-11934, IL01-16170, and IL02-18228.

IL01-11934			IL01-16170			IL02-18228		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	19%	6.7	1 Brk	29%	7.4	1 Brk	13%	7.7
2 Brk	23%	6.8	2 Brk	37%	7.6	2 Brk	16%	7.7
1 Mids	38%	7.0	1 Mids	51%	7.8	1 Mids	33%	8.0
Grader	43%	7.0	Grader	58%	7.9	Grader	37%	8.0
2 Mids	55%	7.4	Duster	67%	8.1	Duster	47%	8.2
Duster	63%	7.6	3 Brk	71%	8.2	2 Mids	62%	8.6
3 Brk	71%	7.8	2 Mids	89%	8.6	3 Brk	71%	8.9
3 Mids	92%	8.2	3 Mids	97%	8.8	3 Mids	92%	9.5
4 Mids	98%	8.4	4 Mids	99%	8.8	4 Mids	98%	9.7
5 Mids	100%	8.5	5 Mids	100%	8.9	5 Mids	100%	9.8

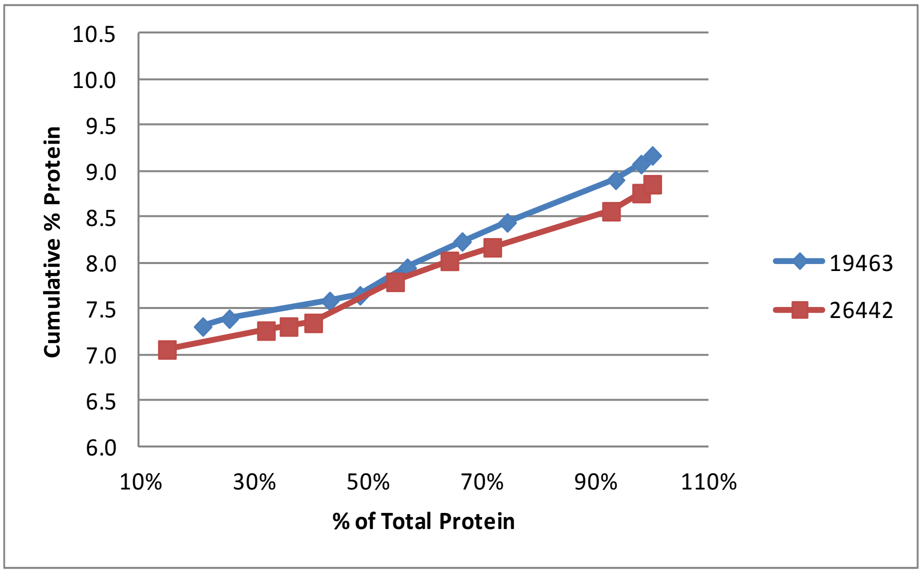


Table 13: Mill Stream Protein: IL02-19463 and IL99-26442.

IL02-19463			IL99-26442		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	21%	7.3	1 Brk	15%	7.1
2 Brk	26%	7.4	1 Mids	32%	7.3
1 Mids	43%	7.6	2 Brk	36%	7.3
Grader	49%	7.7	Grader	40%	7.3
Duster	57%	8.0	2 Mids	55%	7.8
2 Mids	67%	8.2	Duster	64%	8.0
3 Brk	75%	8.4	3 Brk	72%	8.2
3 Mids	94%	8.9	3 Mids	93%	8.6
4 Mids	98%	9.1	4 Mids	98%	8.8
5 Mids	100%	9.2	5 Mids	100%	8.9

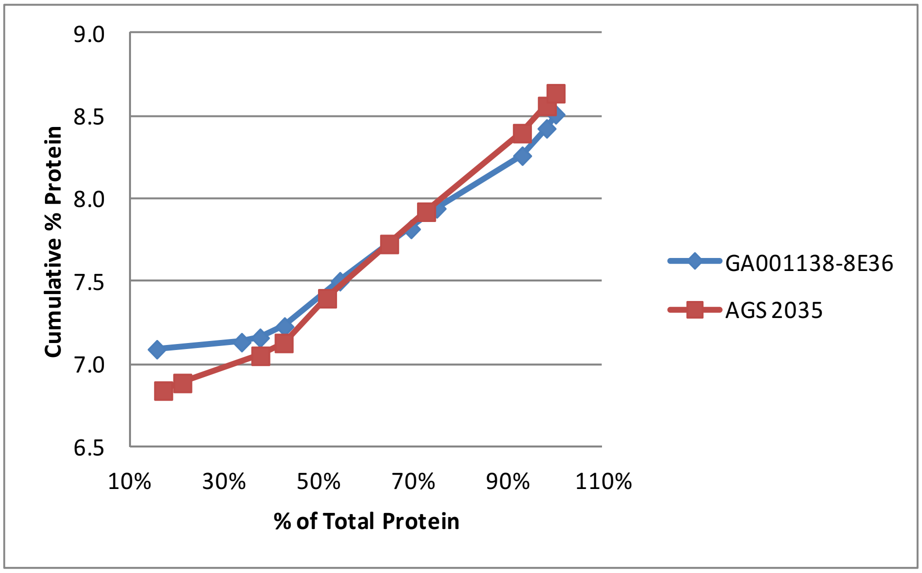


Table 14: Mill Stream Protein: GA001138-8E36 and AGS 2035.

GA001138-E36			AGS 2035		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
1 Brk	16%	7.1	1 Brk	17%	6.8
1 Mids	34%	7.1	2 Brk	21%	6.9
2 Brk	38%	7.2	1 Mids	38%	7.1
Grader	43%	7.2	Grader	43%	7.1
Duster	54%	7.5	Duster	52%	7.4
2 Mids	69%	7.8	2 Mids	65%	7.7
3 Brk	75%	7.9	3 Brk	73%	7.9
3 Mids	93%	8.3	3 Mids	93%	8.4
4 Mids	98%	8.4	4 Mids	98%	8.6
5 Mids	100%	8.5	5 Mids	100%	8.6

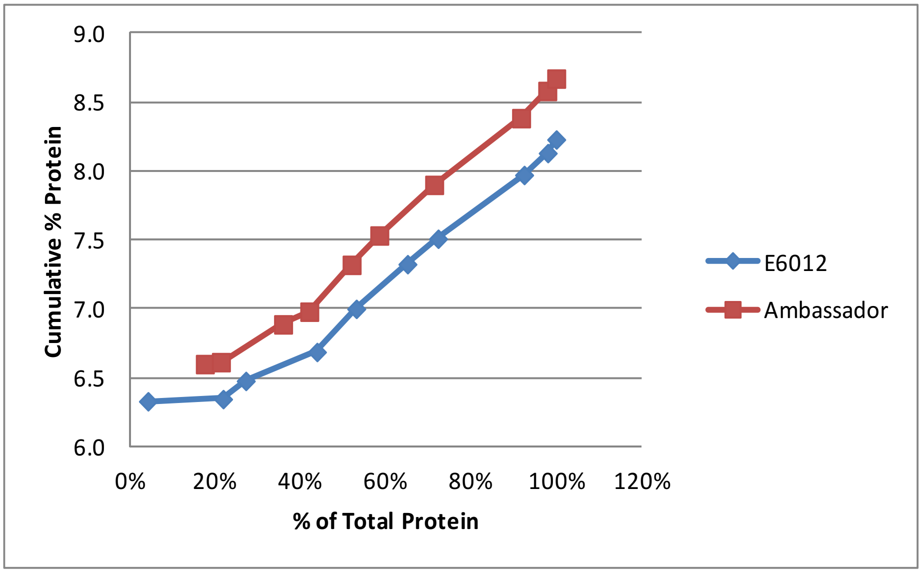


Table 15: Mill Stream Protein: E6012 and Ambassador.

E6012			Ambassador		
Mill Stream	Cumulative Mill Stream %	Cumulative Protein %	Mill Stream	Cumulative Mill Stream %	Cumulative Protein %
2 Brk	4%	6.3	1 Brk	18%	6.6
1 Brk	22%	6.3	2 Brk	21%	6.6
Grader	27%	6.5	1 Mids	36%	6.9
1 Mids	44%	6.7	Grader	42%	7.0
Duster	53%	7.0	Duster	52%	7.3
2 Mids	65%	7.3	3 Brk	59%	7.5
3 Brk	72%	7.5	2 Mids	71%	7.9
3 Mids	92%	8.0	3 Mids	92%	8.4
4 Mids	98%	8.1	4 Mids	98%	8.6
5 Mids	100%	8.2	5 Mids	100%	8.7

Collaborator Evaluations

Ron Lindgren; ADM Milling, Shawnee Mission, Kansas

Scott Baker; ConAgra Foods, Omaha, Nebraska

Colleen Kuznik; Horizon Milling, Minneapolis, Minnesota

Grace Lai; Kellogg's, Kalamazoo, Michigan

Diane Gannon; Kraft-Nabisco, Toledo, Ohio

Jeanny Zimeri; Kraft-Nabisco, East Hanover, New Jersey

Jim Schuh; The Mennel Milling Company, Fostoria, Ohio

Marianne Teagler; Siemer Milling Company, Teutopolis, Illinois

Cathy Butti; Syngenta-Agripro, Berthoud, Colorado

Bon Lee; Wheat Marketing Center, Portland, Oregon

Gary Hoe; Wheat Marketing Center, Portland, Oregon

Doug Engle; USDA-ARS Western Wheat Quality Laboratory, Pullman, Washington

Scott Beil; USDA-ARS Soft Wheat Quality Laboratory, Wooster, Ohio

ADM Milling

Table 16: ADM Milling Datasheet: Solvent Retention Capasity, Alveograph, and Cookies (10-50D).

	SRC's				Alveograph		Cookies (10-50D)			
	Water (%)	NaCarb (%)	Sucrose (%)	Lactic Acid (%)	P/L	W (joules)	Width (mm)	Thick (mm)	W/T (mm)	Spread Factor
VA05W-151	53.1	70.7	93.4	103.5	1.19	144	483	61	7.92	77.28
VA05W-251	52.7	68.4	86.7	94.1	0.47	87	491	54	9.09	88.74
Merl (ck)	51.9	66.2	83.6	92.5	0.52	81	498	55	9.05	88.37
SY 1526	54.1	69.7	86.4	94.4	0.23	41	490	58	8.45	82.96
Branson (ck)	46.2	76.4	80.7	106.1	0.24	80	491	58	8.46	83.13
IL 00-8061	49.5	72.3	83.7	107.7	0.27	87	505	55	9.18	88.51
IL 00-8530	48.5	75.4	80.5	108.3	0.22	82	500	53	9.43	90.94
IL 00-8633	49.5	77.4	83.7	109.0	0.21	68	501	54	9.28	89.44
IL 01-11934	51.9	74.8	84.7	112.9	0.34	117	491	57	8.61	83.04
IL 01-16170	50.6	78.7	84.7	111.9	0.3	85	491	57	8.61	83.04
IL 02-18228	52.6	76.1	86.5	110.6	0.47	129	464	65	7.14	68.81
IL 02-19463	50.5	78.5	88.4	114.1	0.26	97	490	59	8.31	80.06
IL 99-26442	52.0	76.3	87.2	112.2	0.37	156	491	60	8.18	78.89
GA001138-8E36	51.9	76.2	81.5	103.3	0.66	175	478	60	7.97	78.23
AGS 2035 (ck)	51.3	72.4	88.8	105.6	1.11	167	475	63	7.54	74.04
E6012	50.7	76.2	86.4	114.0	0.35	115	482	60	8.03	77.44
Ambassador (ck)	48.7	72.4	81.8	108.8	0.27	85	486	57	8.53	82.19

Table 17: ADM Milling Evaluation/Comments.

		1 poor, 9 excellent		1 poor, 9 excellent
		Question 1: Product Performance Like/Dislike Comments		Question 2: Overall Acceptability Like/Dislike Comments
VA05W-151	5	Dislike, good dough, no checking	5	Low SF
VA05W-251	8	Like, good dough, good checking	8	Good SF, equal to check, good overall
Merl (ck)	8	Like, good dough, good checking	8	Good SF, equal to check, good overall
SY 1526	6	Average, less checking	6	Good SF, comparable to check
Branson (ck)	7	Like, good dough, less checking	7	Good SF
IL 00-8061	8	Like, dry dough, less checking	8	Good SF, better than check, good overall
IL 00-8530	8	Like, dry dough, less checking	8	Good SF, better than check, good overall
IL 00-8633	8	Like, good dough, less checking	8	Good SF, better than check, good overall
IL 01-11934	6	Average, good dough, less checking	6	Good SF, comparable to check
IL 01-16170	6	Average, good dough, less checking	6	Good SF, comparable to check
IL 02-18228	4	Dislike, dry dough, no checking	4	Very low SF, worst of group
IL 02-19463	6	Average, good dough, less checking	6	Low SF
IL 99-26442	5	Dislike, dry dough, less checking	5	Low SF
GA001138-8E36	6	Average, good dough, less checking	6	Good SF, better than check
AGS 2035 (ck)	6	Average, good dough, less checking	6	Low SF
E6012	6	Average, good dough, less checking	6	Low SF
Ambassador (ck)	6	Average, good dough, less checking	6	Low SF

ConAgra Foods

Table 18: ConAgra Foods Datasheet: Primary Flour Analysis and BranScan.

	Primary Flour Analysis			BranScan			
	Moisture (%)	Protein (%)	Ash (%)	Bran (%)	Aluerone (%)	Bran Particles	Aluerone Particles
VA05W-151	13.7	8.2	0.459	0.20	1.04	7.46	34.09
VA05W-251	13.4	7.6	0.415	0.23	1.05	8.91	31.82
Merl (ck)	13.8	7.3	0.494	0.26	1.04	10.36	31.73
SY 1526	14.0	9.7	0.442	0.22	0.60	9.77	12.41
Branson (ck)	14.1	8.8	0.587	0.29	0.61	11.68	13.46
IL 00-8061	14.1	9.4	0.402	0.27	0.68	10.77	19.32
IL 00-8530	14.0	9.1	0.437	0.24	0.56	11.46	12.86
IL 00-8633	14.0	8.8	0.487	0.24	0.62	10.68	15.00
IL 01-11934	13.7	9.0	0.462	0.24	0.70	9.36	16.55
IL 01-16170	14.0	9.5	0.439	0.17	0.46	6.82	9.82
IL 02-18228	14.0	10.8	0.444	0.29	0.79	11.27	19.68
IL 02-19463	13.8	9.7	0.434	0.29	0.76	11.82	18.55
IL 99-26442	13.9	9.4	0.438	0.29	0.89	11.86	23.64
GA001138-8E36	13.5	9.0	0.470	0.18	0.92	6.32	26.23
AGS 2035 (ck)	13.4	9.2	0.427	0.23	0.77	8.86	22.86
E6012	13.7	8.8	0.429	0.08	0.75	3.32	20.50
Ambassador (ck)	13.3	9.3	0.455	0.06	0.75	2.23	21.36

Table 19: ConAgra Foods Datasheet: Solvent Retention Capacity and Cookies (10-50D) Analysis.

	SRC's					Cookies (10-50D)		
	Water (%)	NaCarb (%)	Sucrose (%)	Lactic Acid (%)	SRC Ratio	Width (mm)	Thick (mm)	W/T Ratio (mm)
VA05W-151	57.91	78.00	106.95	120.16	0.65	472	63	7.5
VA05W-251	53.90	73.24	106.30	99.56	0.55	486	60	8.1
Merl (ck)	54.66	76.35	101.64	96.91	0.54	486	60	8.1
SY 1526	54.01	80.05	102.59	92.56	0.51	496	62	8.0
Branson (ck)	52.52	78.63	98.72	109.24	0.62	499	60	8.3
IL 00-8061	55.29	77.36	101.27	102.31	0.57	494	63	7.8
IL 00-8530	53.46	77.90	100.03	115.03	0.65	500	61	8.2
IL 00-8633	54.94	80.53	103.92	113.02	0.61	507	59	8.6
IL 01-11934	60.71	79.31	103.56	127.18	0.70	490	63	7.8
IL 01-16170	57.14	82.44	104.44	118.24	0.63	487	63	7.7
IL 02-18228	56.92	80.58	101.08	119.92	0.66	472	69	6.8
IL 02-19463	57.50	80.97	104.68	129.11	0.70	492	64.5	7.6
IL 99-26442	59.07	80.32	104.39	127.54	0.69	484	65	7.4
GA001138-8E36	57.32	79.31	109.95	113.30	0.60	476	61	7.8
AGS 2035 (ck)	57.04	81.01	110.25	117.42	0.61	476	66	7.2
E6012	55.38	78.52	103.67	123.82	0.68	480	65	7.4
Ambassador (ck)	54.36	75.94	100.00	108.22	0.62	493	61.5	8.0

Table 20: ConAgra Foods Evaluation/Comments

	1 poor, 9 excellent		
		Question 2: Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	3		
VA05W-251	5		
Merl (ck)	5		
SY 1526	4		
Branson (ck)	5		
IL 00-8061	4		
IL 00-8530	5		
IL 00-8633	6		
IL 01-11934	4		
IL 01-16170	4		
IL 02-18228	1	poor spread factor	High protein
IL 02-19463	3		
IL 99-26442	3		
GA001138-8E36	4		
AGS 2035 (ck)	2	poor spread factor	
E6012	3		
Ambassador (ck)	4		

Horizon Milling

Table 21: Horizon Milling Datasheet: Cookies (10-50D)

	Cookies (10-50D)					
	Width (mm)	Thick (mm)	W/T (mm)	Spread Factor	Crust	Score
VA05W-151	465	60	7.75	75.64	3.5	4
VA05W-251	484	52	9.31	90.84	4.0	7
Merl (ck)	481	54	8.91	86.94	3.5	6
SY 1526	490	54	9.07	88.56	4.0	7
Branson (ck)	485	53	9.15	89.31	3.0	7
IL 00-8061	479	55	8.71	85.00	3.5	6
IL 00-8530	489	55	8.89	86.78	3.0	6
IL 00-8633	494	53	9.32	90.97	3.5	7
IL 01-11934	481	57	8.44	82.36	3.0	5
IL 01-16170	477	56	8.52	83.13	3.0	5
IL 02-18228	462	62	7.45	72.73	4.0	4
IL 02-19463	485	54	8.98	87.66	3.5	6
IL 99-26442	478	58	8.24	80.44	3.5	5
GA001138-8E36	471	54	8.72	85.13	4.0	6
AGS 2035 (ck)	463	60	7.72	75.31	3.5	4
E6012	472	60	7.87	76.78	3.5	4
Ambassador (ck)	475	58	8.19	79.93	3.0	5

Table 22: Horizon Milling Evaluation/Comments

	1 poor, 9 excellent	Question 1: Product Performance Like/Dislike Comments	1 poor, 9 excellent	Question 2: Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	4	very low SF	4	worst performance of group	
VA05W-251	7	good SF	7	best performance, better than check	low protein
Merl (ck)	6	acceptable SF	6	good overall	low protein
SY 1526	7	good SF	7	good overall, but check was better	
Branson (ck)	7	good SF	7	check best of group	
IL 00-8061	6	slightly low SF	6	average performance	
IL 00-8530	6	acceptable SF	6	good overall	
IL 00-8633	7	good SF	7	best of group, better than check	
IL 01-11934	5	low SF	5	average performance	
IL 01-16170	5	low SF	5	average performance	
IL 02-18228	4	very low SF	4	worst performance of the group	high protein
IL 02-19463	6	acceptable SF	6	good overall	
IL 99-26442	5	low SF	5	average performance	
GA001138-8E36	6	slightly low SF	6	average, but much better than check	high ash
AGS 2035 (ck)	4	very low SF	4	below average	
E6012	4	very low SF	4	worse than check sample	
Ambassador (ck)	5	low SF	5	average performance	high ash

Kellogg's

Table 23: Kellogg's Datasheet: Primary Analysis and Solvent Retention Capacity.

	Primary Analysis					SRC's			
	Flour Moisture (%)	Flour Protein (%)	Ash (%)	FN	pH	Water (%)	NaCarb (%)	Sucrose (%)	Lactic Acid (%)
VA05W-151	13.5	8.2	0.44	433	6.23	53.2	69.9	95.6	111.1
VA05W-251	13.3	7.6	0.42	423	6.24	50.7	65.6	87.1	91.7
Merl (ck)	13.8	7.4	0.42	399	6.25	50.8	69.8	89.5	91.2
SY 1526	13.9	9.7	0.45	363	6.18	49.9	77.9	90.0	101.9
Branson (ck)	14.0	8.8	0.45	378	6.14	51.7	77.0	87.1	110.0
IL 00-8061	14.2	9.4	0.38	376	6.20	51.8	74.2	89.7	113.3
IL 00-8530	13.9	9.1	0.43	356	6.24	46.7	76.2	85.0	114.2
IL 00-8633	14.0	8.8	0.45	358	6.20	49.2	79.5	89.7	112.8
IL 01-11934	13.6	9.0	0.44	375	6.21	50.6	75.5	87.8	118.2
IL 01-16170	14.0	9.5	0.45	438	6.23	51.4	80.5	89.1	120.5
IL 02-18228	13.9	10.9	0.44	439	6.51	53.8	74.9	90.5	114.2
IL 02-19463	13.7	9.7	0.42	375	6.30	50.4	80.7	91.6	126.9
IL 99-26442	13.7	9.3	0.45	360	6.42	54.7	76.2	90.7	120.8
GA001138-8E36	13.4	8.9	0.48	466	6.28	54.2	72.3	95.4	101.5
AGS 2035 (ck)	13.4	9.2	0.44	442	6.26	53.4	69.4	94.9	105.4
E6012	13.6	8.8	0.46	376	6.29	51.1	76.6	89.4	118.1
Ambassador (ck)	13.2	9.3	0.49	421	6.24	50.9	71.5	85.0	109.9

Table 24: Kellogg's Datasheet: Alveograph and Farinograph.

	Alveograph					Farinograph			
	P	L	P/L	le	W	Water Absorp	Develop Time	Stability	Degree of Softening
	(mm)	(mm)	(ratio)		(joules)	(%)	(min)	(min)	
VA05W-151	63	80	0.79	54.3	107	55.1	1.7	6.2	65
VA05W-251	35	93	0.38	43.5	55	53.3	1.4	6.9	69
Merl (ck)	36	88	0.41	41.6	55	52.3	1.3	7.8	60
SY 1526	22	187	0.12	27.5	29	52.8	1.7	2.9	126
Branson (ck)	26	172	0.15	38.1	39	53.1	1.2	4.3	101
IL 00-8061	31	155	0.2	39.5	47	54.7	3.2	5.3	88
IL 00-8530	25	190	0.13	39.5	37	51.4	1.4	4.2	84
IL 00-8633	22	203	0.11	40.4	33	49.5	1.7	7.2	62
IL 01-11934	36	160	0.22	47.3	57	53.0	1.7	6.0	74
IL 01-16170	30	163	0.18	36.4	43	53.0	1.2	2.6	116
IL 02-18228	47	129	0.36	42.0	72	56.9	2.2	6.1	81
IL 02-19463	29	168	0.17	38.8	43	53.7	1.4	3.5	123
IL 99-26442	41	172	0.24	48.6	66	54.9	1.5	10.3	56
GA001138-8E36	52	99	0.53	55.9	89	53.2	1.5	19.1	39
AGS 2035 (ck)	67	88	0.76	59.3	118	54.3	1.7	19.4	16
E6012	38	140	0.27	47.5	61	52.3	1.7	7.1	70
Ambassador (ck)	28	204	0.14	40.7	42	52.4	1.7	5.2	97

Table 25: Kellogg's Datasheet: Rapid Visco-Analyzer.

	RVA							
	Peak Time (min)	Peak (cP)	Through (cP)	Brkdown (cP)	Setback (cP)	Final (cP)	Pasting Temp (ºC)	Peak/ Final (ratio)
VA05W-151	6.1	2581	1789	792	1657	3446	82.3	0.75
VA05W-251	6.1	2411	1655	756	1598	3253	83.3	0.74
Merl (ck)	6.0	2030	1413	617	1463	2876	84.2	0.71
SY 1526	6.0	2697	1517	1180	1374	2891	84.1	0.93
Branson (ck)	6.0	2985	1519	1466	1373	2892	84.0	1.03
IL 00-8061	6.0	2618	1457	1161	1345	2802	84.2	0.93
IL 00-8530	5.9	2679	1433	1246	1401	2834	81.6	0.95
IL 00-8633	5.9	2468	1316	1152	1349	2665	83.3	0.93
IL 01-11934	5.9	2824	1547	1277	1391	2938	80.8	0.96
IL 01-16170	6.1	3191	1819	1372	1507	3326	83.2	0.96
IL 02-18228	6.1	2862	1809	1053	1472	3281	84.9	0.87
IL 02-19463	5.9	2757	1439	1318	1265	2704	84.1	1.02
IL 99-26442	5.9	2473	1315	1158	1238	2553	82.5	0.97
GA001138-8E36	6.3	2936	2016	920	1500	3516	83.3	0.84
AGS 2035 (ck)	6.1	2793	1887	906	1580	3467	82.4	0.81
E6012	6.1	2387	1505	882	1391	2896	84.1	0.82
Ambassador (ck)	6.0	2542	1613	929	1465	3078	83.4	0.83

Table 26: Kellogg's Evaluation/Comments.

	Comments
	Mitigating, Physical/Chemical Properties
VA05W-151	high protein, better protein quality (SRC-LA) and better Farinograph water absorption
VA05W-251	similar to ck sample; no improvement in parameters
Merl (ck)	
SY 1526	Increased protein content however protein quality decreased (as measured by both SRC and Farinograph).
Branson (ck)	
IL 00-8061	Similar to ck sample. Only slight improvement in Farinograph measurements.
IL 00-8530	Similar to ck sample no overall improvement.
IL 00-8633	Lower water holding capacity as measured by both SRC-Water and Farinograph water absorption.
IL 01-11934	Identical to ck sample (no significant difference)
IL 01-16170	Increase in protein content (~0.7%) however no significant increase in water absorption. Increased SRC-LA may be due to increase in protein quantity not quality.
IL 02-18228	Significant increace in protein content (2%) and increase water holding capacitity (SRC-water and Farinograph water absorption) however not protein quality -similar SRC -LA as ck sample
IL 02-19463	Higer protein content (1% increase) and higher SRC-AC (better quality) however with similar water absorption as measured by SRC-water and Farinograph water absorption.
IL 99-26442	Improvement in protein quantity and quality and increase water absorption. (preferred)
GA001138-8E36	Similar to ck sample no overall improvement.
AGS 2035 (ck)	
E6012	Very similar to ck sample with slight improvement in protein quality.
Ambassador (ck)	

Kraft-Nabisco

Table 27: Kraft Datasheet: Solvent Retention Capacity and Alveograph.

	SRC's					Alveograph		
	Water (%)	NaCarb (%)	Sucrose (%)	Lactic Acid (%)	LA/ SC+S	P (mm)	L (mm)	W (joules)
VA05W-151	54.5	76.6	105.1	112.9	0.621	56	58	121
VA05W-251	50.6	73.0	101.6	91.3	0.523	32	83	76
Merl (ck)	52.2	74.5	98.1	89.6	0.519	35	67	72
SY 1526	53.0	76.6	106.1	85.2	0.467	24	101	45
Branson (ck)	53.0	78.9	102.2	98.9	0.546	26	113	68
IL 00-8061	53.4	76.1	106.6	94.5	0.517	30	117	78
IL 00-8530	51.8	75.3	99.8	105.1	0.600	25	120	72
IL 00-8633	50.8	81.1	103.4	108.8	0.590	22	122	65
IL 01-11934	53.8	77.5	105.3	111.2	0.608	35	95	99
IL 01-16170	56.3	80.3	106.8	106.8	0.571	29	129	71
IL 02-18228	61.2	81.1	100.3	116.6	0.643	42	101	114
IL 02-19463	54.0	80.6	105.1	120.3	0.648	29	125	85
IL 99-26442	52.3	77.5	99.3	110.0	0.622	41	121	139
GA001138-8E36	54.3	78.4	108.0	106.7	0.572	50	85	148
AGS 2035 (ck)	55.3	78.0	106.3	107.3	0.582	58	62	137
E6012	54.4	77.5	104.9	112.2	0.615	36	101	104
Ambassador (ck)	52.5	74.6	96.8	106.3	0.620	27	125	80

Table 28: Kraft Datasheet: Wire-cut Cookie Evaluation (10-53)

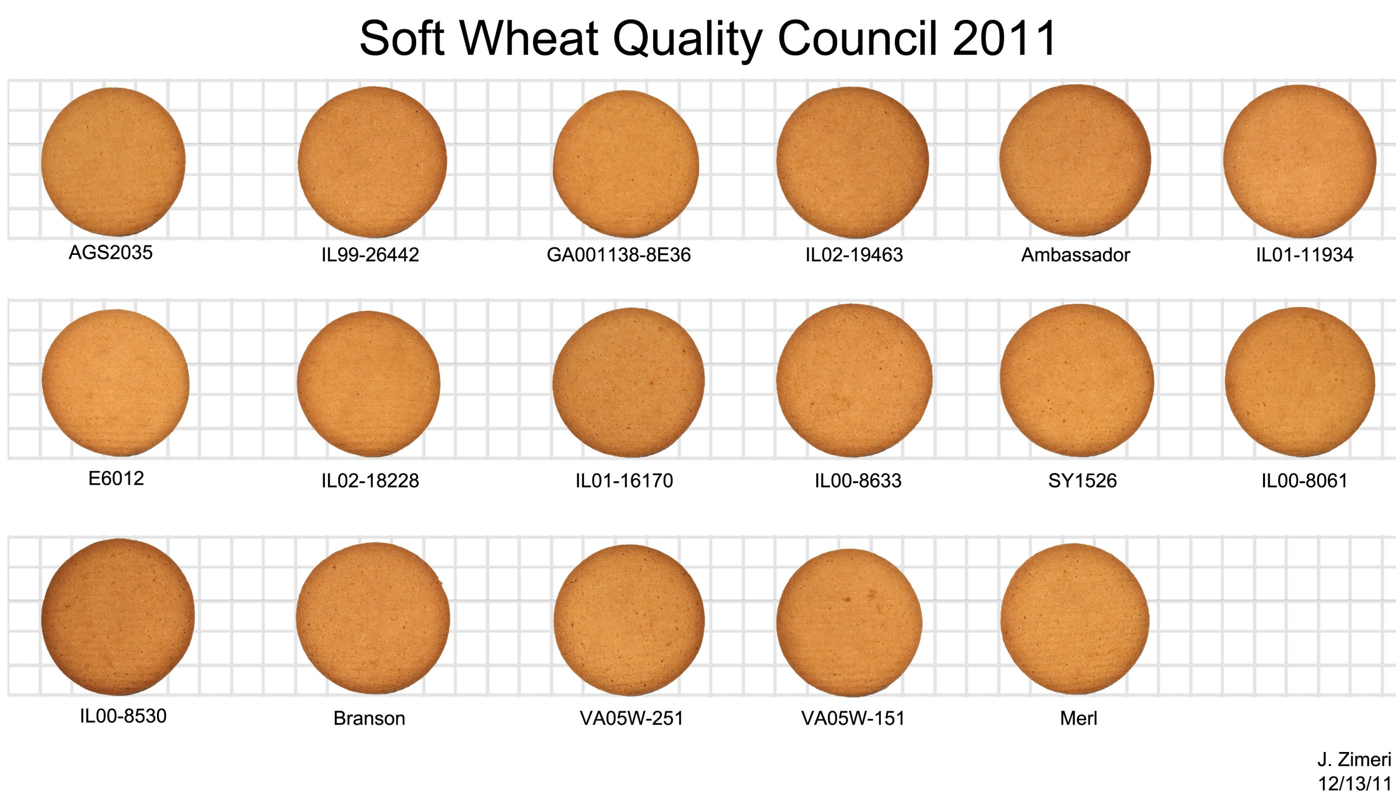
	Wire-cut Cookies						
	Dough Firmness (g)	Stack Height (cm x4)	Width (cm x4)	Length (cm x4)	Average Diameter (cm x4)	Weight Loss (%)	Final Moisture (%)
VA05W-151	151	4.15	30.8	31.2	31.0	13.8	3.9
VA05W-251	137	3.80	31.9	31.9	31.9	14.3	3.3
Merl (ck)	134	3.98	31.6	31.8	31.7	14.1	3.5
SY 1526	142	4.09	32.4	32.5	32.5	13.8	3.8
Branson (ck)	149	3.99	32.6	31.9	32.3	14.2	3.4
IL 00-8061	149	4.14	31.9	31.8	31.9	13.8	3.9
IL 00-8530	134	3.86	32.9	32.6	32.8	14.6	3.1
IL 00-8633	125	3.99	32.7	32.4	32.6	14.1	3.5
IL 01-11934	168	4.10	32.0	32.1	32.1	13.8	3.9
IL 01-16170	142	4.30	31.8	31.5	31.7	13.8	3.9
IL 02-18228	160	4.24	30.6	30.9	30.8	13.9	3.8
IL 02-19463	160	4.06	32.7	32.4	32.6	14.0	3.7
IL 99-26442	152	4.24	31.4	32.0	31.7	13.5	4.1
GA001138-8E36	155	4.20	30.8	31.3	31.1	13.6	4.0
AGS 2035 (ck)	153	4.55	30.5	31.3	30.9	13.0	4.6
E6012	156	4.32	31.2	31.2	31.2	13.1	4.6
Ambassador (ck)	145	4.02	32.0	32.2	32.1	14.2	3.4

Table 29: Kraft Evaluation/Comments

	1 poor, 9 excellent		1 poor, 9 excellent	
		Question 1: Product Performance Like/Dislike Comments		Question 2: Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	8	Good For cracker use. Ok for cookie	7	More multipurpose for cookie or cracker use	Concerning short exensibility as seen by alveo L
VA05W-251	7	Nice cookie wheat. Better than the check	7	Best for cookies, not quite enough gluten for crackers	Overall nice functionality Soft wheat.
Merl (ck)	6	OK cookie wheat, slightly weak for cracker	6	OK cookie wheat, too weak for cracker	Overall nice functionality Soft wheat.
SY 1526	3	Poor for cracker, marginal for cookie due to lack of gouten performance.	2	too weak in gluetn potential	poorest in the data set
Branson (ck)	8	marginal for crackers, great for cookies	8	nice gluten potential	Nice soft wheat
IL 00-8061	5	concerning for cracker use	7	concern for crackers, OK for cookies	OK gluten potential
IL 00-8530	7	good cookie, marginal cracker	8	good overall performer	nice low water absorbtion
IL 00-8633	7	good cookie, marginal cracker	8	good overall performer	very hard, too high starch damage
IL 01-11934	7	good cookie, marginal cracker	8	good overall performer	2nd best in the set
IL 01-16170	6	OK cookie wheat, slightly weak for cracker	6	Hard: Very high starch damage, high pentosans	concerning hardness and water absorbtion
IL 02-18228	7	high water absorbiton, hard to bake out water	7	Hard: Very high starch damage	too highwater absorbtion and starch damage
IL 02-19463	8		8	Hard: Very high starch damage	too highwater absorbtion and starch damage
IL 99-26442	8	Some concern over low water loss in cookie bake, and was the highest water retention...	9	Best overall of the set	concerning cookie height, but the flour profile looks very good.
GA001138-8E36	6	too high in water binding for cookies and marginal for cracker	6	Ok cookie and cracker–concerned with bakeout ability	comparable to the check, not an improvement
AGS 2035 (ck)	6	too high in water binding for cookies and marginal for cracker	6	Ok cookie and cracker–concerned with bakeout ability	short gluten extensibility
E6012	7	Concern on water retention of cookie bake and high stack height	7	Ok for crackers.	high water retention on cookie bake and flour profiles.
Ambassador (ck)	8	Best cookie bake of this year	9	good for cookies and crackers	nice low water absorbtion yet high gluten.

Figure 1: Kraft Wire-cut Cookies; Stack Height.

Figure 2: Kraft Wire-cut Cookies.



The Mennel Milling Company

Table 30: The Mennel Milling Company Datasheet: Solvent Retention Capacity and Farinograph.

	SRC's				Farinograph			
	Water	NaCarb	Sucrose	Lactic Acid	Water Absorp	Develop Time	Stability	MTI
	(%)	(%)	(%)	(%)	(min)	(min)	(min)	
VA05W-151	58.4	75.1	103.7	116.2				
VA05W-251	54.1	73.4	99.7	96.0				
Merl (ck)	54.2	73.6	97.6	95.9				
SY 1526	53.3	81.4	101.6	105.8	53.0	2.5	3.0	94
Branson (ck)	53.6	79.3	99.3	114.2	53.3	1.8	3.8	88
IL 00-8061	53.5	76.5	98.5	114.7				
IL 00-8530	52.7	82.9	99.7	117.6				
IL 00-8633	53.0	77.6	95.8	116.7				
IL 01-11934	55.7	79.7	102.7	128.0				
IL 01-16170	55.4	81.9	101.1	126.7				
IL 02-18228	56.8	80.5	100.5	121.9	57.8	3.5	6.9	45
IL 02-19463	55.1	81.2	103.1	136.2	55.0	1.4	2.1	125
IL 99-26442	56.2	80.5	100.4	128.2				
GA001138-8E36	56.1	77.5	107.8	112.4				
AGS 2035 (ck)	55.5	75.3	103.4	118.0				
E6012	54.9	79.8	101.1	132.0				
Ambassador (ck)	53.7	75.7	96.8	124.2				

Table 31: The Mennel Milling Company Datasheet: Rapid Visco-Analyzer.

	RVA						
	Peak Time (min)	Peak (cP)	Trough (cP)	Breakdown (cP)	Setback (cP)	Final (cP)	Peak/ Final
VA05W-151	6.1	239.1	168.0	71.1	143.2	311.2	0.77
VA05W-251	6.1	236.3	136.8	99.6	116.7	253.4	0.93
Merl (ck)	6.0	192.3	131.1	61.3	127.8	258.9	0.74
SY 1526	6.1	254.0	146.2	107.8	121.9	268.1	0.95
Branson (ck)	6.1	270.1	140.7	129.4	122.8	263.4	1.03
IL 00-8061	6.1	225.5	154.8	70.7	136.1	290.9	0.78
IL 00-8530	5.9	249.4	135.6	113.3	126.8	262.3	0.95
IL 00-8633	5.9	229.4	122.2	107.3	120.3	242.5	0.95
IL 01-11934	6.1	252.3	142.3	106.6	119.7	262.5	0.96
IL 01-16170	6.2	282.2	167.2	115.0	130.8	298.0	0.95
IL 02-18228	6.3	264.3	179.3	85.1	125.8	305.0	0.87
IL 02-19463	6.1	257.2	143.5	113.7	113.7	257.2	1.00
IL 99-26442	5.9	226.0	124.3	101.7	110.7	235.0	0.96
GA001138-8E36	6.5	261.0	187.1	73.9	128.5	315.6	0.83
AGS 2035 (ck)	6.3	251.7	175.3	76.3	136.5	311.8	0.81
E6012	6.1	217.3	140.1	77.3	123.4	263.5	0.82
Ambassador (ck)	6.1	237.7	148.8	88.8	131.7	280.5	0.85

Table 32: The Mennel Milling Company Datasheet: Cookies (10-50D) and Biscuits.

	Sugar Snap Cookies				Biscuits		
	Width (mm)	Thick (mm)	W/T (mm)	Spread Factor	Width (mm)	Height (mm)	Weight (g)
VA05W-151	479.8	64.1	7.5	70.4	254.5	197	134.7
VA05W-251	494.0	59.8	8.3	77.7	254.5	194	124.4
Merl (ck)	492.3	58.8	8.4	78.8	253.5	202	125.0
SY 1526	493.5	60.4	8.2	76.8	264.0	237	134.0
Branson (ck)	501.8	60.9	8.2	77.5	265.5	236	134.2
IL 00-8061	490.0	65.9	7.4	69.9	253.0	219	131.1
IL 00-8530	509.8	59.6	8.6	80.4	258.5	234	135.6
IL 00-8633	501.8	61.0	8.2	77.3	262.5	226	135.8
IL 01-11934	494.8	64.7	7.6	73.2	251.5	238	135.3
IL 01-16170	483.5	66.2	7.3	69.9	265.0	222	129.8
IL 02-18228	468.3	72.3	6.5	62.1	254.5	232	140.3
IL 02-19463	493.0	65.7	7.5	71.8	262.0	231	137.4
IL 99-26442	486.3	67.6	7.2	68.9	252.5	234	142.0
GA001138-8E36	477.3	63.5	7.5	72.0	246.0	221	135.0
AGS 2035 (ck)	475.8	68.6	6.9	66.4	248.5	213.5	132.0
E6012	481.0	71.4	6.7	64.5	248.0	222	131.9
Ambassador (ck)	491.5	65.9	7.5	71.4	249.0	226	133.3

Figure 3: The Mennel Milling Company Sugar Snap Cookies.

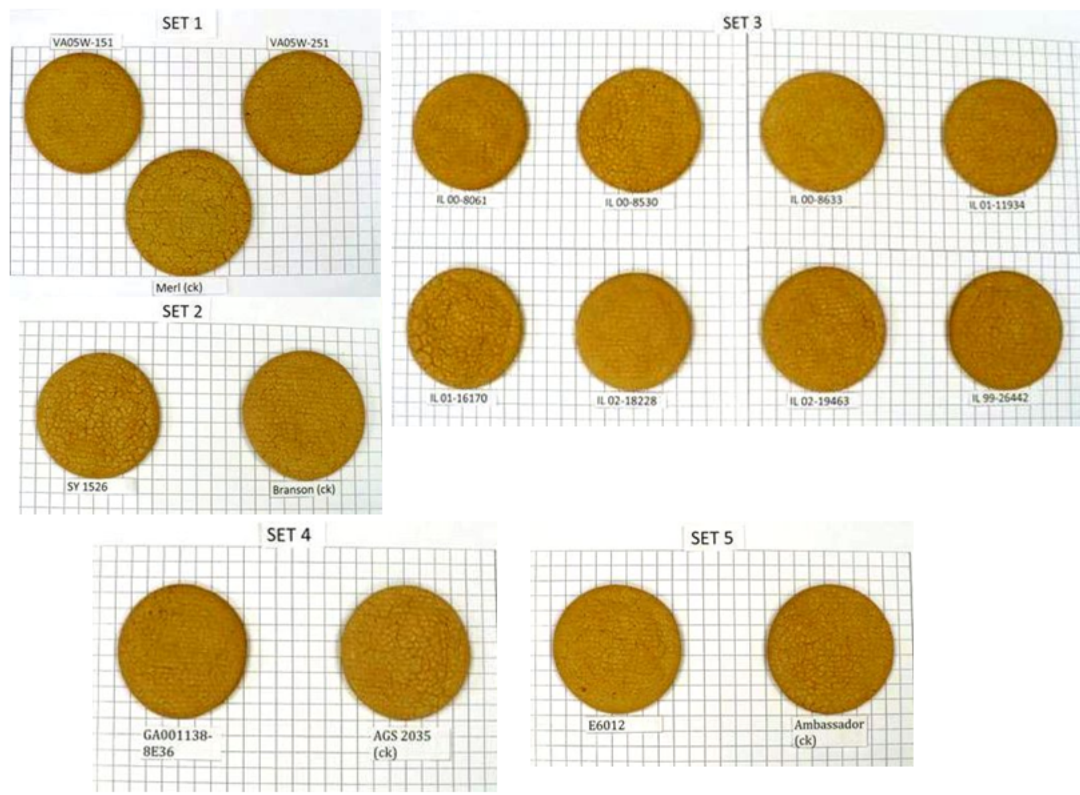


Table 33: The Mennel Milling Company Evaluation/Comments.

	1 poor, 9 excellent		1 poor, 9 excellent	
	Question 1: Product Performance	Like/Dislike Comments	Question 2: Overall Acceptability	Like/Dislike Comments
VA05W-151	5	Lowest spread of the set - Highest protein	6	
VA05W-251	7	Good spread -a lot of cracks	7	
Merl (ck)	8	Highest spread of the set with tight cracking	8	
SY 1526	7	Good spread and high protein-tight cracking	7	
Branson (ck)	7	Highest spread of the set- tight cracking	7	
IL 00-8061	5		5	
IL 00-8530	9		9	
IL 00-8633	7		7	
IL 01-11934	6		6	
IL 01-16170	5	Deep Wide Cracks- low spread	4	
IL 02-18228	5	Lowest spread of the set- Hi Pro- Low cracks	4	
IL 02-19463	6		6	
IL 99-26442	5	Low spread- tight cracks	5	
GA001138-8E36	5	Low spread-tight cracks	5	
AGS 2035 (ck)	4	Lowest spread- excess cracks	4	
E6012	4	Good pro-low spread	4	
Ambassador (ck)	5	Good pro-low spread-tight cracks	5	

Siemmer Milling Company

Table 34: Siemmer Milling Company Datasheet: Alveograph.

	Alveograph			
	P (mm)	L (mm)	P/L (ratio)	W (joules)
VA05W-151	67.0	63.6	1.054	163
VA05W-251	37.7	70.3	0.536	84.8
Merl (ck)	42.4	65.1	0.652	86.2
SY 1526	25.6	57.3	0.447	42.5
Branson (ck)	31.7	102.8	0.308	80.6
IL 00-8061	35.9	102.8	0.349	97.1
IL 00-8530	29.7	125.9	0.236	95.9
IL 00-8633	24.9	140.5	0.177	78.1
IL 01-11934	40.2	117	0.344	133.4
IL 01-16170	31.9	113.1	0.282	82
IL 02-18228	50.7	83.7	0.606	120.8
IL 02-19463	33.1	119.9	0.276	99.5
IL 99-26442	44.3	123.9	0.358	146.3
GA001138-8E36	62.7	75.6	0.829	171
AGS 2035 (ck)	75.2	71.8	1.047	221.7
E6012	41.8	114.1	0.366	129.4
Ambassador (ck)	30.6	151.3	0.202	102.5

Syngenta-AgriPro

Table 35: Syngenta-AgriPro Datasheet: Solvent Retention Capacity and Sugar Snap Cookies, AACC Method 10-52.02.

	SRC's					Sugar Snap
	Water	NaCarb	Sucrose	Lactic Acid	LA/ SC+S	Cookies
	(%)	(%)	(%)	(%)		(Dia. cm)
VA05W-151	57	75	104	109	0.61	16.5
VA05W-251	54	72	97	90	0.53	16.7
Merl (ck)	55	72	96	89	0.53	16.4
SY 1526	55	81	99	90	0.50	17.0
Branson (ck)	55	78	99	101	0.57	16.7
IL 00-8061	55	74	97	100	0.58	16.5
IL 00-8530	53	77	93	106	0.62	17.2
IL 00-8633	56	79	94	107	0.62	16.9
IL 01-11934	55	77	99	114	0.65	16.8
IL 01-16170	56	82	104	111	0.60	16.6
IL 02-18228	57	79	100	104	0.58	15.8
IL 02-19463	56	80	103	117	0.64	16.8
IL 99-26442	56	76	96	116	0.67	16.6
GA001138-8E36	56	77	105	100	0.55	16.4
AGS 2035 (ck)	56	74	101	107	0.61	16.2
E6012	54	80	97	113	0.64	16.6
Ambassador (ck)	55	73	94	105	0.63	16.7

Table 36: Syngenta-AgriPro Evaluation/Comments.

	1 poor, 9 excellent		1 poor, 9 excellent		
		Question 1: Product Performance Like/Dislike Comments		Question 2: Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	5		4		Higher SRC
VA05W-251	6	Best cookie of set	6	Better than ck	Equal SRC to check
Merl (ck)	4		4		
SY 1526	8	Better than ck, Better cookie spread	7		
Branson (ck)	6		6		Sl higher LA
IL 00-8061	5		5		
IL 00-8530	8	Best overall cookie	7	Better Than ck	
IL 00-8633	7		6	Equal to ck	
IL 01-11934	7		6	Equal to ck	
IL 01-16170	5		5		
IL 02-18228	3	Small Cookie No Tgrain	3		Higher SRC, Higher prot
IL 02-19463	7		6	Equal to ck	
IL 99-26442	5		5		
GA001138-8E36	4		4	Equal to ck	
AGS 2035 (ck)	4		4		
E6012	5		5		
Ambassador (ck)	6		6	Better than exp	

Wheat Marketing Center

Table 37: Wheat Marketing Center Datasheet: Sponge Cake.

	Sponge Cake Factors			Sponge Cake	
	External	Crumb Grain	Texture	Volume (ml)	Total Score
VA05W-151	13	21	27	1240	61
VA05W-251	12	18	24	1242	54
Merl (ck)	12	18	27	1242	57
SY 1526	14	20	21	1258	55
Branson (ck)	10	16	27	1301	53
IL 00-8061	12	20	27	1257	59
IL 00-8530	12	18	21	1251	51
IL 00-8633	10	16	27	1234	53
IL 01-11934	10	21	24	1269	55
IL 01-16170	14	20	21	1271	55
IL 02-18228	13	21	24	1259	58
IL 02-19463	14	20	21	1219	55
IL 99-26442	10	15	24	1219	49
GA001138-8E36	13	20	21	1240	54
AGS 2035 (ck)	13	20	24	1216	57
E6012	10	18	27	1261	55
Ambassador (ck)	12	18	24	1205	54

Table 38: Wheat Marketing Center Evaluation/Comments

	1 poor, 9 excellent		1 poor, 9 excellent	
		Question 1: Product Performance Like/Dislike Comments	Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	8	Better ext. & int. than check, very soft crumb texture	8	Highest SG flour extraction. Highest flour protein and flour ash in the set
VA05W-251	6	Similar to check	6	
Merl (ck)	6	Very soft crumb texture	6	
SY 1526	7	Better ext. & int. than check, soft crumb texture	7	Higher SG Flour extraction. Flour protein 0.9% higher than check, but better cake performance
Branson (ck)	5	Very soft crumb texture	5	
IL 00-8061	7	Inferior ext., good int., very soft crumb texture	7	
IL 00-8530	5	Inferior ext. and int., soft crumb texture	5	
IL 00-8633	5	Inferior ext., and int., very soft crumb texture	5	Lowest SG flour extraction
IL 01-11934	6	Inferior ext., good int., very soft crumb texture	6	
IL 01-16170	7	Good ext. and int., soft crumb texture	7	Low SG flour extraction
IL 02-18228	8	Good ext. and int., very soft crumb texture	8	High SG flour extraction, Highest flour protein by more than 1%, but the best cake overall
IL 02-19463	7	Good ext. and int., soft crumb texture	7	
IL 99-26442	4	Inferior ext. and int., very soft crumb texture	4	Lower flour protein, but the worst cake overall
GA001138-8E36	7	Same ext. and int. as check, soft crumb texture	7	Much lower SG flour extraction, Similar cake to the check
AGS 2035 (ck)	7	Very soft crumb texture	7	
E6012	5	Inferior ext., same int. as check, very soft crumb texture	5	Lower flour ash, but inferior exterior cake than check
Ambassador (ck)	6	Very soft crumb texture	6	

Western Wheat Quality Laboratory, USDA-ARS

Table 39: Western Wheat Quality Lab Datasheet: Solvent Retention Capacity and Rapid Visco-Analyzer.

	SRC's				RVA
	Water (%)	NaCarb (%)	Sucrose (%)	Lactic Acid (%)	Peak (cP)
VA05W-151	56.9	78.5	89.8	113.1	147
VA05W-251	53.4	71.6	85.5	92	134
Merl (ck)	53.7	73.1	85.4	89.8	106
SY 1526	53.9	79.3	85.8	93.1	168
Branson (ck)	56.2	79.8	87.9	102.7	196
IL 00-8061	53.5	76.7	86.7	104.1	163
IL 00-8530	53.4	77.6	84.7	109.7	167
IL 00-8633	53.5	79.1	85.1	103.9	146
IL 01-11934	56.9	78.5	88.2	113.3	177
IL 01-16170	58	82.4	87.2	112.5	213
IL 02-18228	57	77.7	88.4	108.8	184
IL 02-19463	58.9	79.3	88.1	117.1	171
IL 99-26442	57.9	78.7	87.7	115.8	139
GA001138-8E36	56.2	78.3	95.7	104.6	193
AGS 2035 (ck)	56.5	77.3	91.0	107.1	175
E6012	54.6	78.6	89.8	113.5	134
Ambassador (ck)	54	75.3	83.7	104.7	154

Table 40: Western Wheat Quality Lab Datasheet: Mixograph, Sugar Snap Cookies, and Sponge Cake.

	Mixograph		Sugar Snap		Sponge Cake	
	Water Absorp (%)	Type	Diameter (cm)	Top Grain Score	Volume (ml)	Texture Score
VA05W-151	57	6M	8.66	6	1285	20
VA05W-251	54.5	6M	9.26	8	1332	22
Merl (ck)	55	6M	9.15	8	1320	21
SY 1526	56.5	2M	8.9	5	1335	22
Branson (ck)	56	5M	9.06	6	1375	20
IL 00-8061	57	3M	8.98	6	1297	18
IL 00-8530	56	6M	9.19	7	1358	21
IL 00-8633	55.5	5M	9.16	7	1385	19
IL 01-11934	55.5	4M	9.1	7	1338	18
IL 01-16170	56	3M	8.82	6	1380	19
IL 02-18228	58.5	4M	8.48	6	1282	18
IL 02-19463	56.5	4M	8.84	6	1400	19
IL 99-26442	57	6M	8.73	5	1208	19
GA001138-8E36	55	8M	8.69	5	1287	19
AGS 2035 (ck)	55.5	8M	8.76	7	1268	18
E6012	56	5M	8.74	6	1337	21
Ambassador (ck)	57	3M	8.82	5	1335	19

Table 41: Western Wheat Quality Lab Datasheet: Alkali Noodle Color @ 0 hr and 24 hrs.

	Alkali Noodle Color @ 0 hr			Alkali Noodle Color @ 24 hr				
	L*	a*	b*	L*	a*	b*	Change in L*	Color Comments
VA05W-151	86.3	-2.0	18.7	77.1	-0.9	25.8	9.2	
VA05W-251	85.2	-1.9	15.6	75.9	-0.8	20.8	9.3	
Merl (ck)	83.4	-2.3	20.6	73.9	-0.6	23.6	9.5	dark noodle color
SY 1526	84.3	-1.5	20.1	70.3	0.4	25.5	14.0	dark noodle color
Branson (ck)	85.1	-1.1	17.1	70.3	0.9	21.2	14.8	dark noodle color
IL 00-8061	84.3	-1.6	20.0	73.0	-0.3	24.4	11.3	dark noodle color
IL 00-8530	83.8	-1.8	22.4	72.0	0.4	27.6	11.8	dark noodle color
IL 00-8633	83.7	-1.7	22.4	71.5	0.1	29.0	12.2	dark noodle color
IL 01-11934	85.9	-1.8	18.2	75.8	-0.8	22.3	10.1	dark noodle color
IL 01-16170	85.6	-1.9	20.6	74.8	-0.3	26.1	10.8	dark noodle color
IL 02-18228	85.1	-1.4	17.4	73.8	0.0	20.2	11.3	dark noodle color
IL 02-19463	85.3	-1.3	17.4	71.8	0.4	21.8	13.5	dark noodle color
IL 99-26442	84.5	-1.1	17.9	73.2	0.2	21.7	11.3	dark noodle color
GA001138-8E36	86.5	-1.8	17.9	77.5	-1.0	21.5	9.0	
AGS 2035 (ck)	86.3	-1.6	18.6	79.1	-0.8	24.7	7.2	bright nootle
E6012	87.7	-2.3	19.8	77.5	-1.1	24.0	10.2	
Ambassador (ck)	89.3	-2.1	16.2	82.8	-1.6	22.2	6.5	very bright noodle

Table 42: Western Wheat Quality Lab Evaluation/Comments

	1 poor, 9 excellent		1 poor, 9 excellent		
		Question 1: Product Performance Like/Dislike Comments		Question 2: Overall Acceptability Like/Dislike Comments	Additional Comments Mitigating, Physical/Chemical Properties
VA05W-151	6	average cookies & better sponge cake	6		strongest flour of set but also highest carb & sucrose SRC
VA05W-251	8	very good cookie & cake	8	good SRC profile	dark noodle color
Merl (ck)	7.5	good cookie & cake	8	good SRC profile	dark noodle color
SY 1526	7	Very nice cake	7	good SRC profile	dark noodle color
Branson (ck)	8	good cookie, excellent cake	8	good SRC profile	strongest gluten flour of the set, dark noodle color
IL 00-8061	7		7		strong gluten flour, dark noodle color
IL 00-8530	7.5		7.5		strong gluten flour, dark noodle color
IL 00-8633	8.5	very good cake	8.5		dark noodle color
IL 01-11934	7.5		7	high sucrose SRC	strong gluten flour, dark noodle color
IL 01-16170	7	very good cake	6.5	high carbonate SRC	strong gluten flour, high starch pasting type, high carb SRC, dark noodle color
IL 02-18228	6		6		strong gluten flour, dark noodle color
IL 02-19463	6	very good cake	5.5	high sucrose SRC	strong gluten flour, high sucrose SRC, dark noodle color
IL 99-26442	6.5		6.5		strong gluten flour
GA001138-8E36	6		6		strong gluten flour
AGS 2035 (ck)	6.5		6.5		strong gluten flour, bright noodle color
E6012	7.5	very good cake	7.5		strong gluten flour, high sucrose SRC
Ambassador (ck)	7	good cake	7		strong gluten flour, VERY bright noodle color, high sucrose SRC

Soft Wheat Quality Laboratory, USDA-ARS

Table 43: SWQL: Grain and Milling Data.

	Density		SKCS				Milling	
	Test Weight (lb/bu)	TKW	Moisture	Diameter	Weight	Hardness	Break Flour	Straight Grade
VA05W-151	63.8	32.7	14.7	2.09	32.3	39.9	22.6	73.9
VA05W-251	58.0	38.7	13.2	2.59	38.0	10.8	25.5	72.1
Merl (ck)	60.3	38.6	14.0	2.43	39.5	12.5	28.6	72.6
SY 1526	57.0	30.9	14.1	2.30	32.6	17.3	31.1	72.2
Branson (ck)	57.7	29.5	12.5	2.03	28.3	14.2	28.5	71.5
IL 00-8061	62.4	31.7	14.1	2.25	31.6	28.0	21.2	75.6
IL 00-8530	59.8	27.0	13.9	2.20	29.4	17.7	24.9	75.4
IL 00-8633	57.9	23.3	14.4	2.11	27.1	22.9	23.7	70.8
IL 01-11934	60.2	27.7	14.6	2.13	28.7	28.0	25.6	72.0
IL 01-16170	55.7	21.3	14.0	2.07	26.5	22.8	34.2	71.0
IL 02-18228	63.0	23.9	13.7	2.29	28.3	39.6	21.5	74.7
IL 02-19463	60.4	27.5	14.0	2.17	28.4	13.5	28.3	72.8
IL 99-26442	61.0	27.6	14.3	2.27	31.2	27.1	22.5	73.5
GA001138-8E36	58.8	30.9	15.3	2.40	34.0	37.2	21.3	70.4
AGS 2035	62.9	42.7	14.9	2.69	45.1	19.4	25.1	74.1
E6012	59.3	30.8	14.3	2.23	32.0	19.7	24.7	71.7
Ambassador	60.3	36.6	14.7	2.32	35.3	16.2	24.6	72.3

Table 44: SWQL: Primary Flour and SRC Data.

	Primary Flour Analysis							SRC Results (%)				
	Moisture %	Protein %	pH	Falling #	α-Amylase	Starch Damage	SG Ash	Water	Sodium Carb	Sucrose	Lactic Acid	LA/ SC+S
VA05W-151	13.7	8.1	6.35	416	0.004	5.12	0.444	59.2	77.7	96.9	106.3	0.61
VA05W-251	13.5	7.6	6.33	408	0.013	3.16	0.418	56.0	72.4	93.0	87.8	0.53
Merl (ck)	13.9	7.2	6.30	370	0.015	3.62	0.421	56.0	74.6	90.9	88.6	0.54
SY 1526	14.2	9.6	6.23	353	0.019	3.03	0.430	57.4	80.0	96.7	95.2	0.54
Branson (ck)	14.2	8.7	6.27	364	0.018	2.56	0.444	55.7	81.0	94.6	101.0	0.58
IL 00-8061	14.2	9.3	6.32	357	0.012	4.58	0.398	56.2	76.5	94.0	104.7	0.61
IL 00-8530	14.1	8.9	6.31	341	0.014	3.62	0.429	56.1	79.7	92.5	106.5	0.62
IL 00-8633	14.2	8.6	6.34	354	0.012	3.88	0.449	56.0	80.4	93.5	105.8	0.61
IL 01-11934	13.8	8.9	6.32	368	0.004	3.94	0.436	59.1	81.5	96.7	110.5	0.62
IL 01-16170	14.1	9.3	6.34	427	0.008	2.64	0.430	58.5	83.6	96.4	109.2	0.61
IL 02-18228	14.1	10.7	6.23	414	0.010	3.98	0.435	59.0	80.7	96.3	105.2	0.59
IL 02-19463	13.9	9.6	6.29	354	0.019	2.72	0.408	57.5	82.9	98.7	119.5	0.66
IL 99-26442	13.8	9.1	6.40	343	0.016	4.53	0.420	59.4	80.8	95.4	108.9	0.62
GA001138-8E36	13.5	8.8	6.22	430	0.010	4.95	0.470	58.5	76.6	101.5	98.9	0.55
AGS 2035	13.5	9.1	6.18	426	0.007	4.65	0.424	59.2	77.5	98.6	100.3	0.57
E6012	13.7	9.2	6.33	391	0.007	2.48	0.437	57.0	79.2	95.4	113.5	0.65
Ambassador	13.3	9.2	6.28	377	0.005	2.37	0.468	56.1	77.5	91.1	104.4	0.62

Table 45: SWQL: Rapid Visco-Analyzer and Mixograph Data.

	RVA								Mixograph				
	Peak cP	Through cP	Breakdown cP	Final cP	Setback cP	Peak Time (min)	Pasting Temp ºC	Peak/ Final Ratio	Water Absorp %	Peak Time (min)	Peak Value %	Peak Width %	Peak Width 7min
VA05W-151	2651	1880	772	3537	1657	6.23	85.9	0.75	59	3.62	33.13	13.03	8.36
VA05W-251	2468	1709	759	3274	1565	6.20	85.6	0.75	56	4.82	30.30	8.72	7.38
Merl (ck)	1990	1398	592	2786	1389	6.13	86.8	0.71	56	5.53	30.98	9.16	7.07
SY 1526	2761	1599	1162	2957	1358	6.20	85.6	0.93	58	2.41	33.99	10.13	2.35
Branson (ck)	3030	1560	1470	2931	1371	6.13	84.7	1.03	56	3.89	38.73	12.33	8.06
IL 00-8061	2660	1497	1163	2802	1305	6.13	86.4	0.95	57	3.34	44.52	15.31	7.35
IL 00-8530	2705	1423	1283	2806	1384	5.90	83.5	0.96	57	4.40	38.04	11.89	6.04
IL 00-8633	2548	1328	1220	2660	1333	5.87	84.8	0.96	57	4.27	35.55	11.65	7.50
IL 01-11934	2848	1595	1253	2975	1380	6.13	83.2	0.96	59	4.78	36.99	12.65	9.82
IL 01-16170	3189	1845	1345	3332	1488	6.27	85.6	0.96	59	3.08	35.98	13.29	8.11
IL 02-18228	2918	1945	973	3409	1464	6.40	87.2	0.86	60	3.21	44.81	15.99	8.36
IL 02-19463	2792	1508	1284	2781	1273	6.10	84.7	1.00	60	3.83	41.88	13.89	8.27
IL 99-26442	2456	1310	1146	2489	1179	6.00	84.4	0.99	59	4.43	41.27	12.53	7.46
GA001138-8E36	2911	2098	814	3590	1493	6.53	85.9	0.81	59	6.51	33.00	8.96	8.68
AGS 2035	2789	1957	832	3521	1565	6.37	85.6	0.79	59	6.54	37.69	11.82	10.21
E6012	2367	1499	868	2848	1349	6.17	86.4	0.83	58	3.86	32.76	11.02	7.21
Ambassador	2610	1629	981	3120	1491	6.10	84.8	0.84	58	3.13	43.25	16.64	3.57

Table 46: SWQL: Wire-cut and Sugar Snap Cookie Data.

	Wire-cut				Sugar Snap	
	Diameter cm x 2	Stack Height cm x 2	Force (g)	Distance (mm)	Diameter (cm)	Top Grain Score
VA05W-151	14.85	2.26	953	3.04	17.09	4
VA05W-251	15.36	2.25	986	2.71	17.86	6
Merl (ck)	15.48	2.15	1081	2.87	18.07	6
SY 1526	15.70	2.28	896	3.69	18.10	2
Branson (ck)	15.78	2.13	950	2.66	17.92	2
IL 00-8061	15.55	2.18	993	2.63	17.91	3
IL 00-8530	15.97	2.09	967	2.37	18.11	4
IL 00-8633	15.67	2.15	892	3.63	18.29	3
IL 01-11934	15.47	2.16	931	2.77	17.87	4
IL 01-16170	15.57	2.22	1010	2.38	17.60	2
IL 02-18228	14.60	2.50	874	3.13	16.76	2
IL 02-19463	15.21	2.39	761	2.91	17.93	3
IL 99-26442	15.36	2.25	862	3.27	17.66	3
GA001138-8E36	14.67	2.46	861	4.89	17.04	2
AGS 2035	14.89	2.38	896	3.78	17.07	3
E6012	15.03	2.43	797	3.66	17.32	3
Ambassador	15.51	2.27	879	3.24	17.69	2

Table 47: Combined Product Performance Scores.

	St. Dev.	Ave.
VA05W-151	1.5	5.9
VA05W-251	1.5	7.0
Merl (ck)	1.5	6.5
SY 1526	1.5	6.4
Branson (ck)	1.5	6.9
IL 00-8061	1.5	6.1
IL 00-8530	1.5	7.2
IL 00-8633	1.5	7.1
IL 01-11934	1.5	6.4
IL 01-16170	1.5	5.9
IL 02-18228	1.5	5.3
IL 02-19463	1.5	6.6
IL 99-26442	1.5	5.5
GA001138-8E36	1.5	5.7
AGS 2035	1.5	5.4
E6012	1.5	5.5
Ambassador	1.6	6.1

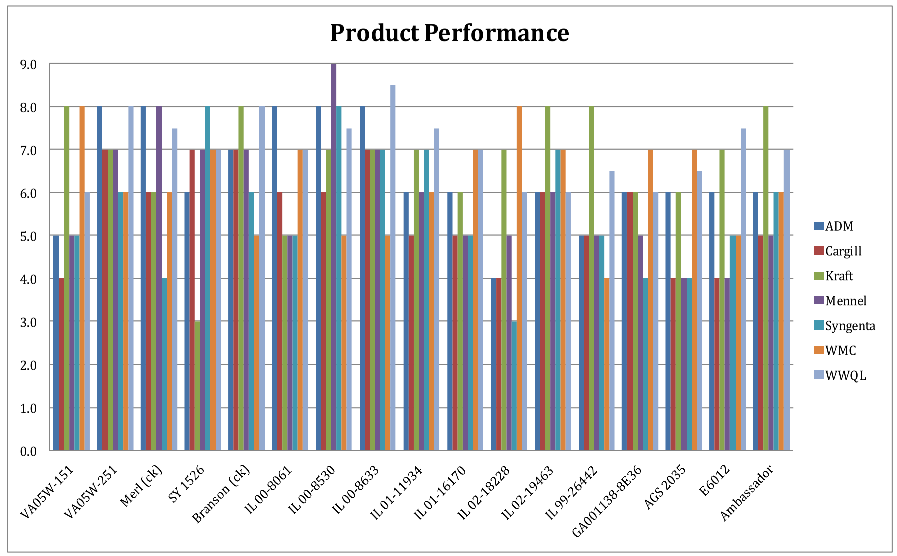
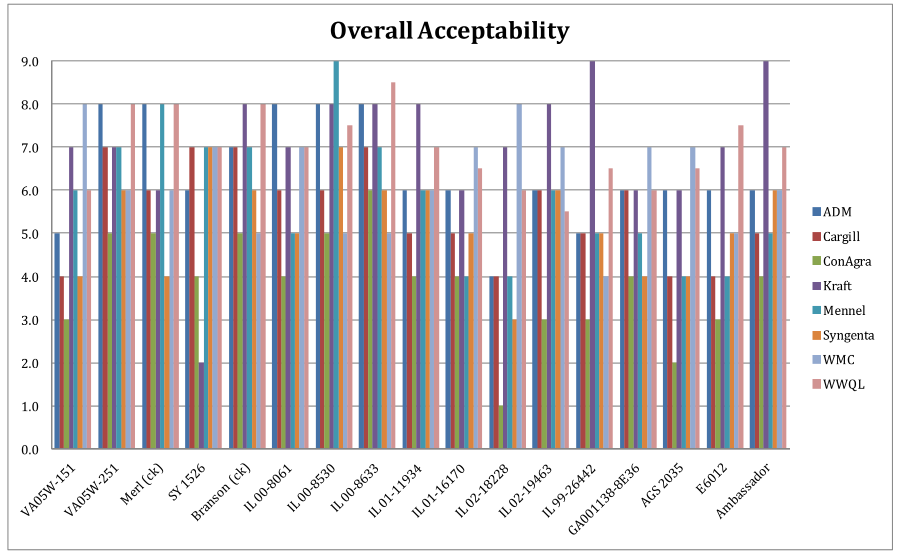


Table 48: Combined Overall Acceptability Scores.

	St. Dev.	Ave.
VA05W-151	1.7	5.4
VA05W-251	1.0	6.8
Merl (ck)	1.5	6.4
SY 1526	1.9	5.9
Branson (ck)	1.2	6.6
IL 00-8061	1.4	6.1
IL 00-8530	1.5	6.9
IL 00-8633	1.2	6.9
IL 01-11934	1.2	6.0
IL 01-16170	1.1	5.4
IL 02-18228	2.3	4.6
IL 02-19463	1.4	5.9
IL 99-26442	1.8	5.3
GA001138-8E36	1.1	5.5
AGS 2035	1.7	4.9
E6012	1.6	5.2
Ambassador	1.5	6.0



Appendix I. Genotyping for Quality Traits

Genotyping for Quality Traits, Anne Sturbaum, USDA-ARS, SWQL

Genotyping was done at the Soft Wheat Quality Lab and the Regional Small Grains Genotyping Laboratory in Raleigh, N.C. for the 17 varieties: VA05W-151, AGS 2035, Ambassador, Branson, E6012, GA001138-8E36, IL00-8061, IL00-8530, IL00-8633, IL01-11934, IL01-16170, IL02-18228, IL02-19463, IL 99-26442, Merl, SY1526, VA05W-251. Checks for this group include Ambassador, Merl and Branson. Merl and SY1526 were heterozygous at several loci, indicating probable impure samples.

High molecular weight glutenins, especially the "5+10" allele at GluD1 and the over expressed Bx7 at GluB1, are useful for selecting favorable milling and baking quality. We report on the GluA1, GluB1, GluD1 loci and the γ-gliadin loci all involved in selecting for strong gluten varieties. AGS2035 and GA001138-8E36 have favorable high molecular weight glutenin alleles at each of the three loci and would be predicted to test for higher gluten values than the other varieties.

Amplification for high molecular weight glutenins at the GluA1 locus, using the marker umn19, identified the Ax2* genotype in all varieties except Ambassador, E6012, IL01-16170, IL02-18228 and IL02-19463. These samples for Merl and SY1526 were heterozygous at the locus (1, 2). All other entries have the Ax1 or null alleles.

Primers identifying a 45 base pair insertion specific to the Bx7 over-expressing allele (Bx7OE) indicated over-expressing Bx7 for AGS 2035, Ambassador and GA001138-8E36. SY1526 was heterozygous for Bx7OE. All other varieties produced a product indicative of the wild type allele at this locus (3).

Primers specific for GluD1, Dx5 (3), generated a PCR product corresponding to the "5+10" genotype in AGS 2035, GA001138-8E36, IL00-8530, IL00-8633 IL01-11934, IL 01-16170, IL02-18228 and IL 99-26442. Branson and VA05W-151 were heterozygous for the "5+10" and "2+12" alleles. All other varieties produced amplification products specific for the "2+12" allele (4).

Allele-specific primers identified the GliD1.2 allele γ-gliadin in a heterozygous state for IL 02-19463 and SY1526. All other varieties had the GliD1.1 allele (5).

A rye translocation provides multiple resistances to powdery mildew, stem rust, leaf rust and stripe rust. The 1RS/1BR translocation was identified in AGS2035, GA001138-8E36, Merl, Sy1526 and VA05W-151. IL01-11934 has the translocation as 1RS/1AL which also confers resistance. These varieties produced an amplification product with scm9F primers specific for rye ω-secalin using the Scm9 marker pair (6, 7).

Alleles of the Vp1B gene (Viviparous-1), as assayed using Vp1B3 primers, are associated with tolerance to preharvest sprouting. E6012, GA001138-8E36, IL00-8633 and VA05W-151 produced a 569 bp product indicating potential tolerance to PHS. All other varieties amplified the larger product (652 bp), indicating probable susceptibility to PHS (9).

Dwarfing genes were tested using markers specific for Rht1 (Rht-B1b), Rht2 (RhtD1b) and Rht8. Branson, SY1526 and all the Illinois lines amplified the Rht1 allele, all others were positive for Rht2. No samples had the Rht8 allele (10).

The semi-dominant Photperiod-D1a (Ppd-D1a) allele confers photoperiod insensitivity in wheat, allowing early flowering. Ambassador, Branson, E6012, IL01-16170, IL02-19463, Merl and VA05W-251 produced the favorable photoperiod allele. SY1526 was heterozygous at the locus and Ppd-D1a was absent in all other varieties (11).

The presence of a stem rust resistance gene, Sr36, is conferred by a translocation from Triticum timopheevi and was tested using the marker wmc477 (12). A 185 base pair amplification product indicates resistance to the stem rust pathogen. Branson, Merl and SY1526 were heterozygous at this locus. All other varieties lack the translocation.

Resistance to fusarium head blight (FHB) is evaluated using markers associated with QTL on chromosomes 3BS (FHB-1) and 5A (Ernie and Ning) (13, 14). None of the varieties had favorable resistance alleles for FHB-1. E6012, IL00-8530 and IL00-8633 have the 5A Ernie resistance on 3BS. IL01-11934 and SY1526 were heterozygous for Ernie at the 5A locus.

All genotypes in this set produced the anticipated banding patterns for normal amylose genotypes (non-waxy) at both the A and B GBSS loci (8).

Table 49: Genotyping for Quality Traits

	Dwarfing Rht	PpD-D1a	Stem Rust Sr36	FHB QTL	HMW GluA1	Over-express Bx70e	HMW GluD1	γ-Gliadins	PHS Vp1	RyeTL
AGS 2035	Rht2	no	no	no	Ax2*	OE	5+10	Gli 1	WT	1RS/1BL
Ambassador	Rht2	YES	no	no	Ax1	OE	2+12	Gli 1	WT	no
Branson	Rht1	YES	HET	no	Ax2*	no	HET	Gli 1	WT	no
E6012	Rht2	YES	no	Ernie	Ax1	no	2+12	Gli 1	569	no
GA001138-8E36	Rht2	no	no	no	Ax2*	OE	5+10	Gli 1	569	1RS/1BL
IL00-8061	Rht1	no	no	no	Ax2*	no	2+12	Gli 1	WT	no
IL00-8530	Rht1	no	no	Ernie	Ax2*	no	5+10	Gli 1	WT	no
IL00-8633	Rht1	no	no	Ernie	Ax2*	no	5+10	Gli 1	569	no
IL01-11934	Rht1	no	no	HET*	Ax2*	OE	5+10	Gli 1	WT	1RS/1AL
IL01-16170	Rht1	YES	no	no	Ax1	no	5+10	Gli 1	WT	no
IL02-18228	Rht1	no	no	no	Ax1 or null	no	5+10	Gli 1	WT	no
IL02-19463	Rht1	YES	no	no	Ax1 or null	no	2+12	HET	WT	no
IL99-26442	Rht1	no	no	no	Ax2*	no	5+10	Gli 1	WT	no
Merl	Rht2	YES	HET	no	HET	no	2+12	HET	WT	1RS/1BL
SY1526	Rht1	HET	HET	HET*	HET	HET	2+12	Gli 1	WT	1RS/1BL
VA05W-251	Rht2	no	no	no	Ax2*	no	HET	Gli 1	569	1RS/1BL
VA05W-151	Rht2	YES	no	no	Ax2*	no	2+12	Gli 1	WT	no

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Appendix II. Materials and Methods of the USDA-ARS SWQL

Whole Kernel Moisture Air-oven method, modified AACC 44-16

Apparatus

1. Tag-Heppenstall rolls
2. Moisture dish:; Aluminum (5.5cm diameter x 1.5cm height, with slipcover lid)
3. Air oven – a convection oven which maintains a temperature of 140 ± 1oC.
4. Aluminum plate to aid in maintaining oven temperature

Procedure

1. Scoop out approximately five grams of grain into a moisture dish. No more than 12 samples should be run at once to maintain accuracy.
2. Run the grain sample through the Tag-Heppenstall rolls with a pan placed below to collect the ground sample. Transfer the ground sample to the moisture dish and cover with the lid.
3. Record the weight of the dish with lid containing the ground sample (initial weight). Samples should be weighed soon after grinding and not allowed to sit for more than a few minutes in order to minimize moisture loss prior to weighing.
4. Open the lid, and place the dish and lid in the oven at 140°C. Set a timer for 90 minutes. Start the timer when the oven reaches 140°C.
5. At the end of the 90 minute drying time, cover the dishes with the lids and transfer them to an aluminum plate outside oven to cool for 4 four minutes. It is recommended that no more than 12 dishes be taken out of the oven at once in order for the cooling time to remain consistent with weigh back.
6. Record the weight of the dish plus lid containing the dried grain (final weight). Continue weighing all dishes that have been taken out of the oven.
7. Empty the samples from the dishes, brush any residue from the dishes and lids, and record the weights (dish weight).
8. Percent moisture may be calculated using the following equation:

$$\% Moisture = \frac{Initial\, Weight - Final\, Weight}{Initial\, Weight - Dish\, Weight} 100$$

Kernel Moisture AACC Method 44-15A Air-oven method.

Whole Wheat Protein

Nitrogen combustion analysis using Elementar Nitrogen Analyzer. Units are recorded in % protein converted from nitrogen x 5.7 and expressed on a 12% moisture basis.

Whole Wheat Falling Number

AACC Method 56-81B Units are expressed in seconds using the Perten Falling Numbers instrument.

Amylase Activity

AACC Method 22-06 Units are expressed in alpha-amylase activity as SKB units/gram (@ 25°C).

Test Weight

AACC Method 55-10 Weight per Winchester bushel of cleaned wheat subsequent to the removal of dockage using a Carter-Day dockage tester. Units are recorded as pounds/bushel (lb/bu) and kilograms/hectoliter (kg/hl).

1000-Kernel Weight

Units are recorded as grams/ 1000 kernels of cleaned wheat. There is little difference between 1000-kernel weight and milling quality when considering shriveled-free grain. However, small kernel cultivars that have 1000-kernel weight below 30 grams likely will have reduced milling yield of about 0.75%.

Single Kernel Characterization System (SKCS)

AACC Method 55-31 SKCS distribution showing % soft (A), semi-soft (B), semi-hard (C), and hard (D); SKCS hardness index; SKCS moisture content; SKCS kernel size; and SKCS kernel weight; along with standard deviations.

Miag Multomat Experimental Flour Mill Unit

The Miag Multomat Mill is a pneumatic conveyance system consisting of eight pair of 254 mm diameter x 102 mm wide rolls, and ten sifting passages. Break rolls operate at 340 rpm for the fast rolls and 145 rpm for the slow rolls; 2.34:1 and reduction at 340 rpm fast and 250 rpm slow; 1.36:1. The first three rolls are break rolls; 1st break:: 14 corrugations/inch, α 40, β 70, land 0.004", 8% spiral; 2nd break: 20 corrugations/inch, α 40, β 75, land 0.002", 10% spiral; 3rd break: 24 corrugations/inch, α 35, β 75, land 0.002", 10% spiral. The five reduction rolls are smooth; , not frosted. Following the second break is the Grader and Duster following the first reduction; allowing for more sifting surface area respectfully. Each mill run including the grader and duster precede six sieves. Residue for this system includes: Head Shorts, Bran, Red Dog, and Tail Shorts.

Experimental Milling Procedure

All soft wheat varieties are tempered to 14.5% moisture level. Generally, tempered wheat is held for at least 24 hours in order for the moisture to equilibrate throughout the grain. The mill operates at a rate of approximately 36 Kg/hour (80 #/hour). Up to 12 kilograms of grain is milled per run. Each of the fourteen streams is weighed and an aliquot is sampled for ash analysis. The Straight Grade flour, each of the three breaks, reduction and duster, is then re-bolted to remove any residual by-product not removed by the mill; 165 micron SSBC. Finished flour is then blended.

The straight grade flour mean volume diameter will be about 130 microns with a flour ash content usually between 0.38% and 0.49%. Flour yields will vary between 70% and 78% and are variety-dependent due to milling quality differences and/or grain condition. Recovery of all mill products will usually be about 98.5%. Least significant differences for straight grade flour yield and break flour yield are 0.75% and 0.82%, respectively.

Flour Moisture, Air-oven method, modified AACC 44-16

Apparatus

1. Moisture dish; : Aluminum (5.5cm diameter x 1.5cm height, with lid)
2. Air oven – a convection oven which maintains a temperature of 140 ± 1oC.
3. Aluminum plate inside oven to aid in maintaining oven temperature.

Procedure

1. Scoop out approximately one1 teaspoon of flour into a moisture dish and cover the dish with the lid. As many as 12 samples may be run at once.

2. Record the weight of the dish plus lid containing the flour sample (initial weight).

3. Open the lid and place the dish and lid in the oven at 140°C. Once all dishes and lids have been placed in the oven, allow the temperature to return to 140°C before setting the timer; set timer for 15 minutes.

4. At the end of the 15 minute drying time, cover the dishes with the lids and transfer them to an aluminum plate outside the oven to cool for 4 four minutes. It is recommended that no more than 12 dishes be taken out of the oven at once in order for the cooling time to remain consistent.

5. Record the weight of the dish plus lid containing the dried flour (final weight). Continue weighing all dishes that have been taken out of the oven.

6. Empty the samples from the dishes, brush any residue from the dishes and lids, and record the weights (dish weight).

7. Percent moisture may be calculated using the following equation:

$$\%\,Moisture = \frac{Initial\,Weight - Final\,Weight}{Initial\,Weight - Dish\,Weight}100$$

Flour Moisture AACC Method 44-15A

Units are expressed as % of flour.

Flour Falling Number AACC Method 56-81B

Units are expressed in seconds using the Perten Falling Numbers instrument. Numbers above 400 seconds reflect factors other than alpha-amylase activity (such as particle size). The correlation between alpha-amylase activity and falling number is best for samples with falling number values between 200 and 300 seconds. For cake flours and batters, 350 seconds is a common minimum value. For breakfast cereals or cookies and other high sugar products, values of 250 seconds are more common cut-off values.]

Flour Protein

Protein determined by NIR using a Unity NIR instrument calibrated by nitrogen combustion analysis using Elementar Nitrogen Analyzer. Units are recorded in % protein converted from nitrogen x 5.7 and expressed on 14% moisture basis.

Flour protein differences among cultivars can be a reliable indicator of genetic variation provided the varieties are grown together, but can vary from year to year at any given location. Flour protein from a single, non-composite sample may not be representative. Based on the Soft Wheat Quality Laboratory grow-outs, protein can vary as much 1.5 % for a cultivar grown at various locations in the same $\frac{1}{2}$ acre field.

Flour protein of 8% to 9% is representative for breeder's samples and SWQL grow-out cultivars. As flour protein increases, the expansive capability of the cookie during the baking process decreases. Flour protein is negatively correlated to cookie diameter ($r=-0.62$, $p<0.0001$) with the cookie shrinking 0.4 cm for every 1 one percentage point increase in protein . The effect of flour protein on cookie size is related in part to increased water absorption due to greater protein content, ; however the amount of cookie shrinkage is greater than that explained by increased water absorption alone.

Protein quality is an evaluation of "elasticity" or gluten strength and is not the same as protein quantity. A cultivar possessing a low quantity of protein could still exhibit strong gluten strength. Gluten strength is thought to be a desirable characteristic for cracker production. Gluten strength is measured using a mixograph and is graded on a scale of 1-8, with 1 as weakest and 8 as strongest gluten.

Evaluation of gluten strength using the mixograph or farinograph is difficult for soft wheat flours that are 8.5% protein and lower. Since the representative protein range for breeders' samples is 8-9%, many of these flours are not adequately evaluated using the mixograph or farinograph methods. The Lactic Acid SRC, which does not require mixing action to assess gluten, tends to be a better measurement of protein quality when evaluating soft wheats. Lactic acid hydrates the native matrix of insoluble polymeric protein (IPP) present in the flour.

Flour Ash AACC Method 08-01

Basic method, expressed on 14% moisture basis.

Flour Amylase activity AACC Method 22-06

Units are expressed in α-amylase activity as SKB units/gram (@ 25°C).

Solvent Retention Capacity Test (SRC)

(Flour Lactic Acid, Sucrose, Water, and Sodium Carbonate Retention Capacities AACC Method 56-11) Units are expressed as %.

Water SRC is a global measure of the water affinity of the macro-polymers (starch, arabinoxylans, gluten, and gliadins). It is often the best predictor of baked product performance. Water SRC is correlated to Farinograph water absorption but does not directly measure the absorption of the glutenin macropolymer hydration during mixing as does the Farinograph. Water SRC is negatively correlated to flour yield and softness equivalent among flour samples milled on the Quad advanced flour mill ($r=-0.43$ and $r=-0.45$, respectively). Lower water values are desired for cookies, cakes, and crackers, with target values below 51% on small experimental mills and 54% on commercial or long-flow experimental mills.

Sucrose SRC is a measure of arabinoxylans (also known as pentosans) content, which can strongly affect water absorption in baked products. Water soluble arabinoxylans are thought to be the fraction that most greatly increases sucrose SRC. Sucrose SRC probably is the best predictor of cookie quality, with sugar snap cookie diameters decreasing by 0.07 cm for each percentage point increase in sucrose SRC. The negative correlation between wire-cut cookie and sucrose SRC values is $r=-0.66$ ($p<0.0001$). Sucrose SRC typically increases in wheat samples with lower flour yield ($r=-0.31$) and lower softness equivalent ($r=-0.23$). The cross hydration of gliadins by sucrose also causes sucrose SRC values to be correlated to flour protein ($r=0.52$) and lactic acid SRC ($r=0.62$). Soft wheat flours for cookies typically have a target of 95% or less when used by the US baking industry for biscuits and crackers. Sucrose SRC values increase by 1% for every 5% increase in lactic acid SRC. The 95% target value can be exceeded in flour samples where a higher lactic acid SRC is required for product manufacture since the higher sucrose SRC is due to gluten hydration and not to swelling of the water soluble arabinoxylans.

Sodium carbonate SRC is a very alkaline solution that ionizes the ends of starch polymers increasing the water binding capacity of the molecule. Sodium carbonate SRC increases as starch damage due to milling increases. Sodium carbonate is an effective predictor of milling yield and is negatively correlated to flour yield on the Quad advanced milling system ($r=-0.48$, $p<0.0001$). It also is one of several predictors of cookie diameter ($r=-0.22$, $p<0.0001$). Normal values for good milling soft varieties are 68% or less.

Lactic acid SRC measures gluten strength. Typical values are below 85% for "weak" soft varieties and above 105% or 110% for "strong" gluten soft varieties. See the above discussion of protein quality in this section for additional details of the lactic acid SRC. Lactic acid SRC results correlate to the SDS-sedimentation test. The lactic acid SRC is also correlated to flour protein concentration, but the effect is dependent on genotypes and growing conditions. The SWQL typically reports a protein-corrected lactic acid SRC value to remove some of the inherent protein fluctuation not due to cultivar genetics. Lactic acid is corrected to 9% protein using the assumption of a 7% increase in lactic acid SRC for every 1% increase in flour protein. On average across 2007 and 2008, the change in lactic acid SRC value was closer to 2% for every 1% protein.

Flour Damaged Starch

As measured by the Chopin SDMatic starch damage instrument using the supplied AACC calibration. Starch damage is a measure of the damage to the starch granule occurring during the milling process.

Micro Assay for Flour Alpha Amylase Activity

AACC Method 22-02 using the Ceralpha K-CERA (Megazyme) alpha-amylase assay procedure for higher throughput to determine flour alpha-amylase activity in a microwell plate. All reagents, controls and precautions are as described in the Megazyme manual.

Rapid Visco-Analyzer (RVA) Method

Viscosity units are in centipoise units, peak time in minutes, pasting temperature in degrees centigrade. The hot pasting viscosity/time analysis of starch and flour was accomplished using a Rapid Visco Analyzer (RVA), Model RVA-4 (Foss North America, Inc., Eden Prairie, MN). The "standard 1" heating profile of that instrument's software (Thermocline for Windows, version 2.0, Newport Scientific Pty. Ltd., Warriewood, NSW, Australia) was employed to produce pasting curves based on 4 g (14% moisture basis) flour and 25 ml deionized water. Maximum heating temperature was 95°C and minimum cooled temperature was 50 °C. Peak pasting viscosity, peak time, minimum (trough) viscosity during cooling, breakdown viscosity (difference between peak and minimum viscosities), final viscosity at the conclusion of cooling, and setback (difference between final and minimum viscosities) were determined for each sample.

Wire Cut Cookie AACC Method 10-53, Macro Method

This method determines the texture (hardness) of the cookies. The use of high-fructose corn syrup and lower sucrose concentration allows for a texture more similar to standard commercial cookie formulations. Differences in hardness reflect differences in flour quality, with softer cookie texture produced with better soft wheat quality.

Sugar Snap Cookie AACC Method 10-52, micro method

Two-cookie expressed in cm, cookie top grain expressed in arbitrary units from unacceptable to outstanding, from 1 to 9, respectively.

Baking Quality of Cookie Flour: AACC method 10-52, Micro Method

Diameter and stack height of cookies baked according to this method are measured and used to evaluate flour baking quality. All data reported in this report were produced using the accepted method prior to December, 2008.

Cookie spread determined within a location is a reliable indicator of the source cultivar's genetic characteristics. However, cookie spread, unlike milling quality, is greatly influenced by environmental conditions. An absolute single value for cookie spread could be misleading. Within a location the single value is significantly important in comparison to known standards. The average cookie spread for three different examples of a cultivar is representative of that wheat.

Cultivars with larger cookie spreads tend to release moisture efficiently during the baking process due to lower water absorption while cultivars yielding smaller diameter cookies tend to be higher in water absorption and hold the moisture longer during baking.

The best single predictor of cookie diameter is sucrose SRC. The strong negative correlation of sucrose SRC to cookie diameter ($r=-0.66$, $p<0.0001$) has led to its adoption in lieu of baking cookies for most samples. The best prediction model for cookie diameter among grain samples milled on the Quadrumat advanced system uses a combination of sucrose SRC, softness equivalent, and flour protein ($R2=0.61$).

These three measures are combined into the baking quality score used in Quad Micro milling with the baking quality score favoring lower sucrose SRC and flour protein and greater softness equivalent values.

Cultivars that possess excellent milling properties nearly always produce large diameter cookie spreads. Poor milling cultivars nearly always produce smaller cookie spreads. Cultivars that are very soft in granulation usually produce good cookie spreads.

AACC Method 10-52: Baking Quality of Cookie Flour

Meera Kweon, Research Food Technologist, Campbell Soup Corp Micro Method Approved December, 2008

Objective

In North America, a "cookie" is a product similar to what is internationally known as a "biscuit". Cookie quality of flour is determined by the interaction among endogenous components of the flour and the ingredients in the mix. This method establishes a carefully controlled competition for water among the various components and ingredients, the results of which are manifest as differing cookie diameters. Larger diameter cookies are preferred and an indicator of good pastry-making and specifically cookie-baking potential. The method is also useful to evaluate other flour types, various flour treatments and other factors, such as ingredients, that affect cookie geometry.

Apparatus

1. National cookie dough micromixer, with head speed of 172 rpm and special cookie dough bowl.
2. Electric mixer, with timer control (Hobart or Kitchen-Aide), with paddle attachment.
3. Aluminum cookie sheet. See note 1.
4. Rolling pin, 5.7 - 7 cm (2.25 - 2.75 in.) diameter. If wood, check for wear to edges from use and replace if necessary.
5. Cookie cutter, 60 mm inside diameter.
6. Small plastic spatula, ground flat at end, with notch cut to fit cookie dough bowl and mixing head pins.
7. Thermometer and humidity meter / hygrometer. See note 2.
8. Baking oven, reel or rotary, electrically heated and capable of maintaining temperature of 205ºC ± 2º (400ºF ± 4º). See note 3.
9. Measuring calipers (large enough to measure 22 cm)

Reagents

1. Solution A. 0.95 M sodium bicarbonate (79.8 g dissolved in water to make 1L).
2. Solution B. 1.9 M ammonium chloride / 1.52 M sodium chloride (101.6 g and 88.8 g respectively, dissolved in water to make 1 L).
3. Sucrose. Any brand of "Baker's Special" sugar: sugar passing through a US No.30 sieve (595 µm openings) only. Particle size affects solubility.
4. Shortening. Non-trans fat, vegetable shortening not containing methyl silicone of medium consistency (e.g. Crisco non-trans fat shortening).
5. Nonfat dry milk. To pass through a US No. 30 sieve (595 µm openings).

Procedure

1. Sift dry ingredients (sucrose, nonfat dry milk, dry sodium bicarbonate; for sufficient creamed mass for different batch sizes, 21-46 cookie pairs; 37.60 g for each pair) together until well-mixed. Cream these ingredients together with shortening using Hobart or Kitchen-Aide mixer, using a paddle attachment, on low speed 1 min, then scrape bowl and paddle; on medium speed 1 min, then scrape; on high speed 30 sec, then scrape; and on high speed 30 sec. Weigh 37.60 g portions of this creamed mass for each cookie-pair to be baked.

2. Scrape measured creamed mass into cookie dough mixing bowl (National cookie dough micro-mixer, using a cookie dough bowl; head speed 172 rpm). Add water: add 4.0 mL solution A, 2.0 mL solution B, and additional water (use water amount for appropriate flour moisture; 8.7 mL total water per cookie pair). Mix 3 min (stopping mixer and scraping after first few sec if shortening is stuck on side of bowl) and scrape with small spatula.

3. Add 40 g flour (14% mb) to mixing bowl. Mix a total of 25 sec. as follows: Mix for the first 10 sec while tapping side of bowl. Scrape dough from mixer and bowl pins; scrape outer edge and bottom of bowl, pushing dough between pins several times. Mix 5 sec and scrape as just described. Mix 5 sec and scrape. Mix 5 sec and scrape mixer pins.

4. Gently scrape dough from bowl, gently form into a single dough mass and cut with spatula into two equal portions. Transfer to a room-temperature cookie sheet with gauge strips. Roll to thickness with one forward and one backward stroke of rolling pin. Cut dough with cookie cutter, discard excess dough, and remove cutter.

5. Immediately place in oven and bake for 10 min. Remove sheet from oven. Cool 5 min and remove cookies from baking sheet.

6. After cookies have cooled to room temperature (at least 30 min), measure cookie diameter using calipers, or image analysis. Lay two cookies edge-to-edge and measure width. Rotate one cookie 90º, the other 45º. Measure again. Rotate both cookies 90º and measure again. Repeat. Average the four readings and divide by two to obtain average diameter of one cookie.

Notes

1. Aluminum cookie sheets made of 3003-H14 aluminum alloy, 2.0 mm (0.08 in) thick, 30.5 X 40.6 cm (12 X 16 in) or 25.4 X 33.0 cm (10 X 13 in), or other sizes required to accommodate oven doors and shelves. Cookie sheets should be manufactured with gauge strips fastened to the long edges of the sheets (gauge strips made of the same alloy as the sheets, 7 mm (0.275 in) thick and the length of the baking sheets). New sheets should be conditioned by lightly greasing and placing in hot oven for 15 min, cooling, and repeating the process two or three times. Cookie sheets should have excess grease wiped off after each cookie pair is baked. Cookie sheets should be washed while warm in water (without use of soap or detergent) and wiped dry after each bake.

2. Dough consistency, stickiness and cookie spread are affected by temperature and humidity. Room and ingredient temperature and humidity should be maintained at constant level among bakes (21ºC ± 1º (70ºF ± 2º) and 30 - 50% are recommended, respectively). Consistent environmental conditions are more important in a lab than adherence to a particular level, within reason.

3. Oven should have a hearth consisting of ceramic-fiber-reinforced structural alumina refractory product (6.4 mm (0.25 in)) thick as shelf liner cut to dimensions of and placed on the steel baking shelf. Oven shelves consisting of wire mesh baking surface are also suitable and may not need shelf liner (to prevent excessive bottom browning).

4. For relatively consistent mixing action, recommended cream mass batch size is 21 - 46 units. Obtain amounts of sugar, nonfat dry milk, sodium bicarbonate and shortening.

5. Oven should be heated to temperature with oven shelves turning. Bake "dummy" cookies out of scrap dough or extra flour to condition the oven before beginning a test bake, at the beginning of a baking series, or if the oven has not been used for 15 min or longer.

References

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Table 50: AACC Method 10-52 Ingredient amounts per cookie pair

Ingredient	Amount
Flour (14% mb)	40 g
Sucrose	24 g
Nonfat dry milk	1.2 g
NaHCO3	0.40 g
NaHCO3 (in Soln A)	0.32 g (in 4 mL)
NH4Cl (in Soln A)	0.20 g (in 2 mL)
NaCl (in Soln B)	0.18 g
Shortening	12.0 g
Added Water1	2.7 mL

Table 51: AACC Method 10-52 Ingredient weights for batch preparation. Ingredient weights (g) for preparing creamed mass for different batch sizes.

Ingredient	20g	25g	30g	35g	40g	45g
Sucrose	504.0	624.0	744.0	864.0	984.0	1104.0
Nonfat dry milk	25.2	31.2	37.2	43.2	49.2	55.2
Sodium bicarbonate	8.4	10.4	12.4	14.4	16.4	18.4
Shortening	252.0	312.0	372.0	432.0	492.0	552.0

Table 52: AACC Method 10-52 Calculated amounts of flour and added water for cookie test formula.

Flour moisture %	Added Water ml	Flour g	Flour moisture %	Added Water ml	Flour g
9.1	4.9	37.8	12.1	3.6	39.1
9.2	4.9	37.8	12.2	3.5	39.2
9.3	4.8	37.9	12.3	3.5	39.2
9.4	4.7	38	12.4	3.4	39.3
9.5	4.7	38	12.5	3.4	39.3
9.6	4.6	38.1	12.6	3.3	39.4
9.7	4.6	38.1	12.7	3.3	39.4
9.8	4.6	38.1	12.8	3.3	39.4
9.9	4.5	38.2	12.9	3.2	39.5
10	4.5	38.2	13	3.2	39.5
10.1	4.4	38.3	13.1	3.1	39.6
10.2	4.4	38.3	13.2	3.1	39.6
10.3	4.3	38.4	13.3	3	39.7
10.4	4.3	38.4	13.4	3	39.7
10.5	4.3	38.4	13.5	2.9	39.8
10.6	4.2	38.5	13.6	2.9	39.8
10.7	4.2	38.5	13.7	2.8	39.9
10.8	4.1	38.6	13.8	2.8	39.9
10.9	4.1	38.6	13.9	2.7	40
11	4	38.7	14	2.7	40
11.1	4	38.7	14.1	2.7	40
11.2	4	38.7	14.2	2.6	40.1
11.3	3.9	38.8	14.3	2.6	40.1
11.4	3.9	38.8	14.4	2.5	40.2
11.5	3.8	38.9	14.5	2.5	40.2
11.6	3.8	38.9	14.6	2.4	40.3
11.7	3.7	39	14.7	2.4	40.3
11.8	3.7	39	14.8	2.3	40.4
11.9	3.7	39	14.9	2.3	40.4
12	3.6	39.1	15	2.2	40.5

Chemically-leavened cracker baking procedure

Developed by Meera Kweon,Research Food Technologist, Campbell Soup Corp.

Background

Traditionally, the baking performance of soft wheat flours has been evaluated by well-established, bench top cookie-baking methods (e.g. AACC Approved Methods 10-52 and 10-53 (AACC International 2000)). In contrast, a bench top cracker-baking method has not been widely explored or implemented as an official method, due to hurdles including the difficulty in finding ideal diagnostic flours and the absence of suitable bench top equipment (e.g. powerful dough mixer, dough sheeter, multi-zone oven).

There are generally three major types of crackers: saltine, chemically-leavened, and savory. The typical processes for preparing saltine and savory crackers usually require about 24 hours, due to a prolonged fermentation time. In comparison, chemically-leavened crackers ordinarily do not require a fermentation step, and their processing is relatively easy and simple to manage. Development of a bench top method for chemically-leavened crackers would enable one to use such a method as a predictive tool for evaluating gluten functionality in flour for crackers.

Soft wheat flours with greater gluten strength are typically preferred for commercial cracker production. The purpose of developing a bench top baking method is to predict the contribution of gluten functionality to overall flour performance for chemically-leavened crackers.

Apparatus

1. Pin mixer (National Manufacturing Co.), with head speed of 102 rpm and a 100g flour batch dough bowl.
2. Dough sheeter (Model SFB 528, width of sheeting rolls, 19 5/8", Univex Corp., Salem, NH)
3. Hand cutter (2.25 x 1.65 in, 7 docker pins, Weidenmiller Co., Itasca, IL)
4. Baking mesh (cord-weave, 13L x 10W in, 0.26 in thickness, Hi Carbon Steel, spec. C-100-3F, Audubon, Feasterville, PA)
5. Baking (cooling) rack
6. Aluminum cookie baking sheet.
7. Baking oven, reel or rotary, electrically heated and capable of maintaining temperature of 500ºF ± 5º).
8. Measuring calipers.

Table 53: Basic ingredients and formula

Ingredient	Formula (g)
Flour	100.0 (14% moist.)
Fine granulated sucrose	9
Salt	0.75
Sodium bicarbonate	1.25
Ammonium bicarbonate	1.25
Monocalcium phosphate monohydrate	1.25
Shortening	12.0
Water	29.0

Mixing procedure

Stage 1:

1. Dissolve fine granulated sucrose in water to prepare a pre-dissolved sugar solution.
2. Weigh 38g of pre-dissolved sugar solution into a 100g pin mixer mixing bowl at room temperature and add ammonium bicarbonate to dissolve.
3. Add room temperature shortening.
4. Mix 1 min.

Stage 2:

1. Add pre-weighed flour, salt, sodium bicarbonate, and monocalcium phosphate.
2. Mix 10 min continuously.
3. Use dough to make a dough ball.

Sheeting procedure:

1. Make a dough ball with hands, and flatten it for sheeting.
2. The sheeted dough is sheeted at dial setting "5" (5.59mm) of the Univex sheeter.

3. Change the sheeting direction knob to the opposite direction and sheet the dough at dial setting "3" (3.78mm).

4. Repeat step 3 three times with dial settings "2" (2.71mm), "1" (1.77mm), and 2nd smallest (0.54mm), sequentially.

5. The sheeted dough is rested for 1 min on the sheeter belt, and dough pieces are cut with a hand cutter (4 pieces of cracker dough) twice to prepare 8 pieces of cracker dough.

6. The 8 pieces of cracker dough are transferred to a cookie baking sheet, and total dough weight is measured before transferring the dough pieces to pre-heated baking mesh.

Baking procedure:
Oven temperature:set 500oF (260oC)

1. Baking time: about 5-6 min (Target moisture: 2.75% (2.0-3.5%))

2. A cracker baking mesh is placed on the top of a baking (cooling) rack, and pre-heated in an oven for 5 min before sheeting dough.

3. Cut cracker dough pieces are placed on pre-heated baking mesh, and placed in an oven for baking.

4. Baked crackers are removed from the oven, and transferred to the cookie baking sheet to measure the cracker weight.

5. Moisture loss during baking is calculated. Length, width and height are measured for 8 crackers, and the average length, width and height are reported.