Milling and Baking Test Results for Eastern Soft Wheats
Harvested in 2016

Soft Wheat Quality Council of the Wheat Quality Council

May 1, 2016

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.

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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 varieties grown in the Eastern 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.

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 soft wheat industries 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 USDA-ARS 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 consisting 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 Lead Scientist 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. (maximum 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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*Check varieties.

Description of Entries

VA10W-119 (SH 7200)

The soft red winter (SRW) wheat line VA10W-119 was developed and released by the Virginia Agricultural Experiment Station in May 2016. It was derived from the cross **KY97C-0540-04** / **GA951079-2E31** (PI 644020). The pedigree of KY97C-0540-04 is 'Coker 9803' (PI 548845) / L910097 // Pioneer Brand '2552' (PI 566924). Parentage of L910097 is Coker 9803 / 'Coker 983' (PI 601076). The parentage of GA951079-2E31 is GA881130 / 'GA-Gore' (PI 561842). VA10W-119 was derived as a bulk of an $F_{4:5}$ headrow selected in 2009. It was evaluated over six years (2011 – 2016) in Virginia's Official Variety Trials and throughout most of the SRW wheat region in the 2012 and 2013 USDA-ARS Uniform Southern SRW Wheat Nurseries. VA10W119 will be marketed by Meherrin, 4020 Wake Forest Rd., Suite 110, Raleigh, NC under the Southern Harvest brand name as variety 'SH 7200'.

VA10W-119 is a broadly adapted, high yielding, early heading, and medium height (*Rht*2 semi-dwarf) SRW wheat. Foliage and spike color of VA10W-119 is blue-green and spikes are awned and slightly tapering to strap in shape. Average head emergence of VA10W-119 in the southern SRW wheat region varied from 95 d in 2012 to 119 d in 2013 and was 1 to 2 d earlier than 'USG 3555' and 2 to 4 d later than 'Jamestown'. Mature plant height of VA10W-119 has varied from 34 to 38 inches on average and is similar in height to 'Hilliard' and 3 inches taller than Jamestown. In the 2012 Uniform Southern Nursery, the mean lodging score for VA10W-119 (0.7) was similar to Pioneer Brand '26R61' (1.1) and significantly ($P \geq 0.05$) lower than those of the other three check varieties (2 – 3). In the 2013 Uniform Southern Nursery, the mean lodging score of VA10W-119 (3.3) was similar to those of USG 3555 (2.4) and AGS 2000 (3.4). Winter hardiness of VA10W-119 is good and better than that of 'AGS 2000'.

VA10W-119 was evaluated at 21 and 18 locations, respectively, in the 2012 and 2013 USDA-ARS Uniform Southern SRW Wheat Nurseries. In the 2012 nursery, VA10W-119 ranked second among 29 entries for grain yield (69.3 bu/ac) with a mean test weight of 57.8 lb/bu. In the 2013 nursery, VA10W-119 ranked third among 33 entries for grain yield (76 bu/ac) with a mean test weight of 57.1 lb/bu.

Grain samples of VA10W-119 produced in six crop environments (2011 and 2015) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. VA10W-119 has exhibited milling and baking qualities that are intermediate to those of 'Shirley' (weak gluten strength) and Jamestown (moderate gluten). Comparisons of milling and baking quality attributes over three to five crop environments for VA10W-119 versus Shirley and Jamestown include: milling quality score (**72.0** vs. 69.6 and 60.4), baking quality score (**50.3** vs. 72.8 and 52.3), softness equivalent score (**59.6** vs. 72.4 and 64.4), flour yield (**70.6%** vs. 69.9% and 68.1%), flour protein (**8.4%** vs. 7.6% and 8.1%), gluten strength (lactic acid retention capacity **114.3%** vs. 90.2% and 109.9%), and cookie spread diameter (**18.3** vs. 18.8 and 18.1 cm). Flour of VA10W-119 likely would be more suitable than that of Shirley for making crackers and other products requiring strong gluten strength.

VA10W-119 is a widely adapted, early heading, Hessian fly resistant (gene *H13*) wheat variety that has high grain yield potential, high test weight, good milling and baking quality, and has

performed well in SRW wheat production areas of the southeastern and mid-Atlantic regions. VA10W-119 expresses intermediate to high levels of resistance to diseases prevalent in the SRW wheat region. These include Hessian fly, leaf and stripe rusts, powdery mildew, Fusarium head blight, *Septoria tritici* leaf blotch, *Stagonospora nodorum* leaf and glume blotch, *Barley and Cereal Yellow Dwarf Viruses*, and *Wheat Soil Borne Mosaic Virus*.

VA11W-106 (L11550)

Soft red winter (SRW) wheat line VA11W-106 was developed and released by the Virginia Agricultural Experiment Station in May 2016. It was derived from the cross Pioneer Brand '25R47' (PI 631473) / 'Jamestown' (PI 653731). VA11W-106 was derived as a bulk of an $F_{5:6}$ headrows selected in 2010 and has been evaluated over four years (2013 – 2016) in Virginia's Official Variety Trials. It also was evaluated throughout the SRW wheat region in the 2014 USDA-ARS Uniform Southern and the 2015 Uniform Eastern SRW Wheat Nurseries. VA11W-106 will be marketed by Limagrain Cereal Seeds as variety 'L11550'.

VA11W-106 is a broadly adapted, high yielding, full-season, medium height, semi-dwarf (gene *Rht*2) SRW wheat. In the southern SRW wheat region, head emergence of VA11W-106 (123 d) in 2014 on average was 4.3 d later than Jamestown. In the eastern SRW wheat region, average head emergence of VA11W-106 (132 d) in 2015 was similar to that of 'Shirley'. In the Uniform Southern and Uniform Eastern nurseries, plant height of VA11W-106 (33 and 32 inches, respectively) was 3 inches shorter than checks 'AGS 2000' and MO-080104. Straw strength of VA11W-106 (1.4 – 2.1) is good and was similar to that of the checks in both the Uniform Southern and Uniform Eastern nurseries. In the 2014 Uniform Southern nursery, winter kill (0 = no injury to 9 = severe injury) of VA11W-106 (2.9) was significantly ($P \leq 0.05$) lower than that of the four check varieties (5.4 – 6.5). In the 2015 Uniform Eastern nursery, winter hardiness of VA11W-106 (1.0) was similar to that of the checks (1.0 – 1.4).

VA11W-106 was evaluated at 21 locations in the 2014 USDA-ARS Uniform Southern SRW Wheat Nursery and ranked fourth among 33 entries for grain yield (81 bu/ac). Average test weight of VA11W-106 (56.2 lb/bu) was similar to the overall trial mean and significantly ($P \leq 0.05$) higher than that of 'USG 3555' (54.4 lb/bu). VA11W-106 also was evaluated at 24 locations in the 2015 USDA-ARS Uniform Eastern SRW Wheat Nursery, and ranked fourth in grain yield (79 lb/bu) among 31 entries. Average test weight of VA11W-106 (55.9 lb/bu) was similar to the overall trial mean, and higher ($P \leq 0.05$) than those of 'Branson' (54.7 lb/bu) and Shirley (53.5 lb/bu).

In quality tests conducted by the USDA-ARS Soft Wheat Quality Lab, VA11W-106 has exhibited milling and baking qualities that are most similar to those of Jamestown and better than those of 'Yorktown'. Comparisons of mean milling and baking quality attributes over three crop environments for **VA11W-106**, Jamestown, and Yorktown include: softness equivalent values of **60.2** versus 57.5 and 58.8%; flour yields of **68.1** versus 68.0 and 66.4%; flour protein concentrations of **7.6** versus 8.1 and 8.1%; gluten strength (lactic acid SRC) of **110** versus 114 and 123%; and cookie spread diameters of **18.4** versus 18.0 and 17.5 cm.

With the exception of stem rust and Hessian fly, VA11W-106 has expressed moderate to high levels of resistance to diseases prevalent in the SRW wheat region. These include powdery

mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf streak, *Barley and Cereal Yellow Dwarf Viruses*, and Fusarium head blight.

Hilliard

Soft red winter (SRW) wheat cultivar Hilliard (tested as VA11W-108) was developed and released by the Virginia Agricultural Experiment Station in May 2015. It was derived from the cross Pioneer Brand '25R47' (PI 631473) / 'Jamestown' (PI 653731). Hilliard was derived as a bulk of an F5:6 headrow selected in 2010 and was evaluated over three years (2013 – 2015) in Virginia's State Variety Trials and throughout the soft red winter (SRW) wheat region in the 2014 USDA-ARS Uniform Southern and Uniform Eastern Soft Red Winter Wheat Nurseries.

Hilliard is a broadly adapted, high yielding, mid-season, medium height, semi-dwarf (gene Rht2) SRW wheat. Plant stem and spike color of Hilliard are green, and its spikes are awned. In the southern SRW wheat region, head emergence of Hilliard (121 d) has been similar to that of 'USG 3555' and 3 days later than Jamestown. In the eastern SRW wheat region, head emergence of Hilliard (136 d) was 1 day later than 'Branson' and 1.5 d earlier than 'Shirley'. Average mature plant height of Hilliard throughout the SRW wheat region has varied from 34 to 38 inches. In the Uniform Southern and Uniform Eastern nurseries, plant height of Hilliard (34 inches) was 2 inches shorter than checks 'AGS 2000' and MO-080104 and 2.5 to 3.5 inches taller than Shirley. Straw strength (0=erect to 9=completely lodged) of Hilliard (0.2 – 2.3) is very good and similar to that of Shirley (0.6 – 2.5). In the Uniform Eastern Nursery, winter hardiness (0 = no injury to 9 = severe injury) of Hilliard (2.2) was similar to that of the checks (1.8 – 2.9), while in the Uniform Southern Nursery, its winter injury (4.0) was less than that of the checks (5.4 – 6.5).

Hilliard was evaluated at 21 sites in the 2014 USDA-ARS Uniform Southern SRW Wheat Nursery and ranked second among 33 entries for grain yield (84 bu/ac). Average test weight of Hilliard (55.8 lb/bu) was similar to the overall trial mean and significantly ($P < 0.05$) higher than that of USG 3555 (54.4 lb/bu). Hilliard also was evaluated at 21 locations in the 2014 USDA-ARS Uniform Eastern SRW Wheat Nursery, and ranked first in grain yield within the eastern wheat region (87.6 lb/bu) and second overall test sites (86.9 lb/bu). Average test weight of Hilliard (56.9 lb/bu) was similar to the overall trial mean, and significantly ($P < 0.05$) higher than those of Branson (55.8 lb/bu) and Shirley (54.7 lb/bu).

Grain samples of Hilliard produced in five crop environments (2012 – 2014) were evaluated for end use quality by the USDA-ARS Soft Wheat Quality Lab. Hilliard has exhibited milling and baking qualities that are intermediate between those of Jamestown and USG 3555. Jamestown has better milling quality attributes than Hilliard or USG 3555, while both Jamestown and Hilliard have superior baking quality compared to USG 3555. While flour of Hilliard has the lowest grain protein content, it has slightly stronger gluten strength than Jamestown or USG 3555.

Hilliard is a widely adapted, mid-season wheat variety with good winter hardiness. It has high grain yield potential, good straw strength, and has performed well over most of the eastern SRW wheat production areas. With the exception of stem rust, Hilliard has expressed moderate to high levels of resistance to diseases prevalent in the SRW wheat region. These include powdery

mildew, leaf rust, stripe rust, leaf and glume blotch, bacterial leaf streak, Soil Borne Mosaic Virus, Barley and Cereal Yellow Dwarf Viruses, Fusarium head blight, and Hessian fly.

Initial Breeder seed of Hilliard, derived in 2013 from a 225 ft2 F9 seed increase block from which visible variant plants were removed prior to harvest, was grown on 0.25 ac at the Virginia Crop Improvement Association's (VCIA) Foundation seed farm and produced 10 units (50 lbs / unit) of seed. In fall 2014, this seed was planted on 7.6 ac at the Foundation seed farm and to produce additional Foundation seed. A purer source of Hilliard Breeder seed was developed upon evaluation of plots derived from 89 selected breeder seed headrows having yellow anther and white coleoptile color. Remnant seed (34 lbs) from these headrows was planted on 0.6 acre at VCIA's Foundation Seed Farm during fall 2014 to produce a purer source of Hilliard breeder seed.

SY 100

M10-1100 is a soft red winter wheat bred by Syngenta Seeds, Inc. for grain production. M10-1100 is a medium tall semi-dwarf variety and has white chaff at maturity. It has medium maturity and its heading is a day later than W1104. M10-1100 has shown above average test weight, moderate resistance to fusarium head blight, moderate resistance to all prevalent leaf diseases in the Midwest and mid-Atlantic including current races of powdery mildew, leaf rust and stripe rusts. It has tested moderately susceptible to septoria leaf blight. It has above average milling and cookie qualities and is an above average broad adaptation end use market variety. M10-1100 appears to be best adapted for grain production in the states of Illinois, Indiana, Missouri, Michigan, Ohio, Wisconsin, Delaware, Maryland, North Carolina, Pennsylvania, and Virginia.

M11-2024# (SR

M11-2024# is an awnless soft red winter wheat bred by Syngenta. It is a medium short height semi-dwarf variety with medium-early maturity heading the same as Branson. M11-2024# has shown above average test weight, moderate resistance to BYD, Soil borne virus, powdery mildew, leaf rust and stripe rust. It has shown very good milling with average cookie baking properties.

M11*3144CS (SY 944)

SY 944: This soft white winter wheat variety delivers excellent milling and baking qualities due to its durable test weight and high grain yield. This medium-late maturity variety offers a strong agronomic package with excellent mildew and soil virus resistance. With good pre-harvest sprouting tolerance and winter survival, SY 944 is hardy and well-suited for the northern growing regions in Michigan and New York.

Branson

Branson is a soft red winter wheat bred and developed by AgriPro Wheat. Branson is a medium height semi dwarf variety with good straw strength. Branson is moderately resistant to Septoria Leaf Blotch and Stripe rust and Powdery Mildew. Intermediate resistance to Soil borne Mosaic virus and Leaf rust. Primary adaptation is the wheat growing regions of Missouri, Illinois, Indiana, Michigan, and Ohio. Juvenile growth habit is semi erect. Plant color at boot stage is dark green. Flag leaf at boot stage is erect and twisted. Waxy bloom is present on the head, stem

and flag leaf sheath. Anther color is yellow. Head shape is strap, mid-dense and awnletted. Glumes are glabrous, narrow in width and long in length with oblique shoulders and obtuse beaks. Seed shape is ovate. Brush hairs are mid-long in length and occupy a large area of the seed tip. Seed crease depth is shallow and width is narrow. Seed cheeks are rounded. Branson has been uniform and stable since 2003. Less than 0.8% of the plants were rouged from the Breeders Seed increase in 2004. Approximately 90% of the rouged variant plants were taller height wheat plants (8 to 15 cm) and 10% were awned plants. AgriPro Wheat maintains seed stock and certified classes of Foundation, Registered and Certified. Certified seed stocks of Branson will be available in the fall of 2005. Certified acreage is not to be published by AOSCA and certifying agencies. Plant Variety Protection is anticipated and Branson may only be sold as a class of certified seed.

Beck 88AA

Beck 88 is and awnless, medium height soft red winter wheat with excellent winter hardiness. Beck 88 is blue-green before maturity, extremely early maturing (heads 3 days earlier than Clark) and recommended for double cropping. It has tremendous standability and excellent Scab tolerance. Beck 88 is best suited for growth in Missouri, Illinois, Indiana, Ohio and Kentucky and shows resistance to scab and Septoria leaf blotch, tolerance to Septoria Glume Blotch, Leaf Rust, Barley yellow dwarf virus and soil borne wheat mosaic virus.
Beck 88 is an exciting double crop performer for Beck's marketing area. This extremely early product adds yield while maintaining standability, winter hardiness, test weight, and scab tolerance. Beck 88 opens new opportunities for double crop in Beck's northern market area. Summarized from Beck's Hybrids Product Description, 2016.

Beck 114

Beck 114 is an awnless, medium height, early maturing soft red winter wheat with outstanding test weight and consistent yield. Beck 114 has excellent yield potential, standability, winter hardiness and disease resistance. Beck 114 is highly resistant to soil borne wheat mosaic virus and Septoria leaf blotch and has good resistance to Septoria glume blotch, FHB (head scab) and barley yellow dwarf virus with tolerance to powdery mildew and leaf rust. Maturing plants are medium green in color.

Beck 123

Beck 123 is an awned, medium tall soft red winter wheat with excellent yield potential and stability, test weight and plant health. Beck 123 has good resistance to Septoria leaf blotch and glume blotch, leaf rust, FHB (head scab) and barley yellow dwarf virus. It is resistant to soil borne wheat mosaic virus. Beck 123 has excellent standability, tiller production winter hardiness, uniformity, straw yield and fall growth are all excellent. Maturing plants are medium green in color.

Beck 123 is a tremendous bin busting yielder. This medium-early variety was the pre-commercial trial champion in 2015. Beck 123 brings a nice plant health package complemented with a gorgeous harvest appearance. Beck 123 will be an exciting variety for years to come. Beck 114 will be released in 2016 for fall planting.

Beck 125

Beck 125 is an awned, medium tall soft red winter wheat with outstanding yield, test weight, winter hardiness and standability. Beck 125 is medium-early maturing (3 days later than Clark) and shows resistance to Septoria leaf blotch, scab, powdery mildew and barley yellow dwarf virus with good tolerance to Septoria Glume Blotch and soil borne wheat mosaic virus. Beck 125 is medium green before maturity. Beck 125 was released in 2014. Beck 125 is a dominant yielder in Beck's entire market area. Winning the precommercial trial each of the last two years it has combined yield, test weight, health and standability. With a gorgeous look at harvest time, Beck 125 is a farmer favorite in a medium maturity. with higher rates of nitrogen. Beck 125 is a broadly adapted, medium early farmer favorite. Summarized from Beck's Hybrids Product Description, 2016.

Beck 128

Beck 128 is an awned, medium tall, soft red winter wheat with outstanding yield potential and excellent standability, winter hardiness, test weight and plant health. Beck 128 is resistant to FHB (head scab) and has good resistance to Septoria glume blotch. Beck 128 is tolerant to Septoria leaf blotch, barley yellow dwarf virus and soil borne wheat mosaic virus and shows some tolerance to powdery mildew and leaf rust. Maturing plants are medium green in color. Beck 128 is a tremendous medium-late variety for better soils. With the FHB1 gene, it has a superior tolerance to head scab. Beck 128 maximizes yield potential through good tillering and aggressive early growth. Beck 128 will compete in every corner of Beck's marketing area. Beck 128 will be released in 2016 for fall planting

Beck 120

Beck 120 is an awned, medium short soft red winter wheat with superior yield, excellent test weight, winter hardiness and standability. Beck 120 is medium-early maturing (2 days later than Clark) and shows resistance to Septoria Glume Blotch and barley yellow dwarf virus, with tolerance to Septoria leaf blotch, scab, powdery mildew and soil borne wheat mosaic virus. Beck 120 is dark green before maturity. Beck 120 was released in 2012.
Beck 120 is a high performing variety that delivers bin-busting yields in a medium early maturity. This awned variety offers excellent standability to perform great under high management with higher rates of nitrogen. Beck 120 is a broadly adapted medium early farmer favorite.

Milling and Baking Results Reported by Collaborators and SWQL

Mill Stream Distribution by SWQL

Table 1. Miag Multomat Mill Stream Yields of the WQC 2016 Crop Year Entries by SWQL

Mill Stream	VA10W -119	VA11W -106	Hilliard	SY 100	M11-2024#	M11*31 44CW	Branson	Beck 88AA	Beck 114	Beck 123	Beck 125	Beck 128	Beck 120
1st Break	8.4	9.8	9.7	11.0	6.1	10.7	10.2	8.0	8.1	10.3	7.7	12.4	7.6
2nd Break	6.6	7.8	8.5	9.9	7.2	7.5	9.7	8.7	8.0	8.6	8.8	11.3	8.9
Grader	3.4	4.0	3.7	4.8	3.0	4.2	4.2	3.7	3.7	4.3	3.4	4.4	3.8
3rd Break	11.3	10.8	11.3	10.1	7.8	10.7	10.5	8.2	9.1	9.5	8.8	9.1	7.8
Total Brk	29.8	32.3	33.3	35.8	24.0	33.2	34.7	28.6	28.9	32.7	28.7	37.2	28.1
1st Middlings	11.7	9.0	10.1	9.8	11.0	10.9	10.8	9.9	8.3	9.1	9.0	10.4	10.7
2nd Middlings	14.4	12.1	11.9	12.1	17.5	13.0	12.5	15.2	14.3	13.0	15.5	11.8	16.9
3rd Middlings	7.0	6.4	5.9	5.5	7.6	5.9	5.2	6.8	8.0	5.9	6.9	5.1	7.4
Re-Dust	6.9	5.2	5.2	5.6	7.3	6.5	6.2	6.2	5.4	5.5	5.3	4.9	7.1
4th Middlings	3.0	3.6	3.0	2.8	4.1	2.7	2.5	4.4	4.9	3.8	4.5	2.9	3.7
5th Middlings	0.9	1.1	1.0	1.0	1.3	0.8	0.9	1.6	1.7	1.3	1.7	1.1	1.1
Total Middlings	43.9	37.5	37.0	36.8	48.8	39.8	38.1	44.0	42.7	38.6	43.0	36.2	46.9
Straight Grade	73.7	69.8	70.3	72.5	72.8	72.9	72.7	72.6	71.6	71.3	71.7	73.4	75.0
Break Shorts	6.2	7.0	7.9	6.7	6.8	5.8	7.2	8.0	8.3	8.6	7.5	6.8	6.8
Red Dog	0.7	0.8	0.9	0.8	0.8	0.5	0.7	1.2	1.2	1.0	1.4	1.0	0.9
Tail Shorts	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.5	0.4	0.4	0.4	0.2	0.3
Bran	18.7	21.9	20.3	19.4	18.8	20.1	18.6	17.5	18.1	18.4	18.5	18.2	17.0
Total Byproduct	25.8	30.0	29.3	27.2	26.7	26.6	26.9	27.1	28.1	28.4	27.9	26.3	25.0

*Check varieties.

Miag Multomat Flour Milling Ash Curves

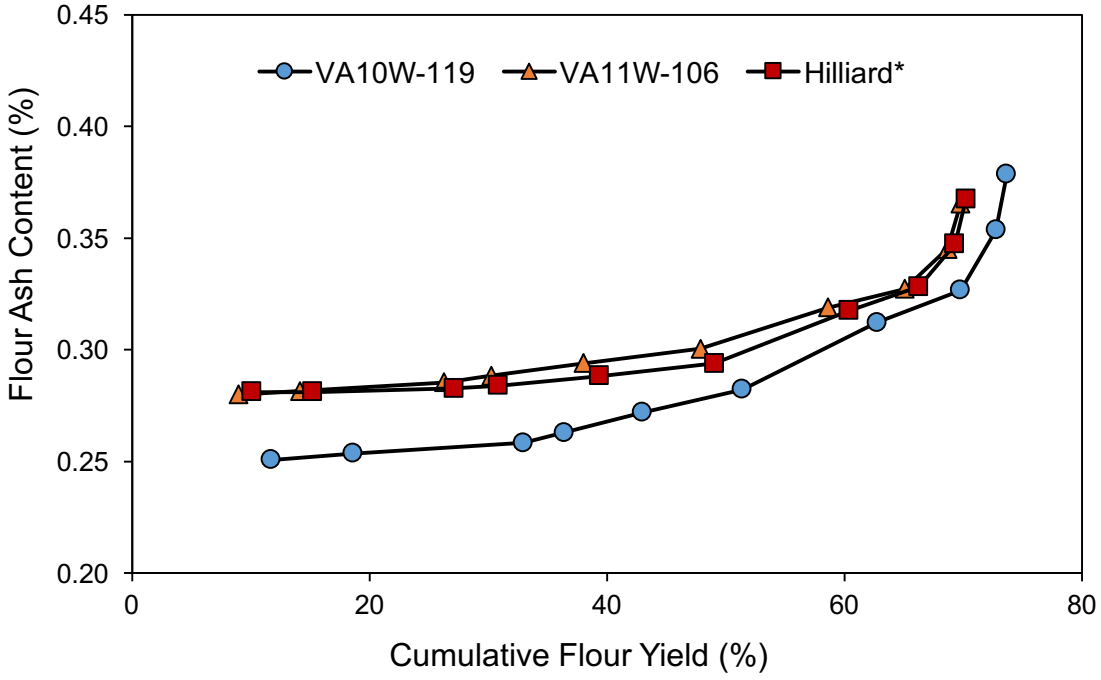

Table 2. Yield and Ash Content of Mill Streams for the WQC 2016 Crop Entries from Virginia Polytechnic Institute and State University

Flour Stream	VA10W-119		VA11W-106		Hilliard*	
	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)
1 Brk	11.7	0.25	9.0	0.28	10.1	0.28
2 Brk	6.9	0.26	5.2	0.28	5.2	0.28
Grader	14.4	0.26	12.1	0.29	11.9	0.28
3 Brk	3.4	0.31	4.0	0.31	3.7	0.29
1 Mids	6.6	0.32	7.8	0.32	8.5	0.30
2 Mids	8.4	0.34	9.8	0.33	9.7	0.32
3 Mids	11.3	0.45	10.8	0.40	11.3	0.42
Re-Dust	7.0	0.46	6.4	0.40	5.9	0.44
4 Mids	3.0	0.98	3.6	0.67	3.0	0.76
5 Mids	0.9	2.43	1.0	2.52	1.8	1.85

*Check variety.

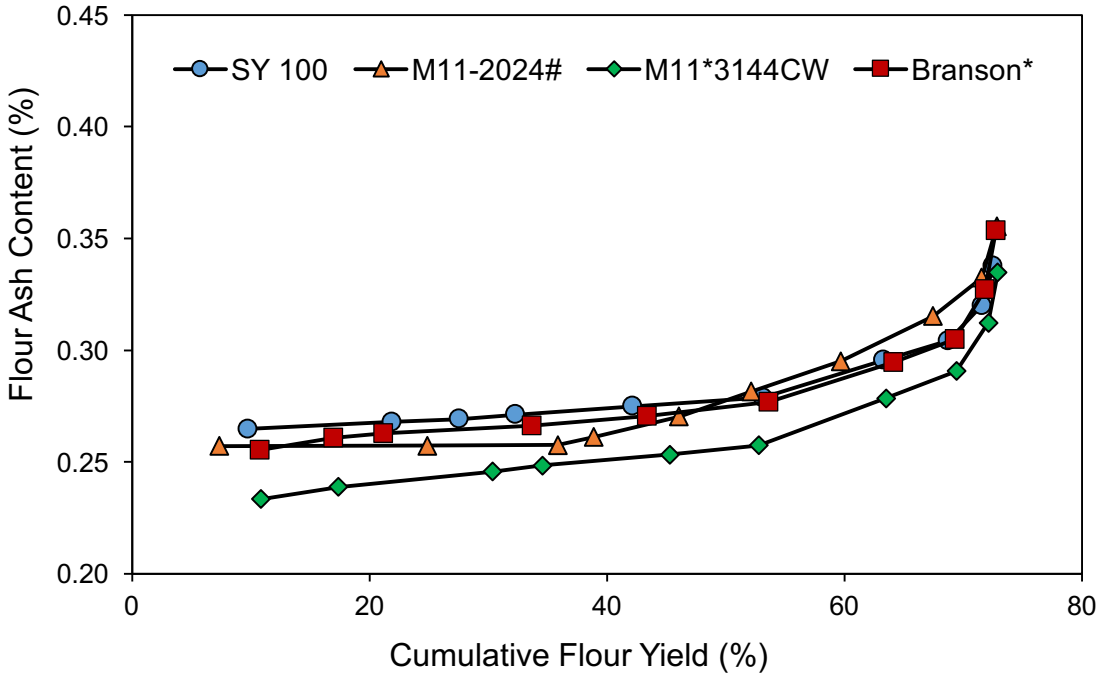

Table 3. Yield and Ash Content of Mill Streams for the WQC 2016 Crop Entries from AgriPro/Syngenta

Flour Stream	SY 100		M11-2024#		M11*3144CW		Branson*	
	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)
1 Brk	9.8	0.26	7.3	0.26	10.9	0.23	10.8	0.26
2 Brk	12.1	0.27	17.5	0.26	6.5	0.25	6.2	0.27
Grader	5.6	0.27	11.0	0.26	13.0	0.25	4.2	0.27
3 Brk	4.8	0.28	3.0	0.30	4.2	0.27	12.5	0.27
1 Mids	9.9	0.29	7.2	0.32	10.7	0.27	9.7	0.29
2 Mids	11.0	0.29	6.1	0.37	7.5	0.28	10.2	0.30
3 Mids	10.1	0.38	7.6	0.39	10.7	0.38	10.5	0.38
Re-Dust	5.5	0.41	7.8	0.47	5.9	0.42	5.2	0.43
4 Mids	2.8	0.70	4.1	0.62	2.7	0.87	2.5	0.94
5 Mids	1.0	1.66	1.3	1.65	0.8	2.40	0.9	2.54

*Check variety.

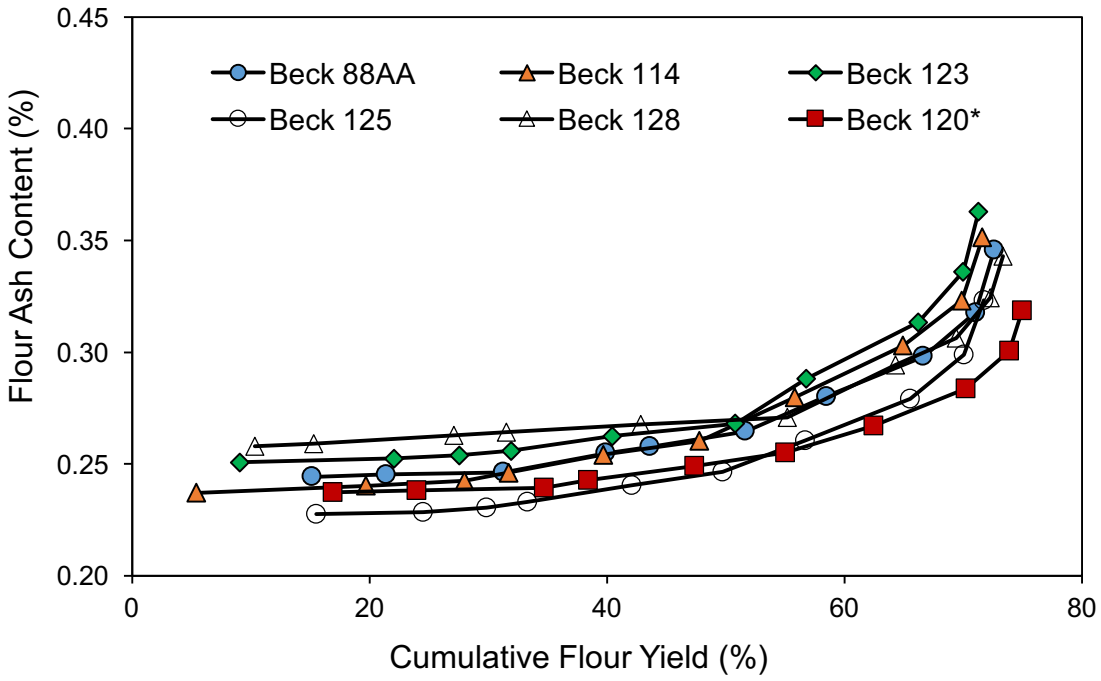

Table 4. Yield and Ash Content of Mill Streams for the WQC 2016 Crop Entries from Beck's Hybrids

Flour Stream	Beck 88AA		Beck 114		Beck 123		Beck 125		Beck 128		Beck 120*	
	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)	Yield (%)	Ash (%)
1 Brk	15.2	0.24	5.4	0.24	9.1	0.25	15.5	0.23	10.4	0.26	16.9	0.24
2 Brk	6.2	0.25	14.3	0.24	13.0	0.25	9.0	0.23	4.9	0.26	7.1	0.24
Grader	9.9	0.25	8.3	0.25	5.5	0.26	5.3	0.24	11.8	0.27	10.7	0.24
3 Brk	8.7	0.29	3.7	0.27	4.3	0.27	3.4	0.25	4.4	0.27	3.8	0.27
1 Mids	3.7	0.29	8.0	0.29	8.6	0.29	8.8	0.27	11.3	0.28	8.9	0.28
2 Mids	8.0	0.30	8.1	0.29	10.3	0.29	7.7	0.28	12.4	0.28	7.6	0.29
3 Mids	6.8	0.40	8.0	0.40	5.9	0.46	6.9	0.36	9.1	0.44	7.4	0.36
Re-Dust	8.2	0.43	9.1	0.44	9.5	0.47	8.8	0.40	5.1	0.46	7.8	0.42
4 Mids	4.4	0.62	4.9	0.59	3.8	0.74	4.5	0.58	2.9	0.76	3.7	0.62
5 Mids	1.6	1.63	1.7	1.49	1.3	1.80	1.7	1.35	1.1	1.59	1.1	1.59

*Check variety.

Wheat grain and flour quality characteristics

Table 5. Grain characteristics and SKCS parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Test Weight (lb/bu)	Grain Protein (%, 12% mb)	Grain Falling Number	SKCS Parameter		
					Hardness	Kernel Weight (mg)	Kernel Diameter (mm)
1	VA10W-119	60.5	9.3	361	20.0	38.0	2.8
1	VA11W-106	60.3	9.0	366	5.8	32.8	2.6
1	Hilliard*	59.5	9.0	369	15.5	32.4	2.6
2	SY 100	58.3	8.4	338	2.5	37.2	2.6
2	M11-2024#	62.8	10.2	362	29.4	37.7	2.9
2	M11*3144CW	60.2	9.75	329	5.7	40.7	2.8
2	Branson*	59.2	8.94	368	1.3	34.8	2.6
3	Beck 88AA	61.4	8.9	369	11.9	41.0	2.9
3	Beck 114	61.7	8.78	374	14.1	34.9	2.7
3	Beck 123	60.1	8.42	344	5.3	37.9	2.8
3	Beck 125	60.8	8.99	345	26.0	30.7	2.5
3	Beck 128	59.0	7.95	335	1.4	35.7	2.7
3	Beck 120*	60.6	8.75	359	22.4	33.9	2.6

*Check varieties.

Table 6. Miag and Quadrumat Milling parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Miag Milling Quality		Quadrumat Milling Quality	
		Break Flour Yield (%)	Straight Grade Flour Yield (%)	Flour Yield (%)	Softness Equivalent (%)
1	VA10W-119	29.8	73.7	72.0	61.7
1	VA11W-106	32.3	69.8	69.0	64.6
1	Hilliard*	33.3	70.3	68.9	65.7
2	SY 100	35.8	72.5	68.8	67.3
2	M11-2024#	24.0	72.8	74.9	47.4
2	M11*3144CW	33.2	72.9	73.7	66.4
2	Branson*	34.7	72.7	71.1	67.7
3	Beck 88AA	28.6	72.6	69.6	56.8
3	Beck 114	28.9	71.6	69.1	59.1
3	Beck 123	32.7	71.3	69.0	65.9
3	Beck 125	28.7	71.7	69.0	60.5
3	Beck 128	37.2	73.4	72.4	69.3
3	Beck 120*	28.1	75.0	72.2	59.4

*Check varieties.

Table 7. Flour quality parameters of the 2016 entries by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Moisture (%)	Protein (%, 14% mb)	pH	α-amylase Activity	Starch Damage (%)	Flour Ash (%, 14% mb)
1	VA10W-119	13.5	8.1	6.06	0.018	3.86	0.39
1	VA11W-106	13.5	7.4	6.06	0.021	2.42	0.36
1	Hilliard*	13.8	7.1	6.08	0.025	3.29	0.36
2	SY 100	13.8	6.3	6.11	0.019	1.99	0.34
2	M11-2024#	14.1	8.2	5.90	0.012	3.33	0.34
2	M11*3144CW	13.8	7.6	6.03	0.011	1.24	0.33
2	Branson*	13.6	7.3	6.07	0.019	1.71	0.35
3	Beck 88AA	13.7	7.5	6.07	0.016	2.03	0.35
3	Beck 114	13.6	7.3	6.02	0.012	3.41	0.35
3	Beck 123	13.8	7.0	6.10	0.017	1.93	0.36
3	Beck 125	13.8	7.7	5.97	0.017	3.78	0.33
3	Beck 128	13.7	5.8	6.09	0.015	1.72	0.35
3	Beck 120*	13.7	7.2	6.02	0.019	4.42	0.32

*Check varieties.

Summaries and Statistics of Combined Cooperator Test Parameters

Table 8. Mean SRC test parameters and overall flour quality scores by ten cooperators (n=10)[a].

Group	Entry	Solvent Retention Capacity (%)*			
		Water	Sodium Carbonate	Sucrose	Lactic Acid
1	VA10W-119	55.3 a	73.7 a	95.4 a	111.9 a
1	VA11W-106	53.9 a	75.1 a	99.6 a	110.0 a
1	Hilliard*	55.4 a	76.2 a	99.0 a	113.9 a
2	SY 100	50.9 b	69.0 a	85.3 bc	97.6 c
2	M11-2024#	53.9 a	70.8 ab	92.0 a	82.6 d
2	M11*3144CW	50.4 b	66.0 b	83.1 c	105.0 b
2	Branson*	52.4 ab	71.6 a	90.4 ab	112.5 a
3	Beck 88AA	52.0 b	69.8 bc	88.1 bcd	106.1 ab
3	Beck 114	55.6 a	75.1 a	100.0 a	109.4 a
3	Beck 123	53.2 ab	69.3 bc	89.1 bc	104.8 b
3	Beck 125	55.4 a	73.2 ab	93.7 ab	106.0 ab
3	Beck 128	53.7 ab	67.8 c	81.6 d	81.3 d
3	Beck 120*	51.9 b	68.8 c	85.9 cd	91.4 c

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

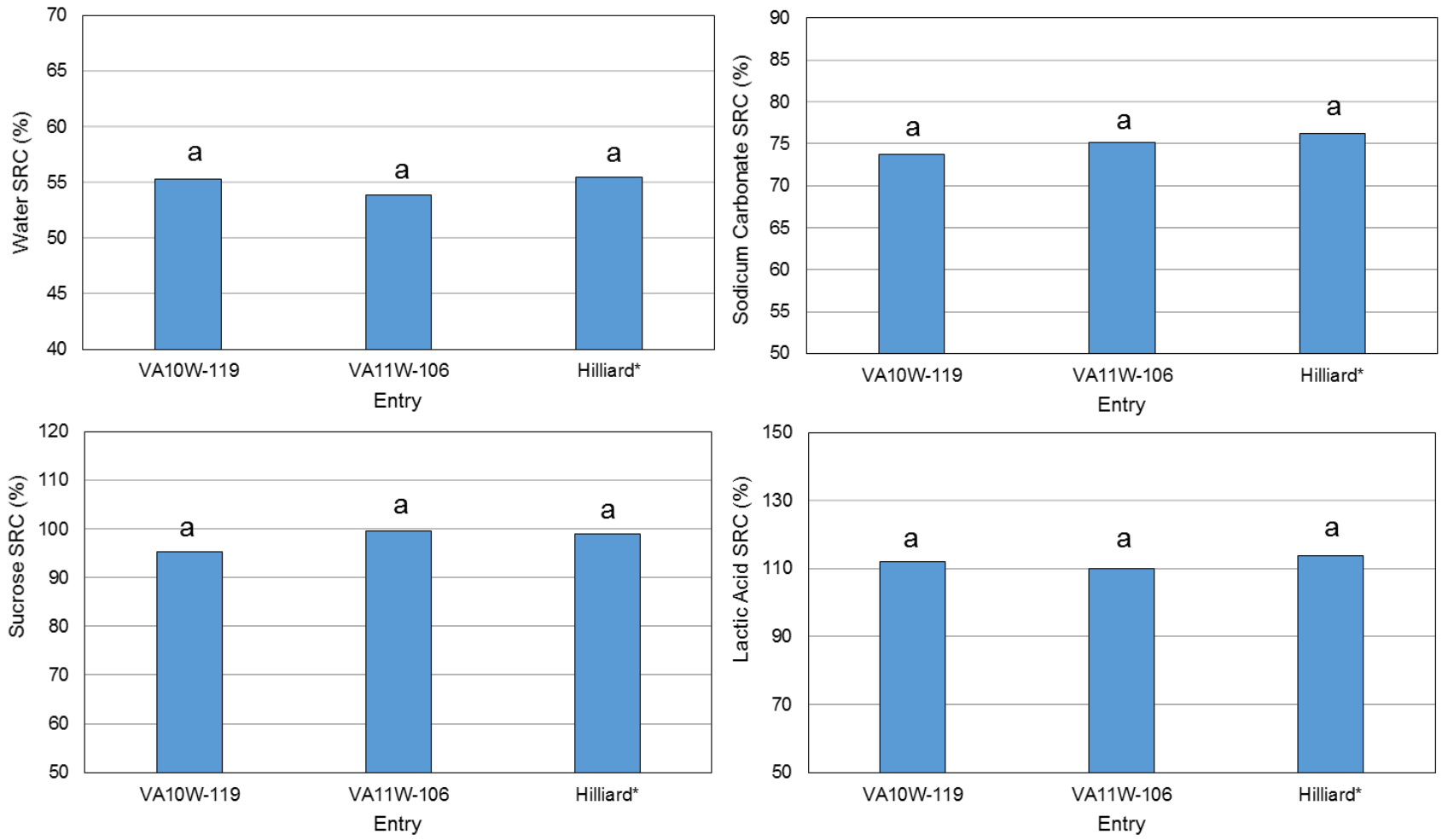

Figure 1. Mean differences in solvent retention capacities of Virginia Polytechnic Institute and State University Entries.

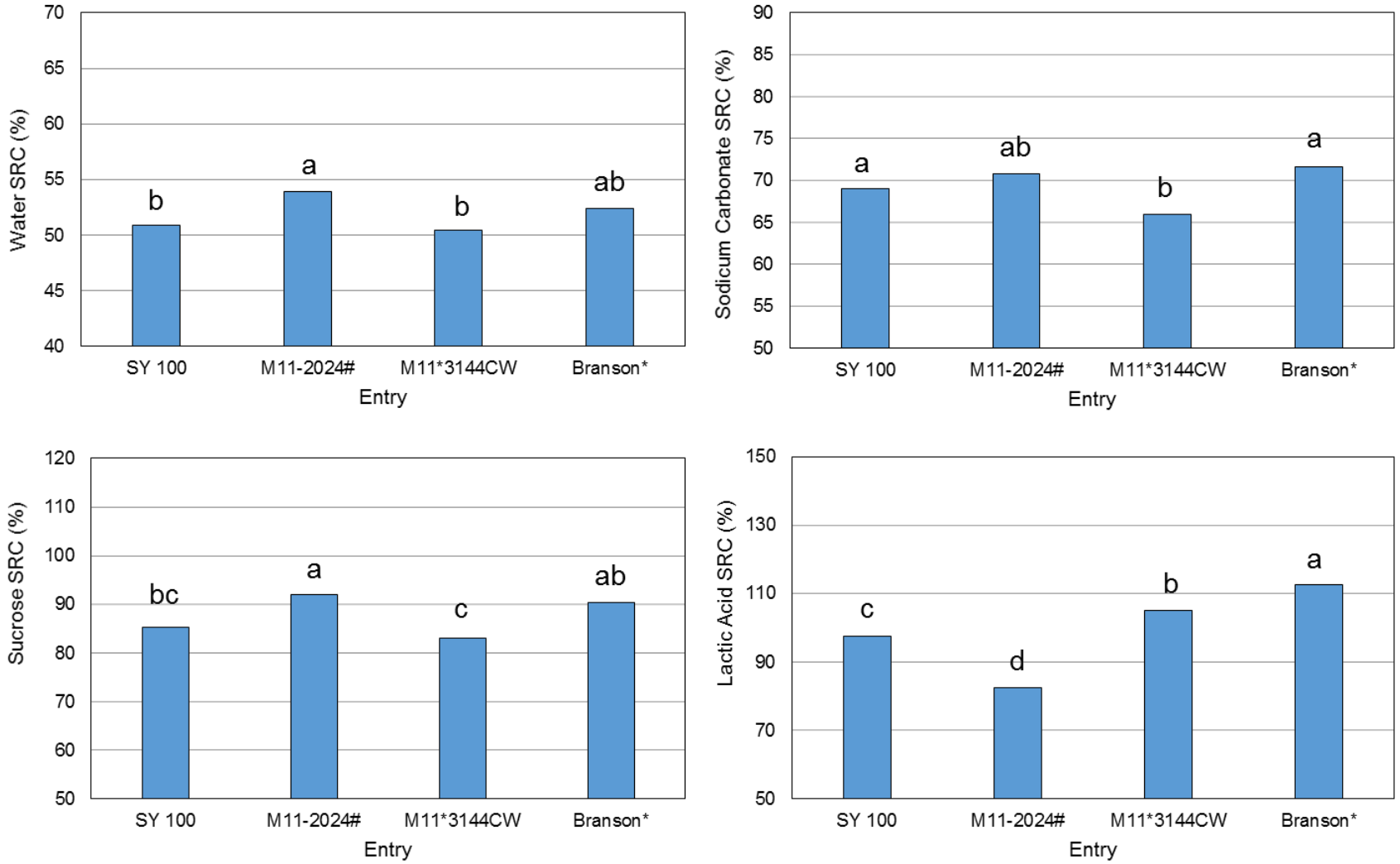

Figure 2. Mean differences in solvent retention capacities of AgriPro/Syngenta Entries.

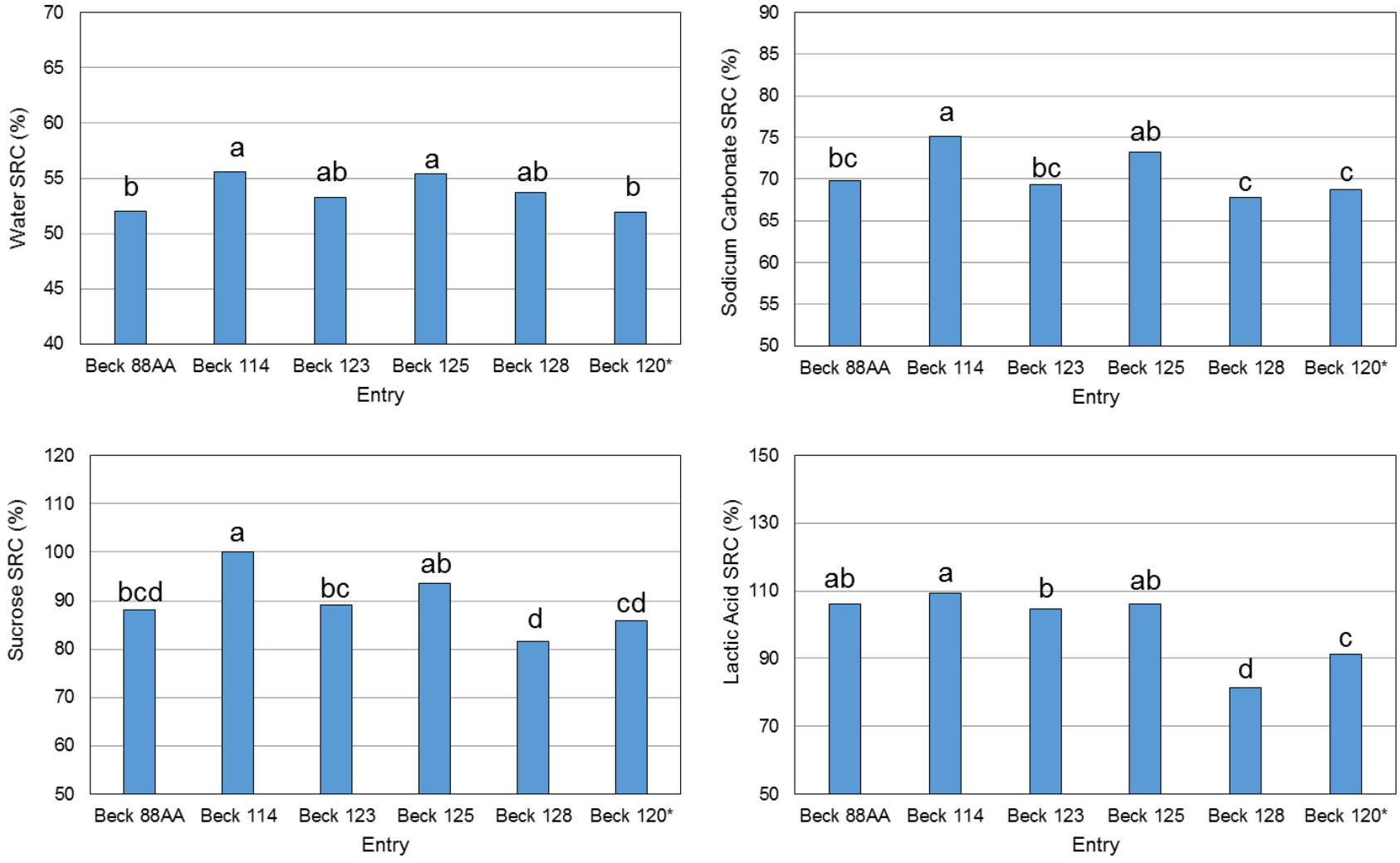

Figure 3. Mean differences in solvent retention capacities of Beck's Hybrids Entries.

Table 9. Mean Alveograph test parameters by three collaborators (n=3)

Group	Entry	Alveograph			
		P	L	P/L Ratio	W
1	VA10W-119	67.3 a	61.0 a	1.11 a	142.4 a
1	VA11W-106	50.4 a	71.8 a	0.73 a	108.9 a
1	Hilliard*	63.0 a	49.2 a	1.37 a	107.6 a
2	SY 100	35.3 a	62.4 b	0.56 b	73.9 a
2	M11-2024#	45.9 a	51.5 b	0.89 a	69.2 a
2	M11*3144CW	29.4 a	94.6 a	0.31 c	77.5 a
2	Branson*	36.7 a	98.1 a	0.39 bc	89.7 a
3	Beck 88AA	37.2 ab	93.3 a	0.39 b	92.0 a
3	Beck 114	67.8 a	51.2 b	1.32 a	122.1 a
3	Beck 123	50.2 ab	48.2 b	1.02 a	103.6 a
3	Beck 125	61.2 a	58.4 b	1.04 a	121.2 a
3	Beck 128	22.6 b	60.3 b	0.38 b	38.1 a
3	Beck 120*	28.1 b	88.5 a	0.32 b	62.0 a

*Check varieties.

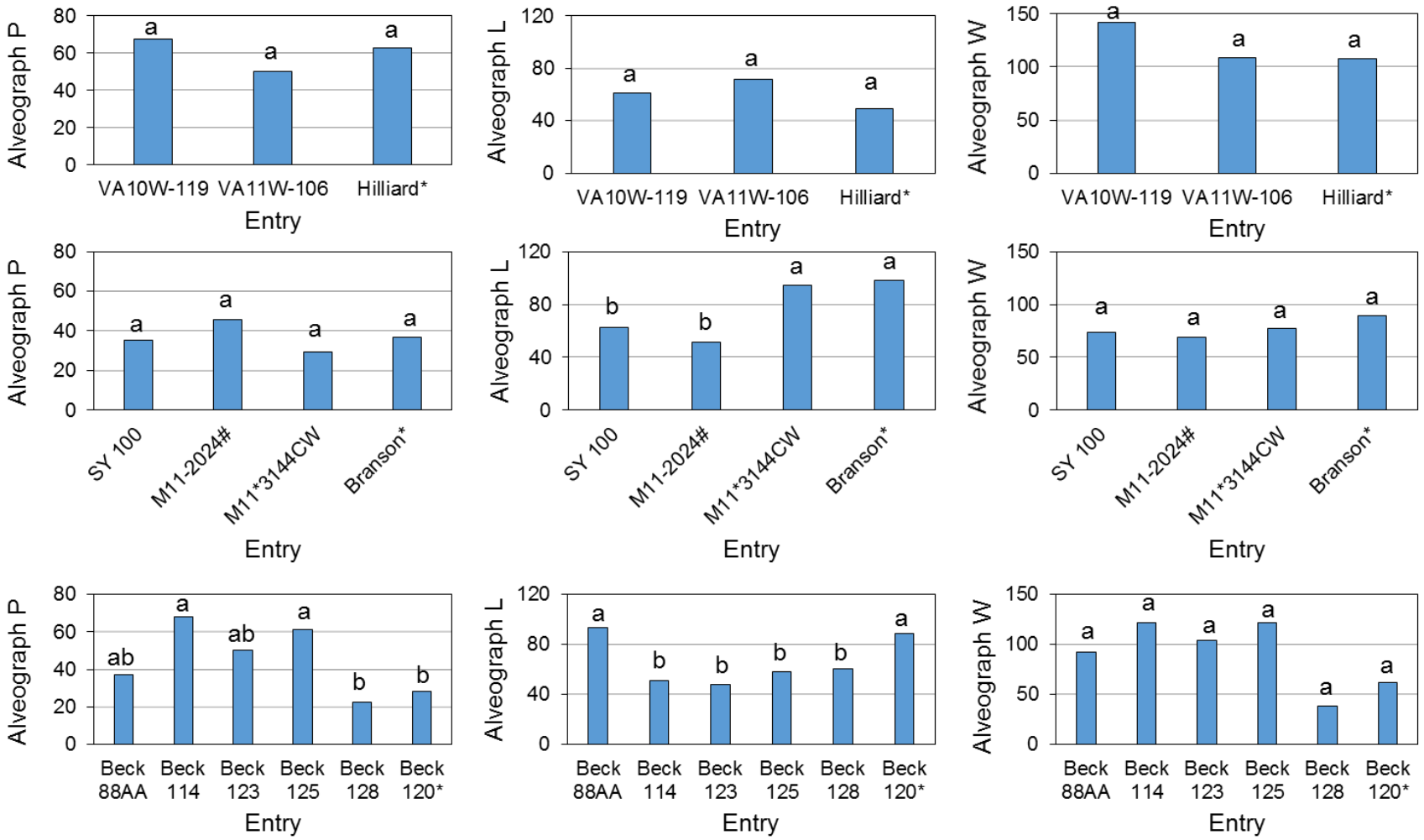

Figure 4 .Mean differences in Alveograph parameters of Virginia Polytechnic Institute (top), AgriPro/Syngenta (middle) and Beck's Hybrids (bottom) entries.

Table 10. Mean Farinograph test parameters by two collaborators (n=2)[a]

Group	Entry	Farinograph (n=2)*			
		Water Absorption (%)	Development Time (min)	Stability (min)	Mixing Tolerance Index (BU)
1	VA10W-119	53.9 a	1.1 a	2.0	97 a
1	VA11W-106	51.5 a	1.1 a	2.3 a	94 a
1	Hilliard*	52.8 a	1.0 a	1.6 a	105 a
2	SY 100	49.6 b	0.7 ab	1.1 b	158 a
2	M11-2024#	55.1 a	1.5 a	2.5 a	126 ab
2	M11*3144CW	50.4 b	0.6 b	1.5 ab	112 ab
2	Branson*	50.5 b	0.5 b	2.5 a	95 b
3	Beck 88AA	51.6 ab	0.9 a	1.9 a	105 bc
3	Beck 114	54.0 a	1.0 a	1.9 a	110 bc
3	Beck 123	51.4 ab	0.8 a	1.3 a	143 ab
3	Beck 125	55.1 a	0.8 a	2.0 a	91 c
3	Beck 128	49.3 b	0.7 a	1.0 a	162 a
3	Beck 120*	52.4 ab	0.7 a	1.4 a	134 abc

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

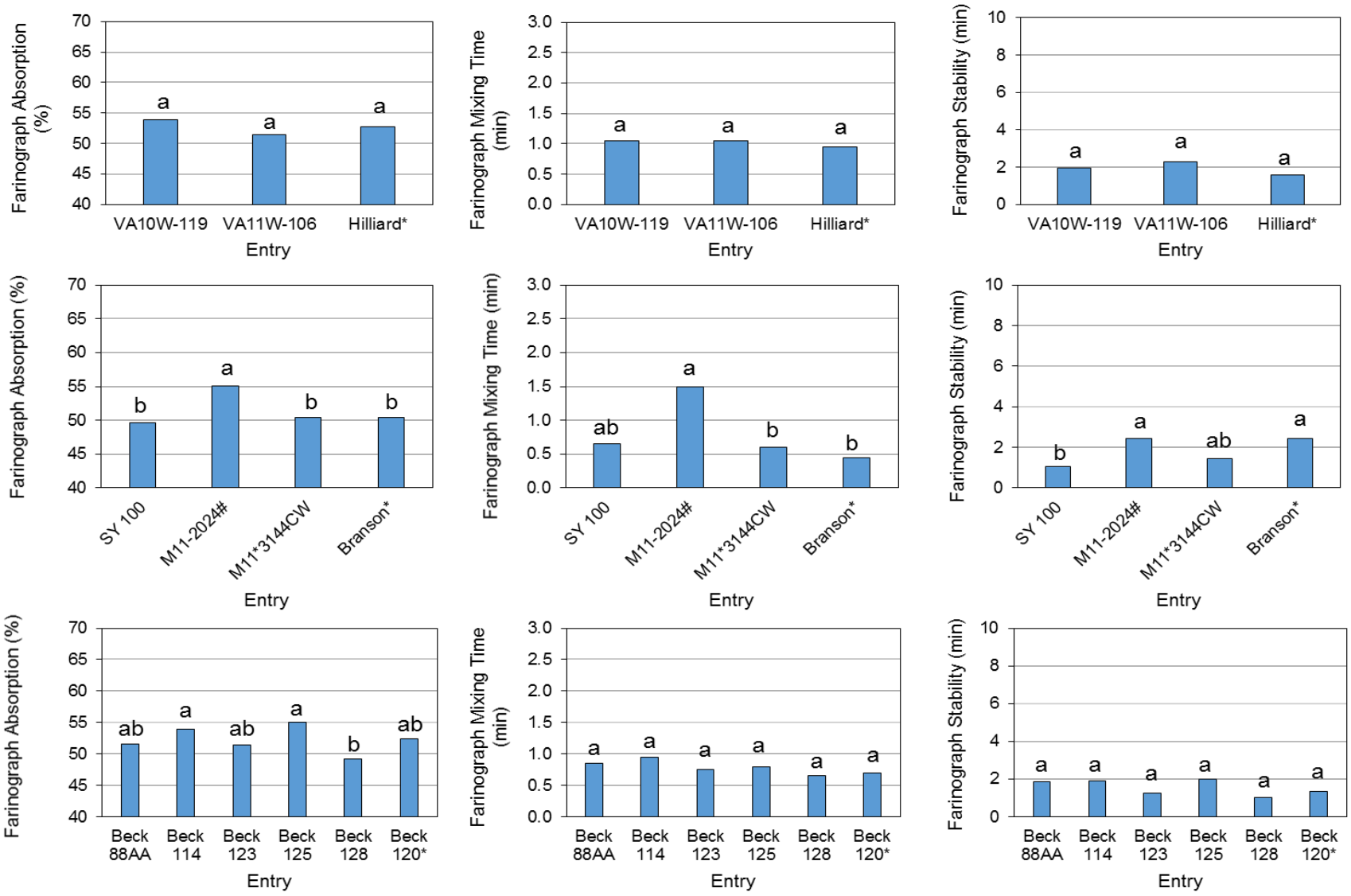

Figure 5. Mean differences in Farinograph parameters of Virginia Polytechnic Institute (top), AgriPro/Syngenta (middle) and Beck's Hybrids (bottom) entries.

Table 11. Mean (n=4) Rapid Visco-Analyzer (RVA) test parameters[a]

Group	Entry	Rapid Visco-Analyzer							
		Peak Time (min)	Peak (cP)	Trough (cP)	Break-down (cP)	Setback (cP)	Final (cP)	Pasting Temperature (°C)	Peak/Final Ratio
1	VA10W-119	6 a	3060 b	2002 b	1058 a	1357 a	3551 b	80.5 a	0.86 a
1	VA11W-106	6 a	3113 b	2063 b	1050 a	1467 a	3741 b	76.9 a	0.83 b
1	Hilliard*	6 a	3324 a	2292 a	1033 a	1510 a	4041 a	79.3 a	0.82 c
2	SY 100	6 a	3259 ab	2017 ab	1244 a	1426 a	3606 ab	78.2 a	0.91 a
2	M11-2024#	6 a	3005 bc	2086 a	920 b	1343 a	3643 a	79.9 a	0.82 c
2	M11*3144CW	6 a	2832 c	1842 b	992 b	1307 a	3301 b	80.3 a	0.86 b
2	Branson*	6 a	3407 a	2137 a	1273 a	1457 a	3762 a	79.2 a	0.91 a
3	Beck 88AA	6 a	3388 a	1974 a	1416 a	1409 a	3492 a	74.4 a	0.97 a
3	Beck 114	6 a	3061 bc	1879 ab	1182 cd	1331 a	3351 a	75.3 a	0.92 b
3	Beck 123	6 a	3250 ab	1930 ab	1318 b	1281 a	3325 ab	75.9 a	0.98 a
3	Beck 125	6 a	2795 d	1664 d	1132 d	1334 a	3132 b	79.2 a	0.89 c
3	Beck 128	6 a	3029 c	1794 cd	1235 bc	1418 a	3361 a	68.9 a	0.90 bc
3	Beck 120*	6 a	2904 cd	1835 bc	1087 d	1404 a	3383 a	78.8 a	0.86 d

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

Table 12. Mean sugar-snap cookie test (AACCI Approved method 10-50D (n=3) & 10-52 (n=4)) parameters[a]

Group	Entry	Sugar-Snap Cookie (10-50D)				Sugar-Snap Cookie (10-52)
		Width (mm)	Thickness (mm)	W/T Ratio (mm)	Spread Factor	Width (cm)
1	VA10W-119	478 a	56.5 a	8.6 a	79.7 b	17.7 b
1	VA11W-106	501 a	52.0 a	9.7 a	90.7 a	18.5 a
1	Hilliard*	499 a	53.3 a	9.5 a	89.0 a	18.2 ab
2	SY 100	523 a	46.8 b	11.3 a	102.3 a	19.1 a
2	M11-2024#	481 b	57.5 a	8.5 b	70.0 b	17.7 b
2	M11*3144CW	511 a	50.0 ab	10.3 a	97.0 a	18.9 a
2	Branson*	508 a	50.3 ab	10.3 a	95.7 a	18.7 a
3	Beck 88AA	513 a	48.3 b	10.7 a	100.3 a	18.6 ab
3	Beck 114	483 b	55.0 ab	9.0 bc	84.3 cd	17.7 c
3	Beck 123	508 ab	51.0 ab	10.1 ab	94.0 ab	18.7 ab
3	Beck 125	482 b	58.3 a	8.4 c	78.3 d	18.0 bc
3	Beck 128	524 a	48.5 ab	10.9 a	101.3 a	19.3 a
3	Beck 120*	506 ab	53.8 ab	9.6 abc	90.0 bc	18.8 ab

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

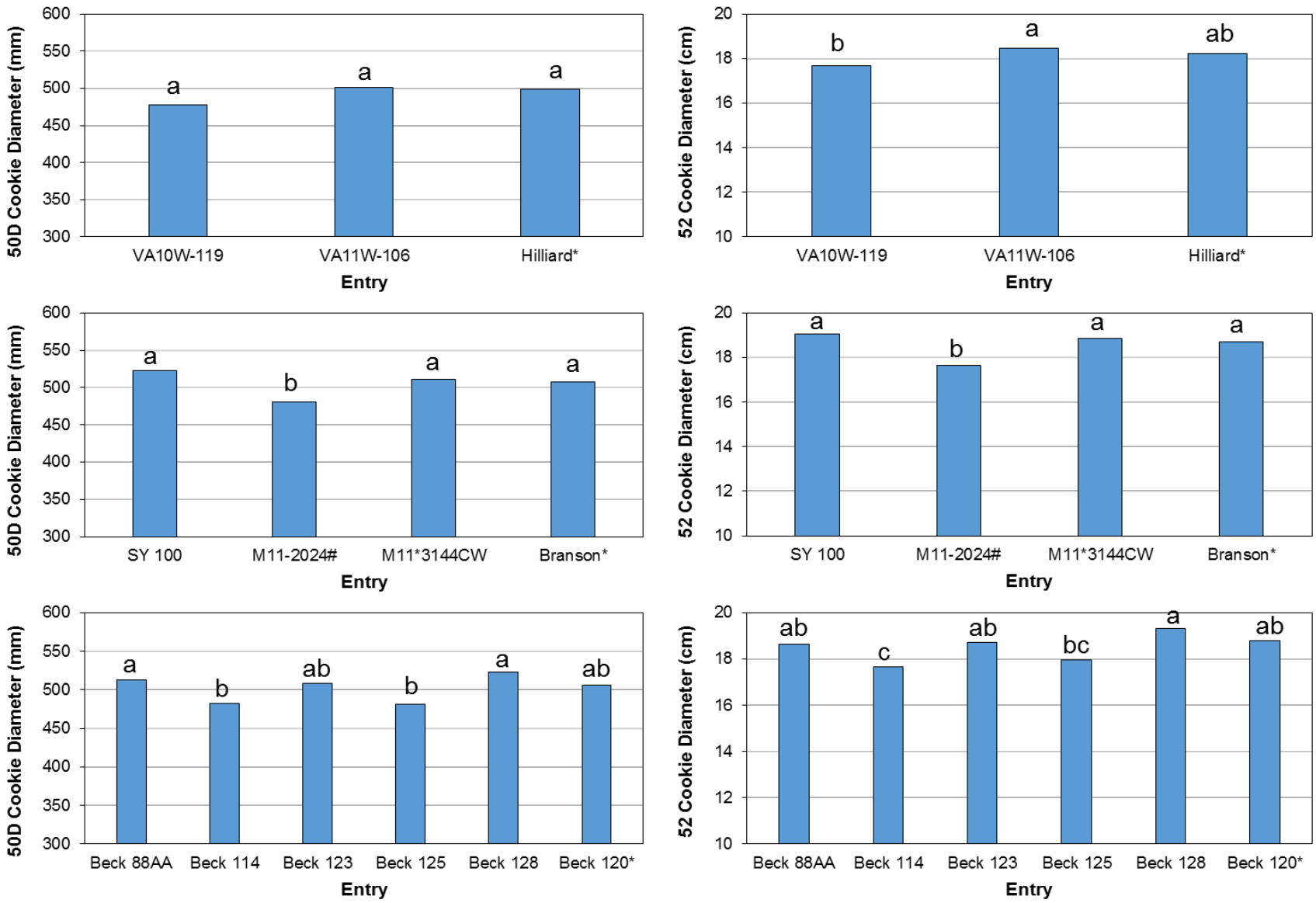

Figure 6. Mean differences in sugar-snap cookie (10-50D & 10-52) diameters of 2016 crop Soft WQC Entries.

Table 13. Mean (n=2) sponge cake baking test parameters[a]

Group	Entry	Sponge Cake	
		Volume (mL)	Texture Score
1	VA10W-119	1251 a	39 a
1	VA11W-106	1305 a	40 a
1	Hilliard*	1314 a	39 a
2	SY 100	1345 a	39 a
2	M11-2024#	1305 a	40 a
2	M11*3144CW	1336 a	40 a
2	Branson*	1321 a	39 a
3	Beck 88AA	1327 a	39 a
3	Beck 114	1266 a	39 a
3	Beck 123	1320 a	39 a
3	Beck 125	1265 a	39 a
3	Beck 128	1332 a	37 a
3	Beck 120*	1278 a	38 a
1	VA10W-119	1251 a	39 a

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

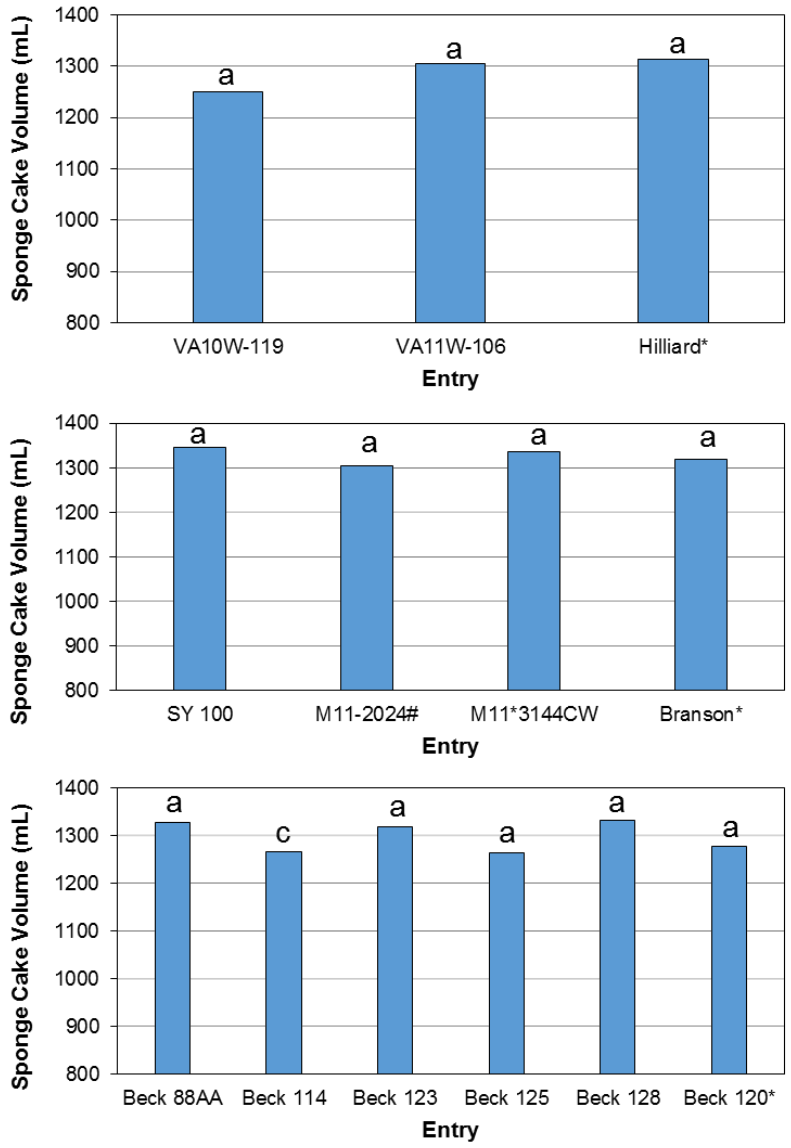

Figure 7. Mean differences in sponge cake volumes of 2016 crop Soft WQC Entries.

Table 14. Mean flour quality scores for making cookies (n=8) and sponge cakes (n=2), and product quality scores[a]

Group	Entry	Cookies		Sponge Cake	
		Flour Score	Product Score	Flour Score	Product Score
1	VA10W-119	5.9 a	5.1 b	5.0 a	5.5 a
1	VA11W-106	5.8 a	7.3 a	6.3 a	7.5 a
1	Hilliard*	5.5 a	6.5 a	5.7 a	7.0 a
2	SY 100	5.7 b	7.4 a	6.3 a	8.0 a
2	M11-2024#	5.6 b	5.1 b	6.0 a	7.0 a
2	M11*3144CW	7.4 a	7.6 a	7.5 a	7.5 a
2	Branson*	6.9 ab	7.4 a	7.3 a	7.0 a
3	Beck 88AA	7.0 a	7.5 a	7.3 ab	8.0 a
3	Beck 114	5.3 ab	4.6 b	5.8 ab	6.0 a
3	Beck 123	6.3 ab	7.3 a	5.8 ab	7.5 a
3	Beck 125	5.6 ab	5.0 b	5.8 ab	7.5 a
3	Beck 128	4.8 b	7.9 a	4.5 b	7.0 a
3	Beck 120*	6.6 a	6.8 a	7.7 a	7.0 a

*Check varieties.

[a]Means with different letters within the same group are significantly different at $P<0.05$.

Cooperator Data for Each Quality Test Parameter

Table 15. Water SRC (%) of 2016 WQC entries by cooperators

Group	Entry	ADM	AgroPro	Ardent	Kellogg	Limagrain	Mennel	Mondelez	StarWest	SWQL	WWQL	Mean	STDEV
1	VA10W-119	55	55	56	49	58	57	55	54	58	56	55	2.5
1	VA11W-106	51	54	.	47	55	55	57	53	58	55	54	3.4
1	Hilliard*	55	57	.	48	55	56	57	55	59	57	56	3.1
2	SY 100	49	52	52	46	54	52	45	52	54	53	51	3.2
2	M11-2024#	57	53	54	48	56	55	54	51	58	53	54	2.9
2	M11*3144CW	.	50	51	46	52	51	50	49	54	51	50	2.2
2	Branson*	.	52	.	46	54	54	54	51	55	53	52	2.9
3	Beck 88AA	.	52	51	46	54	54	54	51	54	52	52	2.6
3	Beck 114	.	55	56	50	57	55	58	54	59	56	56	2.6
3	Beck 123	.	53	52	48	55	53	55	52	57	54	53	2.6
3	Beck 125	.	55	53	50	58	58	56	54	58	57	55	2.7
3	Beck 128	.	52	53	48	55	56	55	53	56	55	54	2.6
3	Beck 120*	.	52	50	46	54	53	52	51	56	53	52	2.7

*Check varieties.

Table 16. Sodium Carbonate SRC (%) of 2016 WQC entries by cooperators

Group	Entry	ADM	AgroPro	Ardent	Kellogg	Limagrain	Mennel	Mondelez	StarWest	SWQL	WWQL	Mean	STDEV
1	VA10W-119	71	72	75	67	78	75	80	74	77	68	74	4.1
1	VA11W-106	77	74	.	69	78	78	80	76	76	68	75	4.0
1	Hilliard*	78	75	.	71	79	78	81	76	78	70	76	3.7
2	SY 100	72	68	70	63	70	69	77	68	70	63	69	4.1
2	M11-2024#	72	69	73	65	75	72	73	72	73	64	71	3.7
2	M11*3144CW	.	65	66	60	68	67	73	66	69	60	66	4.2
2	Branson*	.	70		66	74	73	79	71	74	66	72	4.6
3	Beck 88AA	.	68	70	65	72	70	77	69	73	64	70	4.0
3	Beck 114	.	73	74	69	77	78	84	74	79	68	75	5.2
3	Beck 123	.	69	69	65	72	69	76	68	73	63	69	4.0
3	Beck 125	.	72	74	68	76	75	79	73	76	66	73	4.2
3	Beck 128	.	66	69	64	69	68	72	67	72	63	68	3.1
3	Beck 120*	.	68	69	63	71	70	76	68	72	62	69	4.4

*Check varieties.

Table 17. Sucrose SRC (%) of 2016 WQC entries by cooperators

Group	Entry	ADM	AgroPro	Ardent	Kellogg	Limagrain	Mennel	Mondelez	StarWest	SWQL	WWQL	Mean	STDEV
1	VA10W-119	74	96	105	84	100	101	105	97	92	100	95	9.8
1	VA11W-106	94	99	.	83	105	107	106	104	92	106	99	8.2
1	Hilliard*	100	98	.	83	105	103	106	101	93	102	99	7.1
2	SY 100	85	83	89	73	89	88	92	87	80	87	85	5.5
2	M11-2024#	89	90	97	81	100	97	90	96	88	92	92	5.6
2	M11*3144CW	.	81	85	69	89	86	89	84	80	85	83	5.9
2	Branson*	.	89		74	96	95	100	91	86	92	90	7.8
3	Beck 88AA	.	86	91	72	93	89	104	88	82	88	88	8.4
3	Beck 114	.	98	107	83	107	104	105	101	94	101	100	7.6
3	Beck 123	.	87	93	74	94	90	98	90	85	91	89	6.7
3	Beck 125	.	92	98	78	98	96	100	93	90	98	94	6.8
3	Beck 128	.	79	85	69	86	85	86	82	78	84	82	5.4
3	Beck 120*	.	84	89	72	90	88	94	87	82	87	86	6.4

*Check varieties.

Table 18. Lactic acid SRC (%) of 2016 WQC entries by cooperators

Group	Entry	ADM	AgroPro	Ardent	Kellogg	Limagrain	Mennel	Mondelez	StarWest	SWQL	WWQL	Mean	STDEV
1	VA10W-119	125	104	117	106	107	115	113	113	105	114	112	6.7
1	VA11W-106	131	108	.	109	111	111	98	102	108	112	110	9.1
1	Hilliard*	120	112	.	114	117	118	107	110	111	116	114	4.3
2	SY 100	109	95	99	96	101	103	76	98	99	100	98	8.7
2	M11-2024#	80	77	84	81	85	84	94	80	81	80	83	4.8
2	M11*3144CW	.	101	107	103	112	112	102	104	98	106	105	4.9
2	Branson*	.	109		109	118	119	109	113	107	116	112	4.7
3	Beck 88AA	.	106	108	107	112	110	101	105	101	105	106	3.7
3	Beck 114	.	103	114	104	115	114	113	110	102	110	109	5.1
3	Beck 123	.	101	107	101	109	107	106	106	99	107	105	3.6
3	Beck 125	.	104	110	108	111	109	100	105	103	104	106	3.8
3	Beck 128	.	78	81	81	85	84	78	81	83	81	81	2.4
3	Beck 120*	.	92	97	95	92	94	81	88	94	90	91	4.9

*Check varieties.

Table 19. Farinograph absorption and dough development time of 2016 WQC entries by cooperators

Group	Entry	Absorption (%)				Development Time (min)			
		Kellogg's	Mennel	Mean	STDEV	Kellogg's	Mennel	Mean	STDEV
1	VA10W-119	52.6	55.2	53.9	1.8	1.2	0.9	1.0	0.2
1	VA11W-106	50.3	52.7	51.5	1.7	1.3	0.8	1.0	0.4
1	Hilliard*	52.0	53.6	52.8	1.1	1.2	0.7	1.0	0.3
2	SY 100	48.5	50.7	49.6	1.6	0.8	0.5	0.7	0.2
2	M11-2024#	54.2	56.0	55.1	1.3	1.3	1.7	1.5	0.2
2	M11*3144CW	49.6	51.2	50.4	1.1	0.7	0.5	0.6	0.1
2	Branson*	49.7	51.2	50.5	1.1	0.1	0.8	0.5	0.5
3	Beck 88AA	50.4	52.8	51.6	1.7	1.0	0.7	0.9	0.2
3	Beck 114	52.5	55.4	54.0	2.1	1.2	0.7	1.0	0.3
3	Beck 123	50.2	52.5	51.4	1.6	0.9	0.6	0.7	0.2
3	Beck 125	53.8	56.3	55.1	1.8	0.9	0.7	0.8	0.1
3	Beck 128	48.1	50.4	49.3	1.6	0.8	0.5	0.6	0.2
3	Beck 120*	51.1	53.7	52.4	1.8	1.0	0.4	0.7	0.4

*Check varieties.

Table 20. Farinograph dough stability and mixing tolerance index (MTI) of 2016 WQC entries by cooperators

Group	Entry	Dough Stability (min)				MTI (FU)			
		Kellogg	Mennel	Mean	STDEV	Kellogg	Mennel	Mean	STDEV
1	VA10W-119	2.2	1.7	2.0	0.3	97	97	97.0	0.0
1	VA11W-106	2.8	1.8	2.3	0.7	85	103	94.0	12.7
1	Hilliard*	1.7	1.5	1.6	0.1	115	94	104.5	14.8
2	SY 100	1.0	1.1	1.1	0.1	159	157	158.0	1.4
2	M11-2024#	2.2	2.7	2.5	0.4	125	126	125.5	0.7
2	M11*3144CW	1.6	1.3	1.4	0.2	135	89	112.0	32.5
2	Branson*	2.0	2.9	2.5	0.7	114	76	95.0	26.9
3	Beck 88AA	2.2	1.5	1.8	0.5	100	109	104.5	6.4
3	Beck 114	2.6	1.2	1.9	1.0	80	139	109.5	41.7
3	Beck 123	1.3	1.2	1.2	0.1	143	142	142.5	0.7
3	Beck 125	2.5	1.5	2.0	0.7	92	90	91.0	1.4
3	Beck 128	1.1	0.9	1.0	0.2	156	168	162.0	8.5
3	Beck 120*	1.6	1.1	1.3	0.4	126	142	134.0	11.3

*Check varieties.

Table 21. Sugar-snap cookie (10-50D) diameter (mm) of 2016 WQC entries by cooperators

Group	Entry	ADM	Ardent	Mennel	StarWest	Mean	STDEV
1	VA10W-119	471	457	488	495	478	17.4
1	VA11W-106	491	483	530	498	500	20.7
1	Hilliard*	495	480	513	507	498	14.3
2	SY 100	527	495	533	535	523	18.6
2	M11-2024#	481	465	499	479	481	13.8
2	M11*3144CW	511	486	528	518	511	18.1
2	Branson*	501	490	526	514	508	15.5
3	Beck 88AA	508	486	534	525	513	20.8
3	Beck 114	476	470	495	490	483	11.7
3	Beck 123	504	484	524	520	508	18.2
3	Beck 125	480	461	498	487	481	15.5
3	Beck 128	525	495	546	528	524	21.1
3	Beck 120*	504	479	518	523	506	19.6

*Check varieties.

Table 22. Sugar-snap cookie (10-52) diameter (cm) of 2016 WQC entries by cooperators

Group	Entry	AgriPro	Limagrain	SWQL	WWQL	Mean	STDEV
1	VA10W-119	17.8	17.7	17.1	18.1	17.7	0.43
1	VA11W-106	18.4	18.3	18.2	18.9	18.4	0.31
1	Hilliard*	18.4	17.9	17.7	18.9	18.2	0.53
2	SY 100	19.3	18.3	18.7	19.9	19.1	0.71
2	M11-2024#	17.6	17.5	17.4	18.1	17.6	0.32
2	M11*3144CW	18.9	18.3	18.5	19.7	18.9	0.61
2	Branson*	18.7	18.3	18.5	19.3	18.7	0.44
3	Beck 88AA	18.8	18.0	18.2	19.5	18.6	0.68
3	Beck 114	17.2	17.6	17.6	18.3	17.7	0.47
3	Beck 123	18.6	18.4	18.6	19.2	18.7	0.35
3	Beck 125	17.4	17.4	17.8	19.2	18.0	0.85

*Check varieties.

Table 23. Sponge cake volume of 2016 WQC entries by cooperators

Group	Entry	WMC	WWQL	Mean	STDEV
1	VA10W-119	1219	1282	1251	44.5
1	VA11W-106	1251	1358	1305	75.7
1	Hilliard*	1260	1368	1314	76.4
2	SY 100	1295	1395	1345	70.7
2	M11-2024#	1279	1330	1305	36.1
2	M11*3144CW	1296	1375	1336	55.9
2	Branson*	1253	1388	1321	95.5
3	Beck 88AA	1276	1378	1327	72.1
3	Beck 114	1242	1290	1266	33.9
3	Beck 123	1288	1352	1320	45.3
3	Beck 125	1208	1322	1265	80.6
3	Beck 128	1269	1395	1332	89.1
3	Beck 120*	1206	1350	1278	101.8

*Check varieties.

Table 24. Cookie quality scores of 2016 WQC entries by cooperators

Group	Entry	ADM	AgriPro	Ardent	LimaGrain	Mennel	Mondelez	StarWest	WWQL	Mean	STDEV
1	VA10W-119	6	3	8	4	4	5	6	5	5.1	1.6
1	VA11W-106	8	7	6	7	7	7	8	8	7.3	0.7
1	Hilliard*	8	7	6	4	6	6	7	8	6.5	1.3
2	SY 100	6	9		7	8	6	7	9	7.4	1.3
2	M11-2024#	6	3	8	4	4	4	6	6	5.1	1.6
2	M11*3144CW	8	8	7	7	7	8	8	8	7.6	0.5
2	Branson*	8	8	7	6	6	8	8	8	7.4	0.9
3	Beck 88AA	7	8	7	6	7	8	8	9	7.5	0.9
3	Beck 114	6	2	6	4	5	4	5	5	4.6	1.3
3	Beck 123	8	8	7	7	7	6	7	8	7.3	0.7
3	Beck 125	6	2	8	4	4	4	4	8	5.0	2.1
3	Beck 128	7	9	5	8	9	7	9	9	7.9	1.5
3	Beck 120*	8	8	6	7	6	4	7	8	6.8	1.4

*Check varieties.

Table 25. Sponge cake quality scores of 2016 WQC entries by cooperators

Group	Entry	WMC	WWQL	Mean	STDEV
1	VA10W-119	6	5	5.5	0.7
1	VA11W-106	7	8	7.5	0.7
1	Hilliard*	6	8	7.0	1.4
2	SY 100	7	9	8.0	1.4
2	M11-2024#	8	6	7.0	1.4
2	M11*3144CW	7	8	7.5	0.7
2	Branson*	6	8	7.0	1.4
3	Beck 88AA	7	9	8.0	1.4
3	Beck 114	7	5	6.0	1.4
3	Beck 123	7	8	7.5	0.7
3	Beck 125	7	8	7.5	0.7
3	Beck 128	5	9	7.0	2.8
3	Beck 120*	6	8	7.0	1.4

*Check varieties.

Cooperator Data

ADM Milling Quality Evaluations

Table 26. Solvent retention capacity and sugar-snap cookie baking test parameters by ADM Milling

Group	Entry	Cookie (10-50D)			
		Width (mm)	Thick (mm)	W/T Ratio (mm)	Spread Factor
1	VA10W-119	47.07	5.97	7.88	76.00
1	VA11W-106	49.13	5.43	9.05	87.20
1	Hilliard*	49.47	5.47	9.04	87.20
2	SY 100	52.70	4.90	10.75	104.30
2	M11-2024#	48.10	6.20	7.76	75.20
2	M11*3144CW	51.10	5.30	9.64	93.50
2	Branson*	50.13	5.20	9.64	93.50
3	Beck 88AA	50.83	5.03	10.1	97.40
3	Beck 114	47.63	5.87	8.11	78.20
3	Beck 123	50.37	5.20	9.69	93.40
3	Beck 125	47.97	6.20	7.74	74.60
3	Beck 128	52.50	5.17	10.15	97.90
3	Beck 120*	50.37	5.80	8.68	83.70

*Check varieties.

Table 27. Evaluation comments on flour quality and baked product performance by ADM Milling

		End Product Performance				
		Score: 1 Poor - 9 Excellent				Aditional Comments
Group #	Entry	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119	Cookie		Dry, tough dough, lower spread, low cracks	6	Highest protein of the set
1	VA11W-106	Cookie	Nice spread, tight cracks	Dry, tough dough	8	Similar to the check
1	Hilliard*	Cookie	Nice spread, tight cracks	Dry dough	8	
2	SY 100	Cookie	Good dough, large spread	Excess deep cracks	6	Lowest protein in the set
2	M11-2024#	Cookie		Slightly dry dough, lower spread, low cracks	6	Highest protein in set
2	M11*3144CW	Cookie	Good dough, nice spread, deep/tight cracks		8	Very similar to the check
2	Branson*	Cookie	Good dough, nice spread, deep/tight cracks		8	Same as M11*3144CW
3	Beck 88AA	Cookie	Good dough, tight cracks, large spread		7	
3	Beck 114	Cookie		Dry dough, lower spread, low cracks	6	Highest falling number in set & overall
3	Beck 123	Cookie	Good dough, deep cracks, nice spread		8	
3	Beck 125	Cookie		Dry dough, lower spread, low cracks	6	
3	Beck 128	Cookie	Good dough, large spread	Deep, wide cracks	7	Lowest protein in this set & overall
3	Beck 120*	Cookie	Good dough, deep cracks, avg. spread		8	Similar to Beck's 123 but smaller spread

*Check varieties.

AgriPro/Syngenta Quality Evaluations

Table 28. Solvent retention capacity and cookie baking test parameters by AgriPro

Group	Entry	Solvent Retention Capacity (%)				Cookie (10-52)	
		Water	Sodium Carbonate	Sucrose	Lactic Acid	Width (cm)	Score
1	VA10W-119	55	72	96	104	17.8	3.0
1	VA11W-106	54	74	99	108	18.4	7.0
1	Hilliard*	57	75	98	112	18.4	7.0
2	SY 100	52	68	83	95	19.3	9
2	M11-2024#	53	69	90	77	17.6	3
2	M11*3144CW	50	65	81	101	18.9	8
2	Branson*	52	70	89	109	18.7	8
3	Beck 88AA	52	68	86	106	18.8	8
3	Beck 114	55	73	98	103	17.2	2
3	Beck 123	53	69	87	101	18.6	8
3	Beck 125	55	72	92	104	17.4	2
3	Beck 128	52	66	79	78	19.8	9
3	Beck 120*	52	68	84	92	18.6	8

*Check varieties.

Table 29. Evaluation comments on flour quality and baked product performance by AgriPro/Syngenta

Group	Entry	Analytical Flour Qualities				End Product Performance				Aditional Comments
		Score: 1 Poor - 9 Excellent				Score: 1 Poor - 9 Excellent				
		Likes	Dislikes	Basis	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119		Ash		6	Cookie 10-52		Poorer TG	3	Baked worse than Check
1	VA11W-106	Protein	sl hi SC,SUC	SRC	5	Cookie 10-52	Good Spread & TG		7	
1	Hilliard*	Protein	Sl Hi H2O,SC,SUC	SRC	4	Cookie 10-52	Good Spread & TG		7	Worse SRC of 2016, but baked ok
2	SY 100	Vlow prot, Exc SRC profiles		SRC	7	Cookie 10-52	Excellent cookie		9	Overall excellent cookie flour
2	M11-2024#	low ash/LA/SC	highest prot of set, but good	SRC	6	Cookie 10-52		Poorer TG	3	perfomed worse than Check
2	M11*3144CW	Exc ash, low H2O,SC,SUC		SRC	7	Cookie 10-52	Good Spread, Vgood TG		8	Vgood cookie flour
2	Branson*	protein, H2O,SUC		SRC	6	Cookie 10-52	Good Spread, Vgood TG		8	
3	Beck 88AA	Good H2O, SC, SUC		SRC	7	Cookie 10-52	Good Spread, Vgood TG		8	Vgood cookie flour
3	Beck 114	protein	sl higher H2O,SC,SUC	SRC	4	Cookie 10-52		Smaller, Poorer TG	2	Worse Cookie of 2016
3	Beck 123	protein			7	Cookie 10-52	Good Spread, Vgood TG		8	
3	Beck 125	protein, ash	sl higher H2O	SRC	5	Cookie 10-52		Smaller, Poorer TG	2	
3	Beck 128	Vlow prot, Exc SRC profiles		SRC	8	Cookie 10-52	Excellent cookie		9	Overall excellent cookie flour
3	Beck 120*	Exc SRC profiles, low Ash		SRC	8	Cookie 10-52	Good Spread, Vgood TG		8	Vgood cookie flour

*Check varieties.

Ardent Mills Quality Evaluations

Table 30. Solvent retention capacity and cookie baking test parameters by Ardent Mills

Group	Entry	Solvent retention capacity				Cookies (10-50D)				Alveograph				
		Water	Sodium Carbonate	Sucrose	Lactic Acid	Width (mm)	Thick (mm)	W/T Ratio (mm)	Spread Factor	P	L	W	P/L	le
1	VA10W-119	56	75	105	117	456.5	45.0	10.1	86.3	74	58	147	1.28	43.8
1	VA11W-106					482.5	45.0	10.7	91.2	56	57	100	0.98	38.1
1	Hilliard*					480.0	43.5	11.0	93.9	82	38	112	2.16	
2	SY 100	52	70	89	99	495.0	42.0	11.8	100.3	40	62	78	0.65	40.7
2	M11-2024#	54	73	97	84	465.0	46.0	10.1	86.0					
2	M11*3144CW	51	66	85	107	485.5	40.0	12.1	103.3					
2	Branson*					490.0	41.0	12.0	101.7	44	82	106	0.54	43.7
3	Beck 88AA	51	70	91	108	486.0	39.0	12.5	106.0					
3	Beck 114	56	74	107	114	469.5	42.5	11.0	94.0	76	52	134	1.46	39.6
3	Beck 123	52	69	93	107	484.0	43.0	11.3	95.8					
3	Beck 125	53	74	98	110	461.0	47.0	9.8	83.5					
3	Beck 128	53	69	85	81	495.0	42.0	11.8	100.3					
3	Beck 120*	50	69	89	97	479.0	42.5	11.3	95.9					

*Check varieties.

Table 31. Evaluation comments on flour quality and baked product performance by Ardent Mills

Group	Entry	Analytical Flour Quality				End Product Performance				
		Score: 1 Poor - 9 Excellent				Score: 1 Poor - 9 Excellent				Aditional Comments
		Likes	Dislikes	Basis	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119	Y		Protein	8	Cookies	Y		8	Cookies or Crackers
1	VA11W-106	Y		Alveograph	7	Cookies	Y		6	Cookie or Crackers
1	Hilliard*		Y	Alveograph	6	Cookies		Y	6	Cakes
2	SY 100		Y	Protein	6	Cookies	Y			Biscuits, Protein too low
2	M11-2024#	Y		Protein and SRC	8	Cookies	Y		8	Cookies
2	M11*3144CW	Y		SRC	8	Cookies	Y		7	
2	Branson*	Y		Alveograph	7	Cookies	Y		7	Bisccuits
3	Beck 88AA	Y		SRC	7	Cookies	Y		7	
3	Beck 114		Y	SRC and Alveograph	6	Cookies	Y		6	Cakes
3	Beck 123	Y			7	Cookies	Y		7	
3	Beck 125	Y			6	Cookies	Y		8	
3	Beck 128		Y	Protein and SRC	5	Cookies		Y	5	Protein too low
3	Beck 120*	Y		SRC	6	Cookies		Y	6	

*Check varieties.

Kellogg Quality Evaluations

Table 32. Solvent retention capacity and alveograph parameters by Kellogg

Group	Entry	Solvent retention capacity (%)				Alveograph				
		Water	Sodium Carbonate	Sucrose	Lactic Acid	P	L	P/L	le	W
1	VA10W-119	49	67	84	106	51	65	0.78	53.0	85
1	VA11W-106	47	69	83	109	37	61	0.61	44.6	57
1	Hilliard*	48	71	83	114	49	51	0.96	46.2	77
2	SY 100	46	63	73	96	25	58	0.43	45.2	39
2	M11-2024#	48	65	81	81	40	47	0.85	26.4	52
2	M11*3144CW	46	60	69	103	27	103	0.26	55.7	46
2	Branson*	46	66	74	109	30	104	0.29	47.9	47
3	Beck 88AA	46	65	72	107	30	90	0.33	47.5	47
3	Beck 114	50	69	83	104	52	49	1.06	46.2	82
3	Beck 123	48	65	74	101	34	41	0.83	49.9	55
3	Beck 125	50	68	78	108	49	56	0.88	42.0	75
3	Beck 128	48	64	69	81	21	66	0.32	35.1	30
3	Beck 120*	46	63	72	95	25	90	0.28	41.8	38

*Check varieties.

Table 33. Farinograph and rapid visco-analyzer parameters by Kellogg

Group	Entry	Farinograph				Rapid Visco-Analyzer							
		Water Absorp-tion (%)	Develop-ment Time (min)	Stability (min)	Degree of Softening	Peak Time (min)	Peak (cP)	Trough (cP)	Break -down (cP)	Setback (cP)	Final (cP)	Pasting Temp (°C)	Peak/ Final Ratio
1	VA10W-119	52.6	1.2	2.2	97	6.2	2916	1932	983	-695	3396	63.8	0.86
1	VA11W-106	50.3	1.3	2.8	85	6.1	2952	1944	1008	-778	3564	64.5	0.83
1	Hilliard*	52.0	1.2	1.7	115	6.2	3132	2184	953	-676	3816	64.4	0.82
2	SY 100	48.5	0.8	1	159	6.1	3060	1944	1121	-847	3444	65.4	0.89
2	M11-2024#	54.2	1.3	2.2	125	6.2	2748	1896	852	-579	3336	62.7	0.82
2	M11*3144CW	49.6	0.7	1.6	135	6.1	2496	1620	884	-650	2880	65.3	0.87
2	Branson*	49.7	0.1	2	114	6.1	3252	2076	1186	-864	3612	64.4	0.90
3	Beck 88AA	50.4	1	2.2	100	6.1	3252	1956	1302	-1016	3408	64.4	0.95
3	Beck 114	52.5	1.2	2.6	80	6.1	2904	1800	1102	-804	3168	63.8	0.92
3	Beck 123	50.2	0.9	1.3	143	6.1	3060	1836	1213	-887	3180	65.3	0.96
3	Beck 125	53.8	0.9	2.5	92	5.9	2628	1596	1037	-866	3000	63.5	0.88
3	Beck 128	48.1	0.8	1.1	156	5.9	2856	1728	1131	-919	3240	64.4	0.88
3	Beck 120*	51.1	1	1.6	126	5.9	2772	1740	1031	-864	3252	63.7	0.85

*Check varieties.

Table 34. Evaluation comments on analytical flour quality by Kellogg

Group	Entry	Analytical Flour Qualities					Aditional Comments
		Score: 1 Poor - 9 Excellent					
		Likes	Dislikes	Basis	Score		Mitigating, Physical/Chemical Properties
1	VA10W-119	Higher protein than CK, similar SRC-LA		Protein content and quality	8		Flour functionality measurements are similar to the CK sample. Slightly higher dough elasticity Ie may affect cookie spread and cracker snap back.
1	VA11W-106	Reseasonable SRC-LA		protein and dough properties	7		
1	Hilliard*						
2	SY 100		Protein is too low, even though SRC-LA still okay	Based on cookies and cracker flour functionality	2		
2	M11-2024#	Higher protein than CK	SRC-LA lower than CK, dough elasticity is low.	Based on cookies and cracker flour functionality	5		
2	M11*3144CW	Fairly good gluten quality		Cookie and cracker flour quality	8		Higher elasticity might be a concern for cracker dough / risk of dough sheet snap back.
2	Branson*						
3	Beck 88AA	Similar to CK sample		Cookie/cracker flour functionality	7		
3	Beck 114	Similar to CK sample		"	7		
3	Beck 123	Similar to CK sample		"	7		
3	Beck 125	Similar to CK sample		"	7		
3	Beck 128		Low protein and low gluten quality	"	1		Lack of dough strengh and elasticity
3	Beck 120*						

*Check varieties.

Limagrain Cereal Seeds Quality Evaluations

Table 35. Solvent retention capacity and cookie baking test parameters by Limagrain Cereal Seeds

		Solvent retention capacity (%)				Cookies (10-52)			
Group	Entry	Water	Sodium Carb	Sucrose	Lactic Acid	Width (cm)	Thick (cm)	Crust	Score
1	VA10W-119	57.6	77.9	100.1	107.5	8.9	0.627	2	4
1	VA11W-106	55.0	77.6	104.6	110.9	9.1	0.529	2	7
1	Hilliard*	55.3	79.1	104.9	116.7	9.0	0.687	2	4
2	SY 100	54.4	70.3	88.9	101.4	9.2	0.523	2	7
2	M11-2024#	56.1	74.9	100.0	84.9	8.8	0.702	2	4
2	M11*3144CW	51.8	68.5	88.5	112.0	9.2	0.521	2	7
2	Branson*	53.6	74.3	95.5	118.2	9.1	0.563	2	6
3	Beck 88AA	53.5	72.4	92.6	112.4	9.0	0.579	2	6
3	Beck 114	57.3	77.3	107.3	114.5	8.8	0.74	2	4
3	Beck 123	55.3	72.5	93.8	109.2	9.2	0.57	3	7
3	Beck 125	58.1	75.6	98.2	110.9	8.7	0.657	2	4
3	Beck 128	54.7	69.4	85.6	85.0	9.2	0.503	3	8
3	Beck 120*	53.6	70.8	90.1	92.3	9.3	0.572	3	7

*Check varieties.

Table 36. Evaluation comments on analytical flour quality by Limagrain Cereal Seeds

Group	Entry	Analytical Flour Qualities			End Product Performance			Aditional Comments
		Score: 1 Poor - 9 Excellent			Score: 1 Poor - 9 Excellent			
		Likes	Dislikes	Score	Product	Likes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119			2	10-52.02 cookie		4	higher flour protein and ash
1	VA11W-106			2	10-52.02 cookie		7	good FN and cookie thickness
1	Hilliard*			2	10-52.02 cookie		4	Good LA
2	SY 100	Good SRC Sucrose		5	10-52.02 cookie		7	under 350 FN and performed/good cookie width
2	M11-2024#		Low LA SRC	2	10-52.02 cookie		4	higher flour protein low cookie width
2	M11*3144CW	good overall SRC		5	10-52.02 cookie		7	under 350 FN and performed/good cookie width
2	Branson*			3	10-52.02 cookie		6	overall good
3	Beck 88AA	good overall SRC		3	10-52.02 cookie		6	overall good
3	Beck 114			1	10-52.02 cookie		4	highest FN- poor cookie width,
3	Beck 123			3	10-52.02 cookie	Crust	7	under 350 FN and performed/good cookie width
3	Beck 125			2	10-52.02 cookie		4	did not perform/lower cookie width under 350 FN
3	Beck 128	Good SRC Sucrose	Low LA SRC	5	10-52.02 cookie	Crust	8	under 350 FN and performed/good cookie width very low pro
3	Beck 120*	Good SRC Sucrose	Low LA SRC	5	10-52.02 cookie	Crust	7	very good excluding SRC LA

Mennel Milling Quality Evaluations

Table 37. Solvent retention capacity and Farinograph test parameters by Mennel Milling

Group	Entry	Solvent retention capacity (%)				Farinograph			
		Water	Sodium Carb	Sucrose	Lactic Acid	Water Absorp (min)	Develop Time (min)	Stability (min)	Degree of Softening
1	VA10W-119	57.12	74.73	101.44	115.1	55.2	0.87	1.71	97
1	VA11W-106	55.45	77.59	106.95	110.56	52.7	0.75	1.77	103
1	Hilliard*	55.62	77.63	103.47	117.61	53.6	0.71	1.53	94
2	SY 100	52.11	69.15	87.75	102.92	50.7	0.53	1.13	157
2	M11-2024#	54.64	71.79	96.68	83.61	56	1.65	2.71	126
2	M11*3144CW	50.54	67	85.74	112.2	51.2	0.5	1.27	89
2	Branson*	53.76	73.09	94.86	118.96	51.2	0.83	2.92	76
3	Beck 88AA	53.85	70.22	89.22	109.78	52.8	0.71	1.49	109
3	Beck 114	55.49	77.97	103.56	113.95	55.4	0.74	1.18	139
3	Beck 123	53.32	69.37	90.22	106.86	52.5	0.56	1.15	142
3	Beck 125	57.94	74.69	96.21	108.95	56.3	0.71	1.52	90
3	Beck 128	55.9	68.21	84.9	84.06	50.4	0.49	0.87	168
3	Beck 120*	52.93	69.84	88.12	94.46	53.7	0.43	1.09	142

*Check varieties.

Table 38. Sugar-snap cookie baking test (10-50D) parameters by Mennel Milling

		Cookies (10-50D)				Biscuit		
Group	Entry	Width (mm)	Thick (mm)	W/T Ratio (mm)	Spread Factor	Width (mm)	Height (mm)	Weight (g)
1	VA10W-119	488	62	7.9	77	252	204	133
1	VA11W-106	530	55	9.6	94	262	204	129
1	Hilliard*	513	59	8.7	86	262	205	130
2	SY 100	533	51	10.5	103	267	184	122
2	M11-2024#	499	62	8.1	49	255	208	129
2	M11*3144CW	528	55	9.6	94	266	205	131
2	Branson*	526	57	9.3	91	264	207	129
3	Beck 88AA	534	53	10.0	98	260	214	131
3	Beck 114	495	60	8.2	81	256	195	128
3	Beck 123	524	55	9.5	93	266	196	129
3	Beck 125	498	64	7.8	77	262	198	129
3	Beck 128	546	51	10.8	106	277	186	127
3	Beck 120*	518	56	9.2	90	263	215	129

*Check varieties.

Table 39. Rapid Visco-Analyzer parameters by Mennel Milling

Group	Entry	Peak Time (min)	Peak (cP)	Trough (cP)	Break-down (cP)	Setback (cP)	Final (cP)	Pasting Temp. (°C)	Peak/Final Ratio
1	VA10W-119	6.2	3151	2100	1051	1581	3681	85.9	0.86
1	VA11W-106	6.1	3201	2145	1056	1684	3829	84.9	0.84
1	Hilliard*	6.2	3381	2361	1020	1743	4104	84.0	0.82
2	SY 100	6.1	3328	2097	1231	1612	3709	82.5	0.90
2	M11-2024#	6.3	3145	2235	910	1579	3814	85.6	0.82
2	M11*3144CW	6.2	2998	1976	1022	1556	3532	84.9	0.85
2	Branson*	6.1	3515	2226	1289	1678	3904	83.9	0.90
3	Beck 88AA	6.1	3479	2048	1431	1542	3590	79.1	0.97
3	Beck 114	6.2	3184	1993	1191	1516	3509	85.9	0.91
3	Beck 123	6.2	3363	2027	1336	1420	3447	84.2	0.98
3	Beck 125	6.0	2934	1769	1165	1516	3285	85.1	0.89
3	Beck 128	6.0	3124	1881	1243	1587	3470	70.3	0.90
3	Beck 120*	6.0	2979	1910	1069	1594	3504	84.0	0.85

*Check varieties.

Table 40. Evaluation comments on flour quality and baked product performance by Mennel Milling

Group	Entry	Analytical Flour Qualities			End Product Performance				
		Score: 1 Poor - 9 Excellent			Score: 1 Poor - 9 Excellent				Aditional Comments
		Likes	Dislikes	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119	High LA- highest abs.		7	cookies		Low S.F.	4	Biscuit - Lighter crust color
1	VA11W-106	High LA		7	cookies	Best S.F and Crust		7	Biscuit- compared close to the check- Larger in vol
1	Hilliard*	High LA		8	cookies	Good crust and average SF		6	Biscuit - Good vol and color
2	SY 100	Good LA	Lowest Abs	6	cookies	Best S.F and Crust of the set		8	Biscuit- Lighter crust color than the check
2	M11-2024#	High absopt	low LA	4	cookies		low crust score +lowest SF of all the sets	4	Biscuit-A darker crust.
2	M11*3144CW	high L.A.-	low abs	7	cookies	Better SF than the control		7	Biscuit-Better than the check
2	Branson*	High LA- good stab	low abs	8	cookies	Good SF		6	Biscuit- Good vol and color
3	Beck 88AA	High LA		7	cookies	Better SF and crust than the control		7	Biscuit- Close to the height of the check- Crust better than the check
3	Beck 114	High LA- High Abs		7	cookies		low S.F. and crust score	5	Biscuit- a lot of separation in the biscuit. Smallest width.
3	Beck 123	High LA		6	cookies	Better SF and crust than the control		7	Biscuit- Lower height than the check
3	Beck 125	High LA- highest abs.		6	cookies		low S.F. and crust score	4	Biscuit- compared close to the check- Larger in vol
3	Beck 128	Low LA	low abs- low stab	4	cookies	Best S.F + crust score of all the set		9	Biscuit- largest width but low on height- light crust color
3	Beck 120*	Low LA		5	cookies	Good SF and crust		6	Biscuit- Largest height. Dark Crust color

Mondelez Quality Evaluations

Table 41. Solvent retention capacity and wire-cut cookie evaluation parameters by Mondelez

Group	Entry	Solvent Retention Capacity (%)*					Wire-cut Cookie Evaluation (AACC 10-53)				
		Water	Sodium Carbonate	Sucrose	Lactic Acid	GPI	Dough Firmness (g)	Cookie Stack Ht (cm x4)	Cookie Width (cm x4)	Cookie Length (cm x4)	Final Moisture %
1	VA10W-119	55.0	79.9	104.6	112.6	0.61	156	4.7	28.0	29.2	3.0
1	VA11W-106	57.3	80.1	105.9	98.1	0.53	194	4.0	30.3	31.1	4.0
1	Hilliard*	56.9	81.2	105.6	106.7	0.57	189	4.4	29.6	30.2	4.6
2	SY 100	45.2	77.1	92.2	75.6	0.45	146	4.0	32.7	34.2	3.0
2	M11-2024#	54.2	72.5	89.5	94.4	0.58	181	4.3	29.1	30.5	3.8
2	M11*3144CW	50.2	73.2	88.9	101.7	0.63	139	4.1	31.5	32.5	3.4
2	Branson*						156	4.0	31.4	32.5	3.3
		54.0	79.4	99.6	108.8	0.61					
3	Beck 88AA	54.4	77.1	103.5	100.7	0.56	159	4.0	31.7	33.1	3.5
3	Beck 114	57.5	84.4	104.8	113.0	0.60	191	4.5	29.2	31.0	4.5
3	Beck 123	55.1	75.6	97.5	106.0	0.61	169	4.2	31.2	32.5	3.8
3	Beck 125	55.7	79.2	100.4	100.0	0.56	227	4.8	29.5	31.2	4.6
3	Beck 128	55.3	71.8	85.8	77.6	0.49	142	4.0	33.0	33.7	3.3
3	Beck 120*	52.4	76.0	94.4	80.5	0.47	148	4.4	31.1	31.7	4.1
	Target							<4.1	>31	>30	
	Internal Ref						120	4	31.3	32	3.4

*Check varieties.

Table 42. Evaluation comments on flour and end product quality characteristics by Mondelez

Group	Entry	**Analytical Flour Qualities**					**End Product Performance**			
		Score: 1 Poor - 9 Excellent					Score: 1 Poor - 9 Excellent			
		Likes and Dislikes		Basis	Score		Product	Likes	Dislikes	Score
1	VA10W-119	Low ash and protein	Very good gluten potential, too high pentosans, high damaged starch	SRC/Ash	6		Cookie	Low dough firmness	Performed not better than the check, too high stack height, not suitable for cookies and crackers	5
1	VA11W-106	Low ash and protein	Good gluten potential, too high pentosans, high damaged starch	SRC/Ash	6		Cookie		High dough firmness, performed better than other two, marginal quality for cookies	7
1	Hilliard*	Low ash and protein	Good gluten potential, too high pentosans, high damaged starch	SRC/Ash	6		Cookie		High dough firmness, small cookie diameter, high stack height, not suitable for cookies and crackers	6
2	SY 100	Low ash and protein	Low water absorption, least gluten potential, high damaged starch	SRC/Ash	4		Cookie	Low dough firmness	Large cookie diameter, rough surface, marginal quality for cookies, not suitable for crackers	6
2	M11-2024#	Low ash and protein	Low gluten potential	SRC/Ash	6		Cookie		High dough firmness, small cookie diameter, high stack height, poor quality for cookies, not suitable for cookies and crackers	4
2	M11*3144CW	Low ash and protein	Good gluten potential	SRC/Ash	8		Cookie	Low dough firmness	Good baking performance, suitable for cookies and crackers	8
2	Branson*	Low ash and protein	Good gluten potential, high pentosans and damaged starch	SRC/Ash	7		Cookie	Low dough firmness	Good baking performance, suitable for cookies and crackers	8
3	Beck 88AA	Low ash and protein	Good gluten potential, too high pentosans, high damaged starch	SRC/Ash	6		Cookie	Low dough firmness	Good baking performance, suitable for cookies and crackers	8
3	Beck 114	Low ash and protein	Very good gluten potential, too high pentosans and damaged starch	SRC/Ash	6		Cookie		Small cookie diameter, high stack height, not suitable for cookies and crackers	4
3	Beck 123	Low ash and protein	Good gluten potential, high pentosans and damaged starch	SRC/Ash	7		Cookie	Low dough firmness	High stack height, Good baking performance, suitable for cookies and crackers	6
3	Beck 125	Low ash and protein	Good gluten potential, high pentosans and damaged starch	SRC/Ash	6		Cookie		High dough firmness, small cookie diameter, high stack height, poor quality for cookies, not suitable for cookies and crackers	4
3	Beck 128	Lowest protein	Low gluten potential	SRC/Ash	5		Cookie	Low dough firmness	Large cookie diameter, rough surface, marginal quality for cookies, not suitable for crackers	7
3	Beck 120*	Low ash and protein	Low gluten potential, high pentosans and damaged starch	SRC/Ash	5		Cookie	Low dough firmness	High stack height, poor quality for cookies, not suitable for cookies and crackers	4

Siemer Milling Quality Evaluations

Table 43. Alveograph test parameters by Siemer Milling

Group	Entry	Alveograph			
		P mm	L mm	P/L Ratio	W joules
1	VA10W-119	77	60	1.28	195
1	VA11W-106	58	97	0.60	170
1	Hilliard*	58	59	0.99	134
2	SY 100	41	67	0.61	105
2	M11-2024#	52	56	0.93	86
2	M11*3144CW	32	86	0.37	109
2	Branson*	36	108	0.33	116
3	Beck 88AA	44	97	0.46	137
3	Beck 114	76	53	1.44	150
3	Beck 123	66	55	1.20	152
3	Beck 125	73	61	1.21	167
3	Beck 128	24	55	0.44	46
3	Beck 120*	31	87	0.36	86

*Check varieties.

Table 44. Evaluation comments on alveograph dough test by Siemer Milling

Group	Entry	Analytical Flour Qualities					Aditional Comments
		Score: 1 Poor - 9 Excellent					
		Likes	Dislikes	Basis	Score		Mitigating, Physical/Chemical Properties
1	VA10W-119			Alveo	2		Very strong flour in relation to the alveo. W= 195.3 (Protein though is normal for SWF - 8.1)
1	VA11W-106			Alveo	6		Strong flour in relation to the alveo. (Lower protein though- 7.4)
1	Hilliard*			Alveo	5		Another strong flour in relation to the alveo.- short extensibility (Lower protein- 7.1)
							The dough characteristics for this whole set were normal- not stiff- as would appear in stronger flours.
2	SY 100			Alveo	8		Protein low- 6.3
2	M11-2024#			Alveo	6		Higher peaks- no extensibility - Dough a little stiff.
2	M11*3144CW			Alveo	7		Dough soft.
2	Branson*			Alveo	9		Normal alveo except length a little longer
3	Beck 88AA			Alveo	9		Normal alveo. for SWF.
3	Beck 114			Alveo	4		Strong flour- in relation to the alveo. - no extensibility- slightly stiff dough. Protein only 7.3
3	Beck 123			Alveo	5		Strong flour- in relation to the alveo.- dough somewhat stiff- in regards to the protein at 7.0
3	Beck 125			Alveo	5		Strong flour- in relation to the alveo.- dough a little stiff
3	Beck 128			Alveo	3		Dough soft- slightly sticky- protein low- 5.8 (W only 46.1)
3	Beck 120*			Alveo	9		Normal alveo. for SWF

Star of the West Milling Evaluations

Table 45. Solvent retention capacity, cookie baking test and amyloviscograph test parameters by Star of the West Milling

Group	Entry	Solvent retention capacity (%)					Cookies (10-50D)				Amylograph (BU)
		Water	Sodium Carbonate	Sucrose	Lactic Acid	LA/SC+S	Width (mm)	Thick (mm)	W/T Ratio (mm)	Top grain score	
1	VA10W-119	53.6	74.3	96.9	113.0	0.66	495	59	8.4	3	606
1	VA11W-106	53.4	75.5	104.1	102.1	0.57	498	54	9.2	6	747
1	Hilliard*	54.7	76.3	100.7	110.0	0.62	507	55	9.2	3	819
2	SY 100	51.9	68.1	86.9	97.7	0.63	535	45	11.9	8	790
2	M11-2024#	51.4	71.6	96.0	80.0	0.48	479	60	8.0	5	661
2	M11*3144CW	49.3	65.8	84.4	104.5	0.70	518	52	10.0	6	611
2	Branson*	51.0	71.1	90.9	112.9	0.70	514	51	10.1	7	796
3	Beck 88AA	50.8	69.2	88.1	105.0	0.67	525	51	10.3	6	798
3	Beck 114	54.3	73.9	101.3	110.5	0.63	490	58	8.5	4	636
3	Beck 123	52.3	67.6	90.2	105.7	0.67	520	54	9.7	7	702
3	Beck 125	53.6	72.8	93.3	104.8	0.63	487	60	8.1	4	552
3	Beck 128	53.1	67.3	82.4	81.1	0.54	528	49	10.9	9	684
3	Beck 120*	50.9	68.3	87.3	88.1	0.57	523	58	9.0	5	628

*Check varieties.

Table 46. Rapid Visco-Analyzer parameters by Star of the West Milling

Group	Entry	Peak Time (min)	Peak (cP)	Trough (cP)	Break-down (cP)	Setback (cP)	Final (cP)	Pasting Temp (°C)	Peak/Final Ratio
1	VA10W-119	6	3026	1932	1094	1546	3478	85.5	0.87
1	VA11W-106	6	3063	2009	1054	1675	3684	73.4	0.83
1	Hilliard*	6	3358	2273	1085	1842	4115	83.0	0.82
2	SY 100	6	3341	1993	1348	1625	3618	80.7	0.92
2	M11-2024#	6	3004	2048	956	1595	3643	84.7	0.82
2	M11*3144CW	6	2881	1845	1036	1487	3332	84.8	0.86
2	Branson*	6	3346	2057	1289	1622	3679	83.8	0.91
3	Beck 88AA	6	3346	1887	1459	1505	3392	70.2	0.99
3	Beck 114	6	2989	1783	1206	1467	3250	82.2	0.92
3	Beck 123	6	3179	1848	1331	1374	3222	68.7	0.99
3	Beck 125	6	2714	1566	1148	1427	2993	83.1	0.91
3	Beck 128	6	2995	1717	1278	1554	3271	69.5	0.92
3	Beck 120*	6	2830	1790	1111	1537	3256	83.0	0.87

*Check varieties.

Table 47. Evaluation comments on flour quality and baked product performance by Star of the West Milling

Group	Entry	Analytical Flour Qualities				End Product Performance				Additional Comments
		Score: 1 Poor - 9 Excellent				Score: 1 Poor - 9 Excellent				
		Likes	Dislikes	Basis	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119	Higher protein, good SRC profile			8	Sugar snap Cookie			6	slightly better than check
1	VA11W-106		High Sucrose SRC		6	Sugar snap Cookie	most distinct top pattern of set		8	slightly worse than check-strength is borderline for cracker production
1	Hilliard*	Very high Amylograph	higher sodium carbonate		7	Sugar snap Cookie			7	All three in the set could be viable varieties
2	SY 100		Very low protein		5	Sugar snap Cookie	Very distinct top pattern		7	
2	M11-2024#		Low lactic SRC		6	Sugar snap Cookie		tight cookies	6	low gluten functionality-would not be good for crackers
2	M11*3144CW	Low water SRC, good overall SRC			9	Sugar snap Cookie			8	Slightly better than check
2	Branson*	Good SRC profile			8	Sugar snap Cookie			8	
3	Beck 88AA	Good overall SRC profile		SRC	9	Sugar snap Cookie	good spread		8	Best sample in set good cookies, should be good for most products
3	Beck 114	High lactic SRC	High Sucrose and water SRC		6	Sugar snap Cookie		tight cookies	5	
3	Beck 123	Low sodium carb. Fairly good SRC profile		SRC	8	Sugar snap Cookie			7	A good overall flour
3	Beck 125	Good SRC profile		SRC	7	Sugar snap Cookie		tight cookies-no top pattern	4	
3	Beck 128		very low protein, Low Lactic acid	protein	4	Sugar snap Cookie	very distinct top pattern		9	Protein too low
3	Beck 120*	Good water SRC	Low lactic SRC	src	7	Sugar snap Cookie			7	

Wheat Marketing Center Quality Evaluations

Table 48. Sponge cake baking test parameters by Wheat Marketing Center

Group	Entry	Sponge Cake				
		Volume (ml)	External	Crum Grain	Texture (g)	Texture Score
1	VA10W-119	1219	13	20	21	54
1	VA11W-106	1251	13	20	21	54
1	Hilliard*	1260	12	19	21	52
2	SY 100	1295	12	20	21	53
2	M11-2024#	1279	12	21	24	57
2	M11*3144CW	1296	13	19	21	53
2	Branson*	1253	12	20	21	53
3	Beck 88AA	1276	12	20	21	53
3	Beck 114	1242	13	21	21	55
3	Beck 123	1288	13	20	21	54
3	Beck 125	1208	13	20	21	54
3	Beck 128	1269	13	19	18	50
3	Beck 120*	1206	13	19	21	53

*Check varieties.

Table 49. Evaluation comments on flour quality and sponge cake baking test performance by Wheat Marketing Center

Group	Entry	Analytical Flour Qualities				End Product Performance				
		Score: 1 Poor - 9 Excellent				Score: 1 Poor - 9 Excellent				Aditional Comments
		Likes	Dislikes	Basis	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119		Higher protein and ash than check	Sponge cake	4	Sponge cake	External and Internal slightly better than check	Smaller volume than check	6	Sponge cake quality similar to check
1	VA11W-106	Similar protein and ash to check		Sponge cake	6	Sponge cake	External and Internal slightly better than check, Good volume		7	Sponge cake quality better than check
1	Hilliard*			Sponge cake	6	Sponge cake			6	
2	SY 100	Lower protein and ash than check		Sponge cake	7	Sponge cake	Same score as check, Bigger volume than check		7	Sponge cake quality better than check
2	M11-2024#	Lower ash than check	Higher protein than check	Sponge cake	6	Sponge cake	Higher texture score than check, Good volume		8	Sponge cake quality better than check
2	M11*3144CW	Lower ash than check		Sponge cake	7	Sponge cake	Same score as check, Bigger volume than check		7	Sponge cake quality better than check
2	Branson*			Sponge cake	6	Sponge cake			6	
3	Beck 88AA		Higher ash than check	Sponge cake	5	Sponge cake	Same score as check, Bigger volume than check		7	Sponge cake quality better than check
3	Beck 114		Higher ash than check	Sponge cake	5	Sponge cake	Better internel score than check, Bigger volume than ckeck		7	Sponge cake quality better than check
3	Beck 123		Higher ash than check	Sponge cake	4	Sponge cake	Similar score to check, Bigger volume than check		7	Sponge cake quality better than check
3	Beck 125		Higher protein and ash than check	Sponge cake	5	Sponge cake	Similar score to check, Bigger volume than check		7	Sponge cake quality better than check
3	Beck 128	Lower protein than check	Higher ash than check	Sponge cake	6	Sponge cake	Bigger volume than check	Harder texture than check	5	Sponge cake quality worse than check
3	Beck 120*				6	Sponge cake			6	

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Table 50. Solvent retention capacity and mixograph test parameters by USDA-ARS Western Wheat Quality laboratory

Group	Entry	Solvent Retention Capacity (%)				Mixograph		Mixograph Mid-point	
		Water	Sodium Carbonate	Sucrose	Lactic Acid	Abs. (%)	Type	Work	Width +2min
1	VA10W-119	56.3	68.1	100.0	114.2	53.4	4M	114.3	8.5
1	VA11W-106	55.1	68.3	105.5	112.3	52.9	2M	70.3	7.5
1	Hilliard*	57.4	69.6	102.4	115.6	52.3	4M	25.6	13.8
2	SY 100	53.3	63.0	87.2	99.8	50.3	5M	116.4	6.4
2	M11-2024#	53.1	63.6	92.0	80.2	54.1	2M	74.4	4.1
2	M11*3144CW	50.7	59.7	84.7	105.7	52.8	5M	127.9	9.9
2	Branson*	52.7	65.6	91.5	115.7	52.0	4M	128.8	8.2
3	Beck 88AA	52.3	63.9	88.1	105.2	52.7	4M	120.0	9.7
3	Beck 114	56.4	67.8	100.7	110.1	53.0	3M	29.4	15.1
3	Beck 123	53.5	62.7	91.0	107.2	52.3	3L	22.4	13.1
3	Beck 125	57.1	65.9	98.2	103.8	54.8	4M	35.0	12.5
3	Beck 128	54.5	62.8	83.7	81.0	52.2	1L	42.5	7.0
3	Beck 120*	53.2	61.6	87.2	89.8	52.7	2M	75.0	8.5

*Check varieties.

Table 51. Sugar-snap cookie and sponge cake baking test parameters by USDA-ARS Western Wheat Quality laboratory

Group	Entry	Cookie (10-52) Width (cm)	Sponge Cake	
			Volume (mL)	Texture Score
1	VA10W-119	9.1	1282	24
1	VA11W-106	9.5	1358	26
1	Hilliard*	9.4	1368	25
2	SY 100	10.0	1395	25
2	M11-2024#	9.1	1330	23
2	M11*3144CW	9.9	1375	26
2	Branson*	9.6	1388	25
3	Beck 88AA	9.8	1378	24
3	Beck 114	9.2	1290	23
3	Beck 123	9.6	1352	24
3	Beck 125	9.6	1322	24
3	Beck 128	10.1	1395	24
3	Beck 120*	9.7	1350	22

*Check varieties.

Table 52. Evaluation comments on flour quality and sponge cake baking performance by USDA-ARS Western Wheat Quality Laboratory

Group	Entry	Analytical Flour Qualities				End Product Performance				
		Score: 1 Poor - 9 Excellent				Score: 1 Poor - 9 Excellent				Aditional Comments
		Likes	Dislikes	Basis	Score	Product	Likes	Dislikes	Score	Mitigating, Physical/Chemical Properties
1	VA10W-119		sucrose high		6	Cookie & Cake	good cake	sl low codi dia	5	good ash & protein
1	VA11W-106		sucrose high		6	Cookie & Cake	good cookie, excellent cake		8	good ash & protein
1	Hilliard*		sucrose SRC high, water SCR sl high		6	Cookie & Cake	good cookie, excellent cake		8	good ash & protein
2	SY 100	very low dough abs, good sucrose			8	Cookie & Cake	excellent cookie, excellent cake		9	good ash & protein
2	M11-2024#				7	Cookie & Cake	excellent cake	sl low codi dia	6	good ash & protein
2	M11*3144CW	good sucrose & carbonate			8	Cookie & Cake	excellent cookie, excellent cake		8	good ash & protein
2	Branson*				7	Cookie & Cake	very good cookie, excellent cake		8	good ash & protein
3	Beck 88AA	good sucrose & carbonate			8	Cookie & Cake	excellent cookie, excellent cake		9	good ash & protein
3	Beck 114				7	Cookie & Cake	cookie sl low dia, good cake		5	good ash & protein
3	Beck 123				7	Cookie & Cake	very good cookie, excellent cake		8	good ash & protein
3	Beck 125		water SRC sl high		6	Cookie & Cake	very good cookie, excellent cake		8	good ash & protein
3	Beck 128	good sucrose & carbonate	protein low for evaluation		8	Cookie & Cake	excellent cookie, excellent cake		9	good ash
3	Beck 120*	good sucrose & carbonate			8	Cookie & Cake	excellent cookie, excellent cake		8	good ash & protein

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Table 53. Solvent retention capacity and cookie baking test parameters by USDA-ARS Soft Wheat Quality Laboratory

Group	Entry	Solvent Retention Capacity (%)				Cookie (10-52)	
		Water	Sodium Carbonate	Sucrose	Lactic Acid	Width (cm)	Top Grain Score
1	VA10W-119	57.9	77.0	91.8	104.6	17.1	3
1	VA11W-106	58.1	75.8	92.4	108.0	18.2	6
1	Hilliard*	59.2	77.5	93.0	110.8	17.7	3
2	SY 100	54.4	70.2	80.4	98.9	18.7	5
2	M11-2024#	57.8	72.9	87.8	81.2	17.4	2
2	M11*3144CW	53.9	69.2	79.7	97.8	18.5	6
2	Branson*	54.6	74.5	85.9	107.0	18.5	4
3	Beck 88AA	54.4	73.0	82.4	101.2	18.2	6
3	Beck 114	59.0	78.8	94.1	101.6	17.6	7
3	Beck 123	56.8	72.8	85.5	98.6	18.6	8
3	Beck 125	58.3	76.0	89.7	102.5	17.8	5
3	Beck 128	56.3	71.6	78.4	82.5	18.8	8
3	Beck 120*	55.6	72.1	82.4	94.4	18.6	8

*Check varieties.

Table 54. Rapid Visco-Analyzer parameters by USDA-ARS Soft Wheat Quality Laboratory

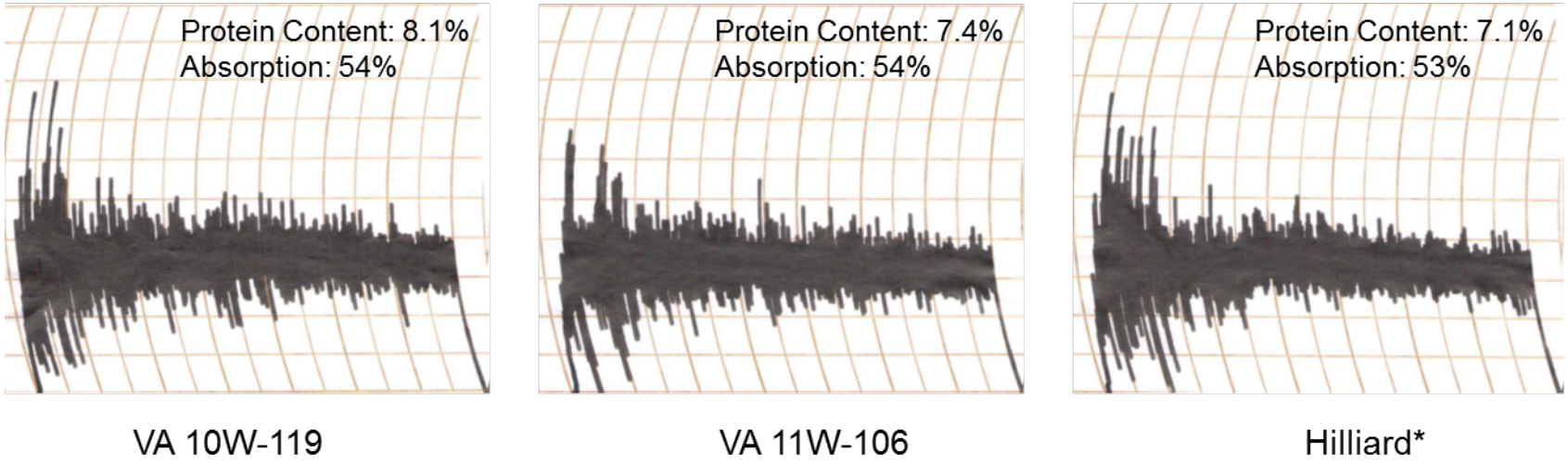
Group	Entry	Peak Time (min)	Peak (cP)	Trough (cP)	Break-down (cP)	Setback (cP)	Final (cP)	Pasting Temperature (°C)	Peak/Final Ratio
1	VA10W-119	6.3	3145	2043	1102	3648	1605	86.8	0.86
1	VA11W-106	6.2	3236	2155	1082	3886	1732	84.7	0.83
1	Hilliard*	6.3	3423	2350	1073	4129	1779	85.6	0.83
2	SY 100	6.1	3307	2033	1274	3651	1618	84.0	0.91
2	M11-2024#	6.3	3123	2163	960	3780	1617	86.7	0.83
2	M11*3144CW	6.3	2952	1927	1026	3460	1534	86.0	0.85
2	Branson*	6.2	3514	2188	1327	3852	1664	84.7	0.91
3	Beck 88AA	6.2	3476	2006	1471	3578	1572	84.0	0.97
3	Beck 114	6.3	3165	1938	1227	3475	1538	69.4	0.91
3	Beck 123	6.3	3398	2008	1390	3452	1444	85.2	0.98
3	Beck 125	6.1	2903	1725	1178	3251	1527	85.1	0.89
3	Beck 128	6.1	3140	1851	1289	3464	1613	71.5	0.91
3	Beck 120*	6.1	3036	1899	1137	3518	1619	84.3	0.86

*Check varieties.

Table 55. Mixograph parameters by USDA-ARS Soft Wheat Quality Laboratory

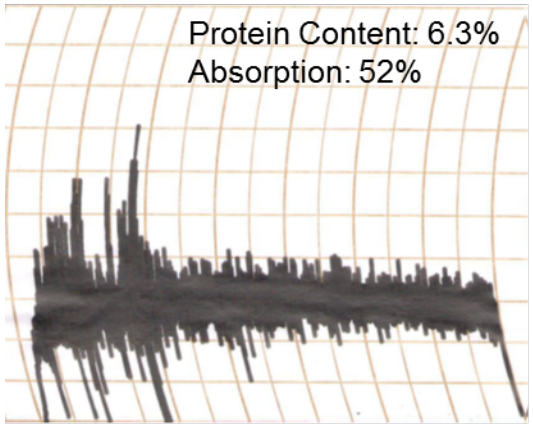
Group	Entry	Mixing Absorption (%)	Peak Time (min)	Peak Value (%)	Peak Width (%)	Width @7min (%)
1	VA10W-119	54.0	0.7	46.8	23.3	9.5
1	VA11W-106	54.0	1.0	43.9	20.8	9.7
1	Hilliard*	53.0	0.7	47.2	26.0	8.1
2	SY 100	52.0	1.7	41.3	21.1	5.7
2	M11-2024#	53.0	0.5	52.2	30.3	4.2
2	M11*3144CW	52.0	0.7	41.4	21.1	8.5
2	Branson*	52.0	0.8	45.3	24.2	8.7
3	Beck 88AA	53.0	0.6	42.0	23.4	7.2
3	Beck 114	54.5	0.8	41.2	16.0	9.5
3	Beck 123	54.0	0.7	38.2	20.3	10.3
3	Beck 125	55.0	1.2	45.2	23.4	7.8
3	Beck 128	52.0	0.8	51.8	35.3	6.3
3	Beck 120*	53.0	1.2	40.3	15.5	6.8

*Check varieties.

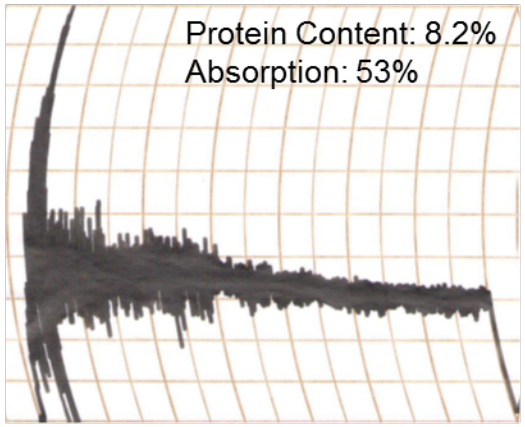


*Check varieties.

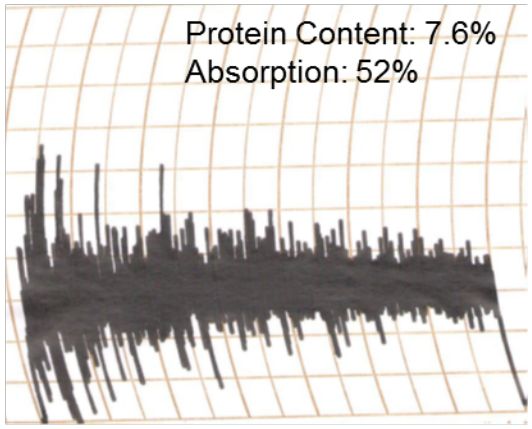
Figure 8. Mixograms of the WQC 2016 Crop Entries from Virginia Polytechnic Institute and State University performed by USDA-ARS Soft Wheat Quality Laboratory.



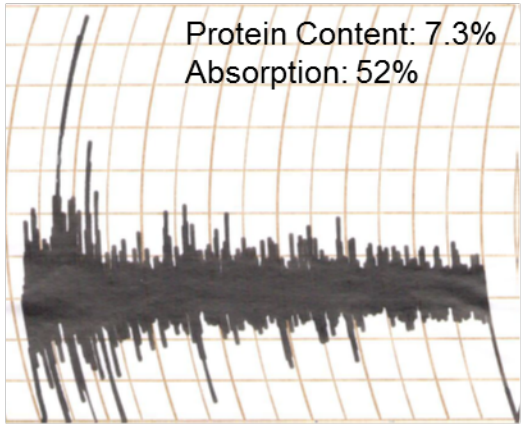
SY 100



M11-2024#



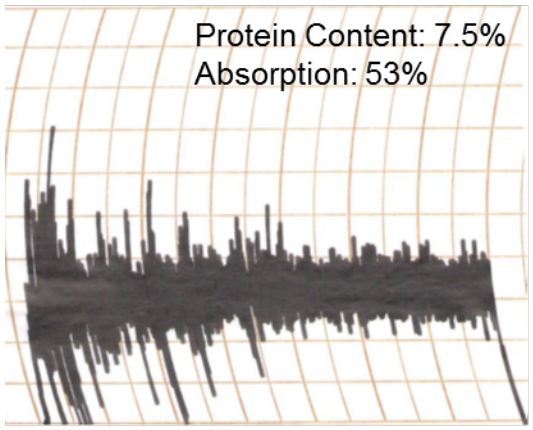
M11*3144CW



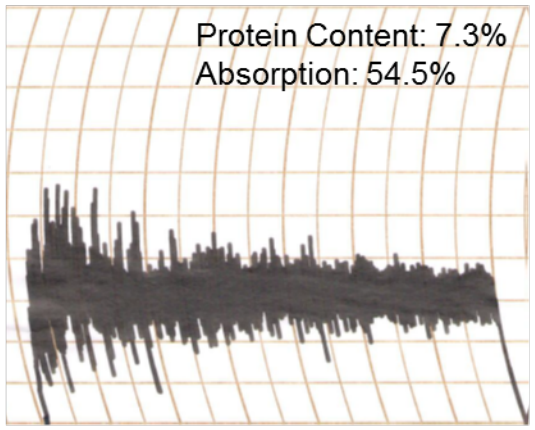
Branson*

*Check varieties.

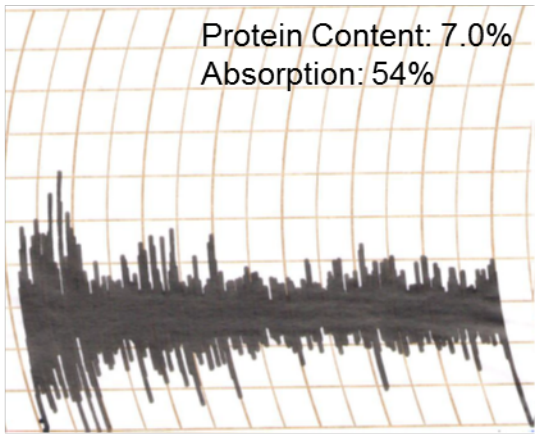
Figure 9. Mixograms of the WQC 2016 crop entries from AgriPro/Syngenta performed by USDA-ARS Soft Wheat Quality Laboratory.



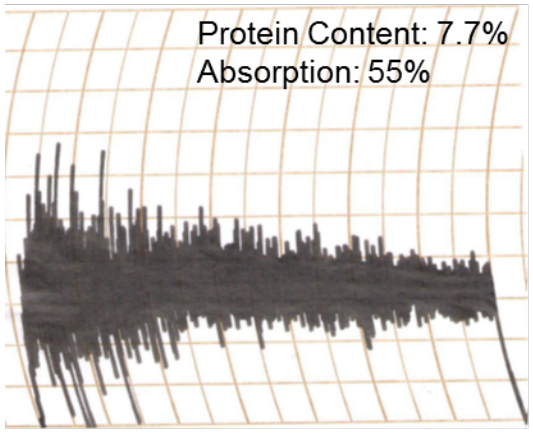
Beck 88AA



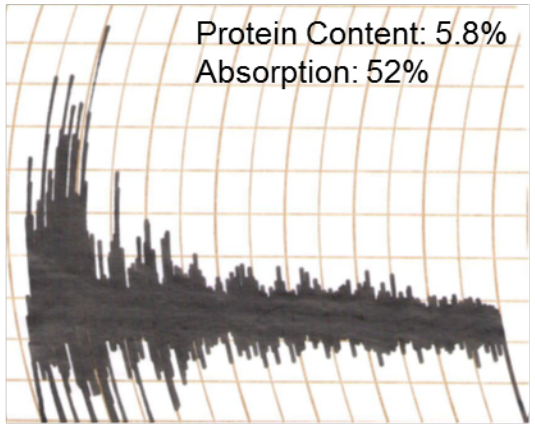
Beck 114



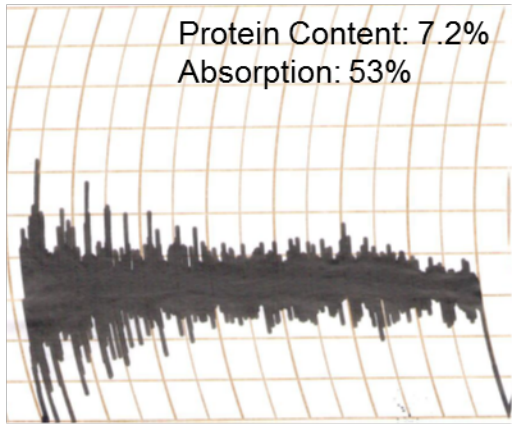
Beck 123



Beck 125



Beck 128



Beck 120*

*Check varieties.

Figure 10. Mixograms of the WQC 2016 crop entries from Beck's Hybrids performed by USDA-ARS Soft Wheat Quality Laboratory.

Table 56. Wheat grain and flour quality characteristics of the 2015 crop Soft Wheat Quality Council entries between 2009 and 2015 crop years

Group	Entry	Test Weight (lb/bu)	Grain Protein (%)	Kernel Hardness	Kernel Diameter (mm)	Kernel Weight (mg)	Flour Yield (%)	Softness Equivalence (%)	Flour Protein (%)	Water SRC (%)	Sodium Carbonate SRC (%)	Sucrose SRC (%)	Lactic Acid SRC (%)	Cookie Diameter (cm)	Cookie Top Grade
1	VA10W-119	62.4	10.6	24.6	2.8	39.2	70.5	55.1	8.7	56.2	69.5	93.7	113.7	18.1	3.9
1	VA11W-106	61.0	10.0	14.1	2.7	34.3	67.7	59.2	8.1	54.1	71.4	93.6	109.2	18.4	3.0
1	Hilliard*	60.5	10.4	18.0	2.7	34.2	67.3	59.2	8.3	54.4	71.9	93.8	117.3	17.5	2.9
2	SY 100	58.7	9.4	7.8	2.6	37.5	70.4	61.7	7.5	53.8	67.1	84.2	96.2	19.1	4.4
2	M11-2024#	61.2	11.9	19.2	2.9	38.2	69.1	50.9	9.9		67.6	90.0	76.1	18.5	2.7
2	M11*3144CW	62.2	9.7	15.6	2.8	42.4	72.6	61.6	7.9		65.6		110.9	18.7	4.5
2	Branson*	56.6	10.6	5.7	2.6	31.0	69.2	61.6	8.3	52.0	65.8	90.3	105.1	18.9	4.5
3	Beck 88AA	59.7	9.9	7.3	2.9	38.8	69.0	58.0	8.2		67.2		125.0	19.0	2.0
3	Beck 123	61.7	9.5	20.1	2.7	35.7	67.9	59.4	7.9		66.4		115.3	18.8	3.0
3	Beck 125	60.1	10.0	22.8	2.6	33.0	68.3	60.5	7.9		69.5		108.0	18.7	4.0
3	Beck 128	60.3	9.1	9.4	2.6	35.4	71.5	64.5	7.3		65.5		102.5	19.3	4.0
3	Beck 120*	59.2	9.8	19.1	2.6	31.9	70.4	59.0	7.7	53.8	67.2	87.9	98.4	18.7	3.4
3	Beck 114	61.7	9.7	22.5	2.7	33.1	68.0	57.4	8.1		71.2		129.7	18.5	3.5

*Check varieties.

Genotyping for Quality Traits: Soft Wheat Quality Council

Anne Sturbaum, January, 2017

Genotyping for traits associated with quality, physiology and disease resistance was done at the Regional Small Grains Genotyping Laboratory (RSGGL) in Raleigh, N.C. and in Wooster for the thirteen WQC entries, Beck 88A, Beck 114, Beck 120, Beck 123, Beck 125, Beck 128, M11*3144CW, M11-2024#, SY 100, VA11W-106 and VA10W-119 with Branson and Hilliard as checks for this set.

Quality

High molecular weight glutenins, especially the alleles for *Dx5 (*"*5+10*") at *GluD1*, the over expressed *Bx7* subunit at *GluB1* and *Ax2** at the *GluA1* loci are useful for selecting preferential milling and baking quality. These alleles correlate with strong gluten and dough strength (Ma et al., 2003). We report on the *GluA1, GluB1* and *GluD1* loci involved in selecting for varieties with specific dough quality.

Amplification for high molecular weight glutenins at the *GluA1* locus, adapted from the marker *umn19* (Liu et al., 2008a) identified the *Ax2** genotype in the WQC entries Beck 114, Beck 120, Beck 125, Beck 128 M11*3144CW, M11-2024#, VA11W-106. VA10W-119, and the two check entries, Branson and Hilliard. Beck 123, Beck 88A and SY100 have the *Ax1* allele at the *GluA* locus.

M11*3144CW, M11-2024# and SY100 have the overexpressing the *GluB1* allele, *Bx7OE*, as tested by primers diagnostic for a 45 base pair insertion specific to the *Bx7* over-expressing *GluB1* allele (Guttieri et al., 2008).

Primers specific for *GluD1* alleles *Dx5* and *Dx2* generated a PCR product corresponding to the "5+10" strong gluten allele for Beck 88A, Beck 114, Beck 123, Beck 125 and "2+12" for all other varieties as well as the checks, Branson and Hilliard. SR 5111 was heterozygous for "2+12+ and "5+10" at the *GluD1* locus. (Wan et al., 2005).

A translocation from chromosome 1 of rye, *Secale cereale L* (1RS), onto wheat chromosome 1B or 1A provides multiple resistances to powdery mildew, stem rust, leaf rust and stripe rust. Amplification products with scm9F primers are specific for rye ω-secalin using the Scm9 marker pair (Saal and Wricke, 1999). The only cultivar bearing the 1B:1R translocation was SR 5111.

Physiology

Mutations in the homeologous photoperiod genes *Ppd-A1*, *Ppd-B1* and *Ppd-D1* of chromosome 2, confer photoperiod insensitivity or day neutral growth in wheat permitting early flowering. Mutations in the *Ppd-D1* allele (Beales et al., 2007), copy number variations in *Ppd-B1* (Díaz et al., 2012) and insertions and deletions in *Ppd-A1* (Nishida et al., 2013) each influence the plant's flowering time allowing early maturation thus lowering the risk of high temperature exposure during grain fill and allowing for early harvest.

All WQC varieties with the exception of M11*3144CW lack photoperiod sensitivity through one or more of the mutant photoperiod alleles described above. Beck 88A and Beck 114 are insensitive through the *Ppd-A1* locus alone, Beck 123 and Branson have both the *Ppd-A1* and *PpdD1* mutant loci, and the remainder of the cultivars are insensitive through only the *Ppd-D1* gene (*Ppd-D1a*).

Dwarfing genes were tested using markers specific for reduced height genes *Rht-B1* and *RhtD1* (formerly *Rht1 and Rht2)*. The mutant alleles, *Rht-B1b* and *Rht-D1b* confer dwarfing traits to reduce plant height, increase yield and improve resistance to lodging (Zhang et al., 2006). WQC varieties M11*3144CW, SR 5111, SY 100, Va11W-106, VA10W-119 and Hilliard were homozygous for the single dwarfing allele, *Rht-D1b*. Beck 88A, Beck 114, Beck 120, Beck 123, Beck 125, Beck 88 and Branson each achieve dwarfing through the *Rht-B1b* locus.

Sr36, Stem Rust Resistance was assayed at the RSGGL for WQC varieties with none of the cultivars bearing the resistant allele. Markers, protocols and references for the disease resistance loci can be found on the MASWheat website: http://maswheat.ucdavis.edu/protocols/index.htm.

The preferred haplotype for sucrose synthase (*HapH* for high grain weight) was observed in Beck 114 and as heterozygous in VA10W-119.

Table 57. Genotypes 2015 WQC cultivars. Assays for high molecular weight glutenins test for the specific allele indicated. A preferred allele is presented in bold type.

Cultivar	Dwarfing	Photoperiod Insensitivity	High Molecular Weight Glutenins			1RS RyeTL	Sucrose Synthase HapH	Stem Rust Resistance (*Sr36*)
			*GluA1 Ax2**	*GluB1 Bx7OE*	*GluD1 5+10*			
VA10W-119	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	HET	no
VA11W-106	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
Hilliard	***Rht-D1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
SY 100	***Rht-D1b***	***Ppd-D1a***	1	**YES**	2+12	non-1RS	no	no
M11-2024#	***Rht-D1b***	***Ppd-D1a***	**2***	**YES**	HET	**1B:1R**	no	no
M11*3144CW	***Rht-D1b***	*sensitive*	**2***	**YES**	2+12	non-1RS	no	no
Branson	***Rht-B1b***	***Ppd-D1a/A1a.1***	**2***	no	2+12	non-1RS	no	no
Beck 88A	***Rht-B1b***	***Ppd-A1a.1***	1	no	**5+10**	non-1RS	**YES**	no
Beck 114	***Rht-B1b***	***Ppd-A1a.1***	**2***	no	**5+10**	non-1RS	no	no
Beck 123	***Rht-B1b***	***Ppd-D1a/A1a.1***	1	no	**5+10**	non-1RS	no	no
Beck 125	***Rht-B1b***	***Ppd-D1a***	**2***	no	**5+10**	non-1RS	no	no
Beck 128	***Rht-B1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no
Beck 120	***Rht-B1b***	***Ppd-D1a***	**2***	no	2+12	non-1RS	no	no

Genotyping References

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

Whole Kernel Moisture, Air-oven Method, AACC Method 44-15.02

What grain is coarsely ground to minimize moisture loss and dried in a convention oven set at 140°C for 90 min. The moisture content is express as the percent loss of weight during drying.

Whole Wheat Protein

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

Falling Number, AACC Method 56-81B

The falling number test measures the travel time of the plunger in seconds (falling number) from the top to the bottom position in a glass tube filled with a suspension of whole grain meal or milled flour, immediately after being cooked in a boiling water jacket to produce gelatinized starch. The higher the viscosity of whole grain meal or flour paste in the glass tube, the longer the travel time of the plunger.

Amylase Activity, AACC Method 22-02-01

Alpha-amylase can be measured directly using a kit from Megazyme, International, Measurement of alpha-Amylase in Plant and Microbial Materials Using the Ceralpha Method. The SWQL uses a modified micro method of the Megazyme assay. Units are expressed in alpha-amylase activity as SKB units/gram (@ 25°C).

Test Weight, AACC Method 55-10

Test weight is measured 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 shows percent soft (A), semi-soft (B), semi-hard (C), and hard (D) SKCS hardness index; moisture content; kernel size; and 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 precedes six sieves. Residue for this system includes head shorts, bran, red dog, and tail shorts.

Experimental Milling Procedure

The Miag Multomat Mill is a pneumatic conveyance system consisting of eight pairs of 254 mm diameter x 102 mm wide rolls, and ten sifting passages. Three of the pairs are corrugated break rolls and five are reduction rolls. Each sifting passage contains six separate sieves. The two top sieves for each of the break rolls are intended to be used as scalp screens for the bran.

Soft red and soft white winter wheat grain is tempered to 14.5% moisture. The tempered grain is held for 24 hours prior to milling and then introduced into the first break rolls at a rate of approximately 600g/min. Straight grade flour is a blend of three break flour streams, grader flour, five reduction streams and 1M re-duster flour. The straight grade flour is then re-bolted to remove any remaining residual by-products not removed by the mill using a stainless steel screen of 165 micron openings. The ash content of the straight grade flour usually range from 0.38 and 0.50%. Bran, head shorts, tail shorts and red dog are by-products, which are not included with the flour. Flour yield of eastern soft wheat varies from 70 to 78%. Flour yield depends on wheat variety and is influenced by environmental growing conditions. Sprouted and/or shriveled kernels negatively impact the flour yield. Recovery of all mill products is usually about 98%.

Flour Moisture, Air-oven Method, AACC Method 44-16.01

Wheat flour (~2 g) is dried on hot aluminum plate in an air oven set at 140°C for 15 min. The moisture content is express as the percent loss of weight during drying.

Flour Protein

Protein determined by near infra-red (NIR), using a Unity NIR instrument calibrated by a nitrogen combustion analysis on the Elementar Nitrogen Analyzer. Units are recorded in percent 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 half-acre field. Flour protein of 8% to 9% is representative for breeder's samples and SWQL grow-out cultivars.

Flour Ash, AACC Method 08-01

Flour ash is determined following the basic AACC method, expressed on 14% moisture basis.

Solvent Retention Capacity Test (SRC), AACC Method 56-11

Flour Lactic Acid, Sucrose, Water, and Sodium Carbonate Retention Capacities (SRC) results are expressed as percent solvent retained by weight.

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. 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 arabinoxylan (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. Soft wheat flours for cookies typically have a target of 95% or less when used by the US baking industry for biscuits and crackers. 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 employs the 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. 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. 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.

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.

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.

Sugar Snap Cookie, Micro Method, AACC Method 10-52

Diameter of Two-cookie expressed in cm, cookie top grain expressed in arbitrary units from unacceptable to outstanding from 1 to 9, respectively, are determined. Diameter and stack height

of cookies baked according to this method are measured and used to evaluate flour baking quality.

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.

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.