U.S. WHEAT ASSOCIATES

Dependable People. Reliable Wheat.

CROP QUALITY
ANALYSIS METHODS

ANALYSIS METHODS FOR USW'S ANNUAL CROP QUALITY REPORT

TABLE OF CONTENTS

LABORATORY TESTING 3

GRADES AND GRADE REQUIREMENTS 4

CONVERSIONS AND GROWING AREAS 5

WHEAT CLASSES 6

ANALYSIS METHODS

- WHEAT GRADE FACTORS 7
- WHEAT NON-GRADE FACTORS 8
- FLOUR AND SEMOLINA FACTORS 13
- DOUGH PROPERTY FACTORS 20
- EVALUATION OF END-PRODUCTS 23

SCAN THE QR CODE TO ACCESS USW'S ANNUAL CROP QUALITY REPORTS.

Available in: Arabic, Chinese, English, French, Italian, Portuguese and Spanish.

REGIONAL REPORTS ARE ALSO AVAILABLE:

Hard White, Soft Red Winter, Soft White, Hard Red Spring, Northern Durum, Hard Red Winter, California Hard Red Winter and Desert Durum.

(Note: Regional reports are primarily available in English.)

LABORATORY TESTING

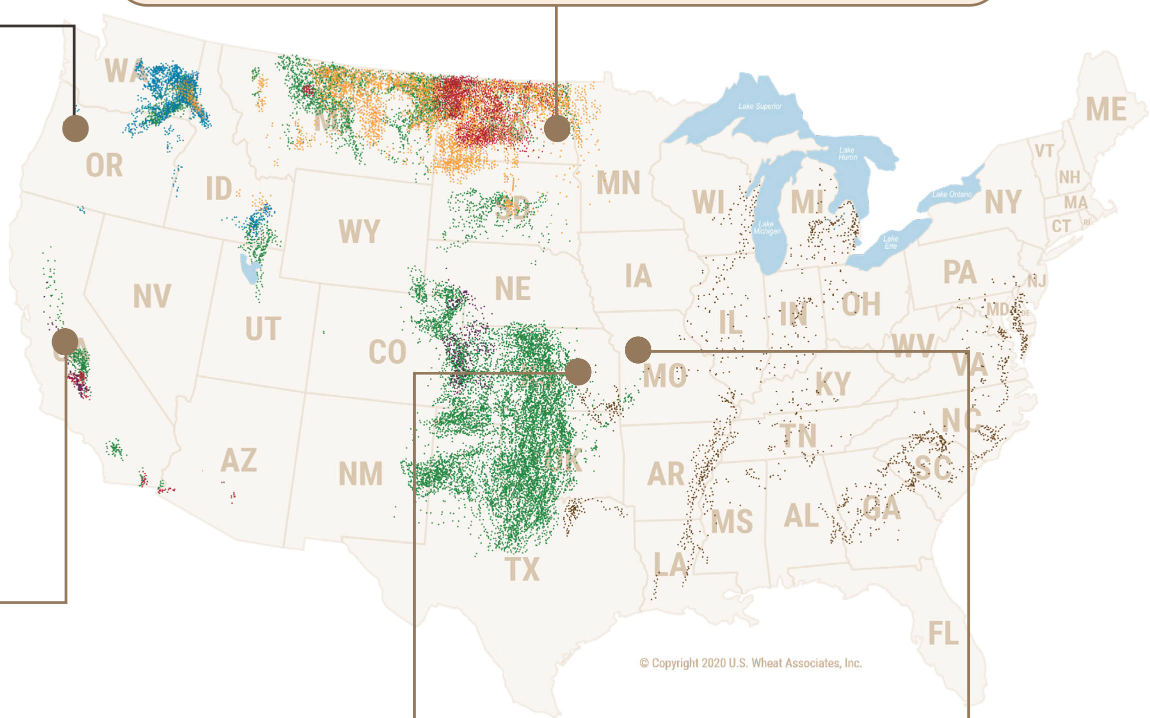
U.S. Wheat Associate's annual Crop Quality Report provides an overview of the quality of each year's U.S. wheat crop. The data in the Crop Quality Report are derived from sample testing and analysis conducted at six partner laboratories across the United States. This document provides an overview of those testing methods behind the data in that annual report. The laboratory locations and the wheat class that each tests is noted below.

Most of the testing methods utilized follow guidelines published by the Cereals & Grains Association, previously known as the American Association of Cereal Chemists International (AACCI). This organization is widely recognized for its approved procedures used to determine kernel quality, flour properties, and final product performance. Non-AACCI methods used for quality testing are also noted. The methods for each test and class are provided in this document.

The HRS Wheat Quality Lab at NDSU in Fargo, North Dakota, conducted quality testing and analyses on **hard red spring (HRS)**.

The Durum Quality Lab at NDSU conducted quality testing and analyses on **Northern Durum**.

The WMC in Portland, Oregon, conducted quality testing and analyses on **soft white (SW)**.



The CWC Laboratory in Woodland, California, conducted quality testing and analyses on **Desert Durum**®.

The USDA/ARS Hard Winter Wheat Quality Lab (HWWQL) in Manhattan, Kansas, conducted the quality testing for **hard red winter (HRW)**. Plains Grains Inc. in Lincoln, Nebraska provided analyses.

Great Plains Analytical Laboratory in Kansas City, Missouri, conducted quality testing on **soft red winter (SRW)**.

GRADES AND GRADE REQUIREMENTS

GRADING FACTORS:	GRADES U.S. NO.:				
	1	2	3	4	5
MINIMUM LIMITS:					
TEST WEIGHT (lb/bu)					
HRS or White Club	58.0	57.0	55.0	53.0	50.0
All other classes and subclasses	60.0	58.0	56.0	54.0	51.0
TEST WEIGHT (kg/hl)					
HRS or White Club	76.4	75.1	72.5	69.9	66.0
Durum	78.2	75.6	73.0	70.4	66.5
All other classes and subclasses	78.9	76.4	73.8	71.2	67.3
MAXIMUM PERCENT LIMITS:					
DEFECTS					
Damaged kernels:					
- Heat (part of total)	0.2	0.2	0.5	1.0	3.0
- Total	2.0	4.0	7.0	10.0	15.0
Foreign material	0.4	0.7	1.3	3.0	5.0
Shrunken and broken kernels	3.0	5.0	8.0	12.0	20.0
Total[1]	3.0	5.0	8.0	12.0	20.0
WHEAT OF OTHER CLASSES[2]					
Contrasting classes	1.0	2.0	3.0	10.0	10.0
Total[3]	3.0	5.0	10.0	10.0	10.0
STONES	0.1	0.1	0.1	0.1	0.1
MAXIMUM COUNT LIMITS (ALL GRADES):					
OTHER MATERIAL (1,000 g sample)					
Animal filth	1				
Castor beans	1				
Crotalaria seeds	2				
Glass	0				
Stones	3				
Unknown foreign substance	3				
Total[4]	4				
Insect-damaged kernels in 100 g	31				

U.S. Sample Grade is wheat that:

(a) does not meet the requirements for U.S. Nos. 1, 2, 3, 4, 5; or
(b) has a musty, sour or commercially objectionable foreign odor (except smut or garlic odor);
(c) is heating or of distinctly low quality.

Notes:
[1] Includes damaged kernels (total), foreign material, and shrunken and broken kernels.
[2] Unclassed wheat of any grade may contain not more than 10.0% of wheat of other classes.
[3] Includes contrasting classes.
[4] Includes any combination of animal filth, caster beans, crotalaria seeds, glass, stones, or unknown foreign substance.

CONVERSIONS AND GROWING AREAS

UNIT CONVERSION FACTORS

The weight units conversion matrix should be read from the top, left. For example: **1 MT** is equal to **1,000 kg**.

	1 bu	1 lb	**1 MT**	1 long ton	1 short ton	1 cwt	1 kg
bu	1	0.017	36.74	37.33	33.33	3.674	0.037
lb	60	1	2,204	2,240	2,000	100	2.205
MT	0.0272	0.0005	1	1.016	0.907	22.05	0.0010
long ton	0.0268	0.0004	0.984	1	0.893	0.045	0.0010
short ton	0.030	0.0005	1.102	1.12	1	0.05	0.0011
cwt	0.600	0.01	22.05	22.40	20.37	1	0.022
kg	27.2	0.45	1,000	1,016	907.2	45.36	1

LEGEND:
bu (*Winchester* bushel)
lb (pound)
MT (metric ton)
cwt (quintal or hundredweight)
kg (kilogram)

LAND AREA:
1 hectare (ha) = 2.47 acres (ac)
1 acre (ac) = 0.40 hectare (ha)

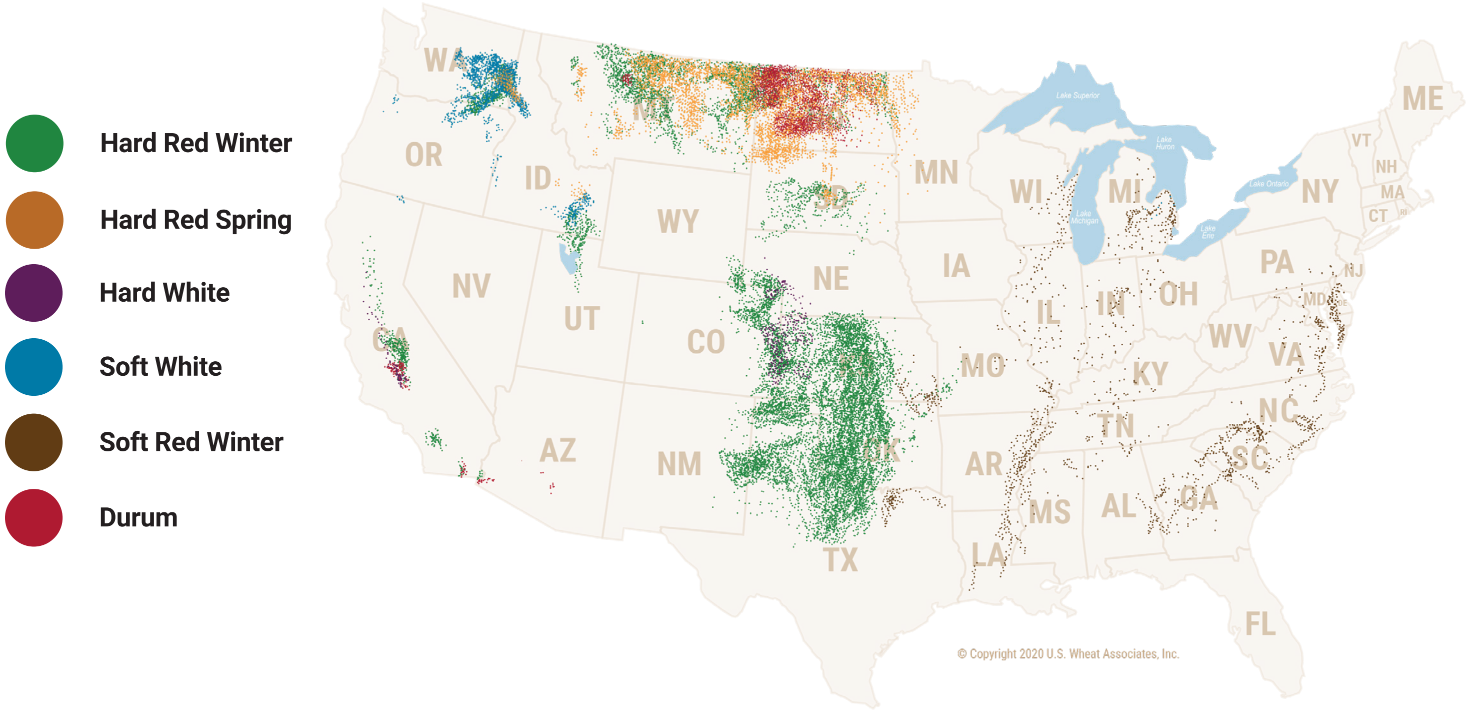
TEST WEIGHT:
Common wheat:
kg/hl = (lb/bu * 1.292) + 1.419

Durum wheat:
kg/hl = (lb/bu * 1.292) + 0.630

FLOUR PROTEIN:
14% mb to db = Protein (14% mb) / 0.86
db to 14% mb = Protein (db) x 0.86

WHEAT PROTEIN:
12% mb to db = Protein (12% mb) / 0.88
db to 12% mb = Protein (db) x 0.88

U.S. WHEAT CLASS GROWING AREAS



WHEAT CLASSES

HARD RED WINTER

Grown in the Great Plains, Pacific Northwest (PNW) and California, hard red winter (HRW) is the most widely grown class in the United States. It is shipped via the Gulf and Pacific ports. It has medium to high protein of 10.0 to 13.0% (12% mb), medium hard endosperm, red bran, medium gluten content and mellow gluten.

HARD RED SPRING

Grown primarily in the North Central region and shipped via the Pacific, Gulf and Great Lakes ports, hard red spring (HRS) wheat is the second largest class of U.S. wheat. It has high protein of 12.0 to 15.0% (12% mb), hard endosperm, red bran, strong gluten and high water absorption. HRS includes three subclasses: dark northern spring (DNS), northern spring (NS) and red spring (RS).

HARD WHITE

The smallest class of wheat in the United States, hard white (HW) is grown in the Southern Plains, Idaho and California, and when available for export, shipped via Pacific and Gulf ports. HW wheat has a hard endosperm, white bran and a medium to high protein content of 10.0 to 14.0% (12% mb). HW includes winter and spring varieties increasing the protein range and functionality within the class.

SOFT WHITE

Grown primarily in the Pacific Northwest (PNW) and shipped via Pacific ports, approximately 80% of soft white (SW) wheat is exported from the United States. It typically has a low protein of 8.5 to 10.5% (12% mb), low moisture and weak gluten. SW includes winter and spring varieties that provide a wide range of protein and functionality within the class. SW also includes three subclasses: soft white, white club and western white.

SOFT RED WINTER

Grown in the eastern third of the United States and shipped via Gulf, Atlantic and Great Lakes ports, soft red winter (SRW) wheat is the third largest class of wheat grown in the United States. SRW is a high-yielding wheat with low protein of 8.5 to 10.5% (12% mb), soft endosperm, red bran and weak gluten. It is used in pastries, cakes, cookies, crackers, pretzels, flat breads and for blending flours.

DURUM

Northern Durum is grown primarily in the North Central region and shipped via Gulf, Great Lakes and Pacific ports, while Desert Durum®, is grown primarily under contract in the desert Southwest (Arizona and California) and shipped via the Gulf or West Coast. Durum is the fifth largest class of wheat grown in the United States and has a high protein content of 12.0 to 15.0% (12% mb), rich amber color, yellow endosperm, high gluten and white bran. Durum includes three subclasses: hard amber durum (HAD), amber durum (AD) and durum.

ANALYSIS METHODS

WHEAT GRADE FACTORS

U.S. Wheat Grade is a numeric value from 1 to 5 or the designation "Sample Grade," which reflects the physical condition of a sample and thus may indicate its general suitability for milling. All numeric factors other than test weight are reported as a percentage by weight of the sample. Unless otherwise noted, all Wheat Grade Factor methodology can be found in the Official U.S. Standards for Grain. Grade determining factors include:

TEST WEIGHT

Test weight is a measure of density in pounds per bushel (lb/bu) or kilograms per hectoliter (kg/hl). Test weight may indicate potential milling yield and the general condition of the sample. Problems during the growing season or at harvest often reduce test weight.

The official USDA measurement is in lb/bu. The conversion formula for converting from lb/bu to kg/hl is:

- Durum wheat: (lb/bu x 1.292) + 0.630 = kg/hl
- Common wheat (all class except durum): (lb/bu x 1.292) + 1.419 = kg/hl

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 55-10.01	AACCI 55-10.01	AACCI 55-10.01	AACCI 55-10.01	AACCI 55-10.01	AACCI 55-10.01

DAMAGED KERNELS

Damaged kernels show signs of disease, insect activity, frost or sprouting and may adversely affect milling and flour quality.

FOREIGN MATERIAL

Foreign material is any material other than wheat that remains after dockage is removed. Because foreign material can be a similar size and weight as wheat and is not easily removed, it may adversely affect milling and flour quality.

SHRUNKEN AND BROKEN

Shrunken and broken kernels have a shrunken or shriveled appearance or were broken in handling and may reduce milling yield.

TOTAL DEFECTS

Total defects is the sum of damaged kernels, foreign material and shrunken and broken kernels.

VITREOUS KERNELS

Vitreous kernels in HRS wheat are uniformly dark and have no spots that appear chalky or soft. In durum wheat, vitreous kernels have a glassy and translucent appearance without any spots that appear chalky. Vitreous kernel is the percentage handpicked from a 15 gram (g) clean wheat sub-sample. Vitreous kernel will not determine numeric grade value but will affect subclass designation.

WHEAT NON-GRADE FACTORS

Non-grade factors do not affect numerical grades but can help assess the quality of the wheat. With the exception of moisture, all non-grade factors are measured after dockage is removed. USDA's Federal Grain Inspection Service (FGIS) or private inspection companies can provide non-grade testing if requested in the sales contract. Flour-based specifications cannot be tested by FGIS at the time of loading but can be contracted out to a private laboratory using composite samples provided by FGIS from the time of loading. Wheat non-grade factors include:

DOCKAGE

Dockage is the percentage by weight of material removed from a sample by the Carter-Day Dockage Tester and does not influence the numerical grade. Being easy to remove, dockage should not affect milling quality but may have other economic effects for buyers. U.S. Wheat Grade Factors are determined after dockage is removed.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
Official USDA procedures.	Official USDA procedures.	Official USDA procedures.	Official USDA procedures.	Official USDA procedures.	Official USDA procedures.

WHEAT MOISTURE

Wheat moisture content is the percentage of water by weight in a sample and is an important indicator of profitability in milling. Flour millers add water to adjust wheat moisture to a standard level before milling. Lower wheat moisture allows more water to be added, increasing the weight of grain to be milled at virtually no cost.

Moisture content is also an indicator of grain storability as wheat and flour with low moisture are more stable during storage. Because moisture can be readily added to or removed from a sample, other analysis results should be mathematically converted to a standard moisture basis (mb), such as 14%, 12% or dry matter (0%), so test results can be consistently evaluated. Moisture is measured before removing dockage from the sample.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.
AACC 39-01.01, 39-10.01 and 39-11.01, Near-Infrared Reflectance (NIR) method.	AACC 39-01.01, 39-10.01 and 39-11.01, Near-Infrared Reflectance (NIR) method.	AACC 39-01.01, 39-10.01 and 39-11.01, Near-Infrared Reflectance (NIR) method.	AACCI 44-15.02, Air-oven method.	AACCI 44-11.01, Dielectric meter method, Motomco Moisture Meter.	AACCI 44-15.02, Air-oven method.

WHEAT PROTEIN

Wheat protein content is the percentage of protein by weight in a sample. Because there is no rapid way to measure wheat protein quality, wheat protein quantity is used in trade and by millers as an indicator of its suitability for various products and is an important factor in determining wheat value.

High protein is usually desired for products such as pan breads, pasta, buns and frozen yeast-raised products. Low protein is usually desired for products such as cookies, wafers, snacks and cakes.

In the U.S., wheat protein is measured on a 12% moisture basis.
The conversion formulas are:

- 12% mb to db = Protein (12% mb) / 0.88
- db to 12% mb = Protein (db) x 0.88

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 12% mb.	Reported on a 12% mb.	Reported on a 12% mb.	Reported on a 12% mb.	Reported on a 12% mb.	Reported on a 12% mb.
AACCI 39-25.01, NIR method, whole kernels.	AACCI 39-25.01, NIR method, whole kernels.	AACCI 39-25.01, NIR method, whole kernels.	AACCI 46-30.01, Dumas CAN method, ground whole meal.	AACCI 39-25.01, NIR method, whole kernels.	AACCI 46-30.01, Dumas CAN method, ground whole meal.

WHEAT ASH

Wheat ash content is the total mineral content present in the entire wheat kernel, including the bran, germ and endosperm. Since minerals are primarily concentrated in the outer layers – especially the bran – wheat ash gives a measure of the grain's overall mineral content. It is commonly used to estimate the potential ash content of flour after milling and serves as an indicator of wheat quality for millers.

Ash in flour can impart a darker color to finished products. Products requiring white (bright) color call for low ash content, while whole wheat flour has higher ash content and a correspondingly darker color.

In the U.S., wheat ash is measured on a 14% moisture basis.

The conversion formulas are:

- 14% mb to db = Ash (14% mb) / 0.86
- db to 14% mb = Ash (db) x 0.86

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.

KERNEL SIZE

Kernel size is a measure of the percentage by weight of large, medium and small kernels in a sample. Large kernels and/or uniform kernel size may help improve milling yield.

The laboratory test method for each class is as follows:

- Shuey, W. 1960. Cereal Sci. Today. 5(3):71-75 for all classes. Wheat is sifted with a RoTap sifter.
- "Large" kernels are retained on a U.S. Standard Sieve No. 7 (with a 2.80 mm opening).
- "Medium" kernels pass through the No. 7 screen but are retained by the Tyler No. 9 or U.S. No. 10 sieves.
- "Small" kernels pass through the Tyler No. 9 or U.S. No. 10 sieves.

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.
Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens.	Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens.	Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens.	Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens.	Tyler No. 7 (2.80 mm) and No. 9 (2.00 mm) screens.	U.S. No. 7 (2.82 mm) and No. 10 (2.00 mm) screens.
				Note: Desert Durum® sieve openings are narrower for large and medium kernels than the openings for Northern Durum.	

SINGLE KERNEL CHARACTERIZATION SYSTEM (SKCS)

The Single Kernel Characterization System (SKCS) analyzes 300 individual kernels from a sample, assessing their size (diameter), weight, hardness (measured by the force required to crush each kernel), and moisture content. Comprehensive SKCS data, which are not included in the Crop Quality Report, include distributions of these factors, offering insights into sample uniformity. Such information enables millers familiar with the system to enhance flour milling yields. Additionally, kernel characteristics may help millers optimize tempering processes and adjust roll gap settings.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.	Reported as-is.
AACCI 54-31.01 using Perten SKCS 4100.	As of 2022, the SKCS test is no longer performed on HRS.	AACCI 54-31.01 using Perten SKCS 4100.	AACCI 54-31.01 using Perten SKCS 4100.	AACCI 54-31.01 using Perten SKCS 4100.	AACCI 54-31.01 using Perten SKCS 4100.

1000 KERNEL WEIGHT

1000 kernel weight (or thousand kernel weight, TKW) is the weight, in grams, of 1,000 kernels of wheat and may indicate specific kernel weight and expected milling yield.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported as-is.	Reported as-is.	Reported on a 14% mb.	Reported as-is.	Reported as-is.	Reported as-is.
The average of SKCS kernel weight in milligrams (mg) x 1,000 equals in g.	Based on a 10 g clean wheat sample counted by an electronic counter, results converted to express weight by 1,000 kernels.	Based on the average weight of three 100-kernel samples multiplied by 10.	Based on a 10 g clean wheat sample counted by an electronic counter, results converted to express weight by 1,000 kernels.	Based on a 10 g clean wheat sample counted by an electronic counter, results converted to express weight by 1,000 kernels.	Based on a 10 g clean wheat sample counted by an electronic counter, results converted to express weight by 1,000 kernels.

SEDIMENTATION

Sedimentation value is a measure of the volume of sediment that results when lactic acid is added to a sifted, ground wheat sample. High sedimentation volume indicates stronger gluten with more high molecular weight glutenin sub-units while low sedimentation volume indicates weaker gluten.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 56-61.02, Sedimentation.	AACCI 56-61.02, Sedimentation.	AACCI 56-61.02, Sedimentation.	AACCI 56-61.02, Sedimentation.	Micro sedimentation, Dick, J.W. and Quick, J.S. 1983. Cereal Chem. 60(4):315-318.	AACCI 56-70.01, Sodium Dodecyl Sulfate (SDS) sedimentation.

WHEAT FALLING NUMBER

Wheat falling number refers to the amount of time it takes for a plunger to drop through a mixture of flour and water heated to 100°C, serving as an indirect indicator of enzyme activity. Falling number usually correlates closely with amylograph peak viscosity results.

Sprouting – which can occur when mature wheat is exposed to moisture at harvest – activates alpha-amylase (α-amylase), which breaks down starch into sugars. High falling number values indicate low α-amylase activity. Some α-amylase is required for certain products such as yeast-raised bread. However, excessive α-amylase in wheat cannot be removed and is difficult to reduce by blending. Flour with excessive amylase activity produces a sticky dough that can cause processing problems and products with poor color, poor crumb grain and weak texture.

In 2019, USDA/FGIS introduced Directive 9180.3, which established a procedure for correcting barometric pressure to address variations in atmospheric pressure that may influence falling number readings.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 56-81.04, 2019 modified procedure.	AACCI 56-81.04, 2019 modified procedure.	AACCI 56-81.04, 2019 modified procedure.	AACCI 56-81.04, 2019 modified procedure.	AACCI 56-81.04.	AACCI 56-81.04.

DON (DEOXYNIVALENOL)

Deoxynivalenol (DON), or vomitoxin, is the most common mycotoxin in wheat. It is produced by molds of Fusarium graminearum, which can be activated during wet and humid conditions during flowering and harvest. All analysis for DON is conducted on ground wheat.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Not tested.	Reported on a 14% mb.	Reported on a 14% mb.	Not tested.
Charm ROSA DonQ2 Quantitative Test.	Gas chromatograph with electron capture detector as described by Tacke, B.K., Casper, H.H. 1996. J. AOAC Int. 79(2):472-5.		Neogen ELISA.	Gas chromatograph with electron capture detector as described by Tacke, B.K., Casper, H.H. 1996. J. AOAC Int. 79(2):472-5.	

FLOUR AND SEMOLINA FACTORS

Flour and semolina tests are conducted to assess specific properties that indicate how flour or semolina will perform during processing, ensuring that the flour or semolina has desirable characteristics for the intended end-product. It is important to remember that all testing is performed on wheat milled in a laboratory setting.

LABORATORY MILLING EXTRACTION

Laboratory milling extraction is the percentage by weight of flour/semolina obtained from a wheat sample. The extraction rate is always significantly lower from a laboratory mill than the rate that can be obtained on a commercial mill. Lab milling is done mainly to obtain flour/semolina for other tests. Settings are not optimized and remain the same year-to-year.

Note: As of 2023, all extraction rates are calculated on a tempered wheat basis using the formula: flour extraction = (weight of flour recovered/weight of tempered wheat milled)*100. Before 2023, HRW, HW, and SW were reported as total product yield; as a result, current extraction figures may appear slightly lower than historical data.

The laboratory test method for each class is as follows:

- Laboratory samples are cleaned and tempered according to AACCI 26-10.02.
- HRS flour is aged 10 days before analysis. Due to timing, no other classes are aged before analysis.

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
Tandem Buhler Mill.	AACCI 26-21.02, Buhler Laboratory Mill (MLU 202).	AACCI 26-31.01, Buhler Laboratory Mill (MLU 202).	AACCI 26-31.01, Buhler Laboratory Mill (MLU 202).	Brabender® Quadrumat Junior Semolina Mill; grain is tempered to 15.5% moisture one day before milling.	Modified Roller Mill.

COLOR

Color measures a sample's lightness (L*) on a scale of 0 to 100 and "chromaticity" or hue on two scales from -60 to +60 for green to red (a*) and blue to yellow (b*). High L* values indicate a bright color and higher b* values indicate more yellow. Durum semolina and flour color are influenced by endosperm color, particle size and ash content and often affects finished product color.

The laboratory test method for each class is as follows:

CIE 1976 L*a*b* color system. Minolta method using Minolta Chroma Meter with Granular-Materials attachment CR-A50.

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
CR-410 colorimeter.	CR-410 colorimeter.	CR-410 colorimeter.	CR-410 colorimeter.	CR-410 colorimeter.	CR-200 colorimeter.

FLOUR AND SEMOLINA PROTEIN

Flour and semolina protein content refers to the percentage of protein present in milled flour or semolina. The milling process removes bran and germ, typically resulting in lower protein content in flour or semolina compared to the original wheat sample. However, this can vary depending on extraction rate and flour type.

The protein level in flour and semolina influences baking characteristics. Products such as pan breads, pasta, buns, and frozen yeast-raised items often require higher protein content, while lower protein levels are preferred for products like cookies, wafers, snacks, or cakes where a more tender texture is desirable.

In the U.S., flour and semolina protein are measured on a 14% moisture basis. The conversion formulas are:

- 14% mb to db = Protein (14% mb) / 0.86
- db to 14% mb = Protein (db) x 0.86

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 39-10.01, NIR method.	AACCI 39-10.01, NIR method.	AACCI 46-30.01, Dumas CAN method.	AACCI 46-30.01, Dumas CAN method.	AACCI 39-10.01, NIR method.	AACCI 46-30.01, Dumas CAN method.

FLOUR ASH

Flour ash is the percentage of mineral residue remaining after flour is incinerated under controlled conditions. It reflects the degree of bran inclusion in the flour, with higher ash values indicating greater presence of these outer kernel components.

Ash content influences flour color and baking characteristics: low-ash flours yield lighter-colored products with lower water absorptions, while high-ash flours are associated with whole wheat or high-extraction flours and greater water absorptions. Ash levels can also be affected by wheat growing conditions (e.g., irrigation) and flour fortification practices due to higher mineral content in the flour. For a complete assessment, ash content should be considered alongside flour color.

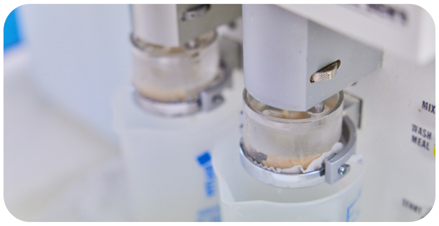
In the U.S., flour ash is measured on a 14% moisture basis. The conversion formulas are:

- 14% mb to db = Ash (14% mb) / 0.86
- db to 14% mb = Ash (db) x 0.86

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.	AACCI 08-01.01.

WET GLUTEN



Wet gluten is a measure of the quantity of gluten in ground wheat (whole meal) or flour as determined using the Glutomatic System. Wet gluten forms when 2% salt water is added to the protein in ground wheat or flour and is responsible for the elasticity and extensibility characteristics of dough. Less initial salt water is used for soft wheat, more initial salt water is used for hard wheat.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 38-12.02 (Glutomatic procedure).	AACCI 38-12.02 (Glutomatic procedure).	AACCI 38-12.02 (Glutomatic procedure). As of 2023, wet gluten values are no longer reported for Club wheat.	AACCI 38-12.02 (Glutomatic procedure).	AACCI 38-12.02 (Glutomatic procedure).	AACCI 38-12.02 (Glutomatic procedure).

GLUTEN INDEX

Gluten index is a measure of gluten strength regardless of the quantity of gluten present and is also determined by the Glutomatic System. Gluten index is used commercially to select durum samples with strong gluten characteristics. As of 2023 gluten index values are no longer reported for HRW, HRS, SW and SRW.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Not tested.	Not tested.	Not tested.	Not tested.	Reported on a 14% mb. Same method as above.	Reported on a 14% mb. Same method as above.

DAMAGED STARCH

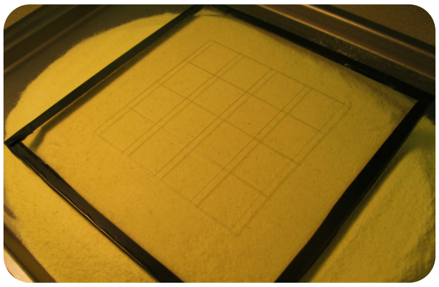
Damaged starch refers to the percentage by weight of starch granules in a flour sample that have been physically broken during the milling process.

Hard wheat flour will typically have higher starch damage than soft wheat flour, due to its harder endosperm and the more aggressive milling required to break down hard wheat kernels. Damaged starch granules readily absorb more water, which affects dough mixing and other processing properties. Because starch damage depends on how the sample was milled, this factor is important for interpreting other reported results.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Not tested.	Not tested.
AACCI 76-30.02, Enzymatic hydrolysis.	AACCI method 76-31.01, Megazyme.	AACCI 76-33.01, SDmatic.	AACCI 76-30.02, Enzymatic hydrolysis.		

SPECKS



Specks in a semolina sample are small particles of bran or other material that escaped the wheat cleaning and semolina purifying process. Millers can control speck count by thoroughly cleaning and properly tempering and conditioning the wheat before milling. Specks can detract from pasta appearance and desirability.

The laboratory test method for each class is as follows:

A random sample is pressed under a clear plate and the specks (brown and black particles) are counted. This is a subjective measurement unless using an objective imaging machine.

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Not tested.	Not tested.	Not tested.	Not tested.	Reported as-is.	Reported as-is.
				Average of three separate 1in^2 determinations is expressed as specks per 10 in^2.	Count 1 in^2 and multiply a factor [(no. of specks x 3) + 2] to get total specks for 10 in^2.

AMYLOGRAPH VISCOSITY

Amylograph viscosity measures flour starch pasting properties that are important to products such as sheeted Asian noodles. Amylograph also measures enzyme (α-amylase) activity indirectly, which is usually from sprout damage

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 22-10.01.	AACCI 22-10.01 modified to use 65 g flour (14% mb) and 450 ml distilled water. Paddles are used.	AACCI 22-10.01 modified to use 65 g flour (14% mb) and 450 ml distilled water. Pins are used.	AACCI 22-10.01.	Not tested.	Not tested.

RAPID VISCO ANALYZER (RVA)

Rapid visco analyzer (RVA) generates a starch pasting curve plotted as viscosity against time and temperature. Measuring the functional and pasting properties of starch and cereal flours during controlled heating, holding, cooling temperature cycles as a paddle rotates at a constant speed can give information on processability of end product texture. Values reported include:

PASTING TEMPERATURE

The temperature (in Celsius) at which starch begins to gelatinize.

- Lower pasting temperatures may indicate early gelatinization, useful for products requiring quick thickening, such as sauces or instant mixes, where early gelatinization is desirable.
- Higher temperatures are preferred for products needing heat-stable starches, like baked goods that undergo prolonged heating, such as bread or sponge cakes.

PEAK VISCOSITY

The measurement of the greatest viscosity [in centipoise (cP)] achieved during heating. More viscous slurries may indicate lower enzyme activity in flour and greater swelling capacity. Less viscous slurries may indicate less swelling capacity and lower water-holding capacity.

- Higher values are ideal for products like bread and noodles, where strong starch swelling and water-holding capacity contribute to softer, cohesive textures and better volume.
- Lower values are ideal for products like cookies and crackers, where reduced swelling helps maintain firmer “clean break” textures and controlled spread.

HOT PASTE VISCOSITY

Also known as Trough Viscosity (in cP), this is the minimum viscosity achieved after the peak viscosity during the holding phase. It can indicate shear thinning potential (starch granule breakdown during shearing).

- Higher or more stable values are beneficial for products requiring structural integrity under heat and shear, such as pasta and bread doughs.
- Lower or unstable values are useful for products that benefit from starch breakdown, like cakes or batters, where a softer texture is desired

FINAL VISCOSITY

Also known as Cold Paste Viscosity (in cP), it is the viscosity at the end of the cooling stage and may indicate the tendency for the gelatinized starch to gel or retrograde after cooling.

- Higher values indicate a greater tendency towards firmer, less pliable textures which may be ideal for certain types of noodles. Higher values may also indicate the potential for faster rates of staling.
- Lower values indicate less retrogradation and slower rates of staling which may be ideal for products requiring minimal firmness post-cooling, like tender cakes or soft cookies.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
RVA data ia not yet available for HRW or SRW.	AACCI 76-21.01, STD1 pasting profile.	AACCI 76-21.01, STD1 pasting profile.	RVA data is not yet available for HRW or SRW.	Not tested.	Not tested.

SOLVENT RETENTION CAPACITY (SRC)

Solvent retention capacity (SRC) is the amount of a solvent retained by flour after a period of solvation and then centrifugation. The retained solvent forms a gel, and its weight is expressed as a percentage of the flour weight, corrected to a 14% moisture basis. Four solvents are commonly used – deionized water, 50% sucrose, 5% lactic acid and 5% sodium carbonate – present a profile of water absorption and retention of the flour measured. Each solvent targets specific flour components and helps predict baking performance.

DEIONIZED WATER SRC (WATER SRC)

Measures the overall water absorption capacity of flour. This value reflects contributions from all flour components (glutenins, damaged starch, arabinoxylans).

- Higher values are ideal for bread products, as they reflect greater overall water absorption capacity, supporting dough development and loaf volume.
- Lower values are preferred for cookies, crackers, and cakes, helping limit water absorption and maintain tender or crisp textures.

50% SUCROSE SRC

Measures water absorption due to arabinoxylans and, to a lesser extent, gliadins.

- Higher values benefit bread products by increasing water retention, which contributes to softness and extended shelf life.
- Lower values are better for cookies and cakes to avoid excessive moisture retention that could compromise spread or crumb structure.

5% SODIUM CARBONATE SRC

Assesses water absorption from damaged starch.

- Moderate values are ideal for bread flour, which helps to balance fermentable carbohydrates for yeast fermentation while also preventing accelerated staling for better shelf life.
- Low values are suitable for cookies, crackers, and cakes, allowing full bake off of water in the oven without compromising texture.

5% LACTIC ACID SRC

Evaluates water absorption due to high molecular weight glutenins.

- Higher values are preferred for bread products, as they indicate strong glutenin content and correlate with better loaf volume and dough strength.
- Lower values are essential for cakes and cookies to minimize gluten strength, ensuring a soft, tender crumb and proper spread.
- Moderate to higher values support cracker structure and layering without excessive toughness.

GLUTEN PERFORMANCE INDEX (GPI)

A calculated index based on three SRC values [lactic acid/(sodium carbonate + sucrose)] and a good predictor of overall performance of flour in baking applications.

- Higher GPI values indicate strong gluten and are ideal for products that require high dough strength and volume, such as bread.
- Lower GPI values are preferred for products that benefit from weak gluten, like cookies and cakes, to maintain tenderness and avoid excessive firmness.
- Moderate GPI values are suitable for products like crackers, which require balanced gluten strength to support structure without becoming overly tough.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Not tested.	Not tested.
AACCI 56-11.02. manual method.	AACCI 56-11.02. modified rocker shaker (SRC Multi-Tube Automatic Shaker) by Poolphol.	AACCI 56-11.02. modified rocker shaker (SRC Multi-Tube Automatic Shaker) by Poolphol.	AACCI 56-11.02. manual method.		

RECOMMENDED SOLVENT RETENTION CAPACITY (SRC) PROFILES

USW's technical staff recommend these Solvent Retention Capacity (SRC) profiles for finished products.

The recommended ranges are intentionally broad to accommodate diverse products and production environments. Most industrial users will define narrower target ranges for each product based on their own formulation experience and performance goals.

SOFT WHEAT PRODUCT FLOURS

SRC SOLVENTS	CRACKER FLOUR (%)*	COOKIE FLOUR (%)*	WAFER FLOUR (%)*
100% Deionized Water	50 to 70	50 to 70	50 to 70
50% Sucrose	80 to 110	80 to 110	80 to 100
5% Sodium Carbonate (pH 11)	60 to 85	60 to 85	60 to 85
5% Lactic Acid (pH 2)	100 to 120	85 to 100	80 to 100

** Solvent weight as percent of flour weight, both weights on 14% moisture basis.*

BREAD FLOUR

	GENERIC PAN BREAD FLOUR		VERY STRONG BAKERS FLOUR	
SRC SOLVENTS	RANGE (%)*	OPTIMUM (%)*	RANGE (%)*	OPTIMUM (%)*
100% Deionized Water	65 to 70	70	65 to 70	70
50% Sucrose	105 to 115	110	105 to 115	110
5% Sodium Carbonate (pH 11)	80 to 90	Maximum 88	80 to 90	Maximum 88
5% Lactic Acid (pH 2)	> 130	140	> 140	150
Gluten Performance Index (GPI)**	Minimum 0.60	Minimum 0.65	Minimum 0.75	Minimum 0.75

** For all except GPI, solvent weight as percent of flour weight, both weights on 14% moisture basis.*
*** GPI = Lactic Acid / (Sucrose + Sodium Carbonate)*

DOUGH PROPERTY FACTORS

Physical dough tests are used to provide information about the rheological properties of flour and dough, which aid in determining how dough will perform during mixing and further processing. This information is essential for knowing the suitability of dough for different end-products and how the dough will perform during the manufacturing process.

FARINOGRAPH

Farinograph generates a curve that indicates the resistance of dough to mixing (torque over time) as flour and water are mixed into dough, providing insights into flour strength, gluten quality, and mixing behavior. The results describe the mixing properties of the dough and include:

PEAK TIME (DOUGH DEVELOPMENT TIME)

The time, measured in minutes, from the first addition of water to the maximum curve-center consistency immediately prior to the first indication of weakening.

- Higher values (long peak times) indicate strong gluten and are preferred for products that require strong gluten and longer dough development time, such as bread.
- Lower values (short peak times) are preferred in applications where weak gluten and shorter mixing times are desired, such as for cookies and crackers.

STABILITY

The time, measured in minutes, between the point where the top of the curve first intersects the 500-BU line (called the “arrival time”) and the point where the top of the curve departs the 500-BU line (“departure time”).

- Higher values (long stability time) indicate strong gluten and are preferred for products that require strong gluten and have high dough tolerance, such as yeast-raised breads.
- Lower values (short stability times) are preferred in applications where weak gluten and limited mixing tolerance is desired, such as soft wheat products.

ABSORPTION

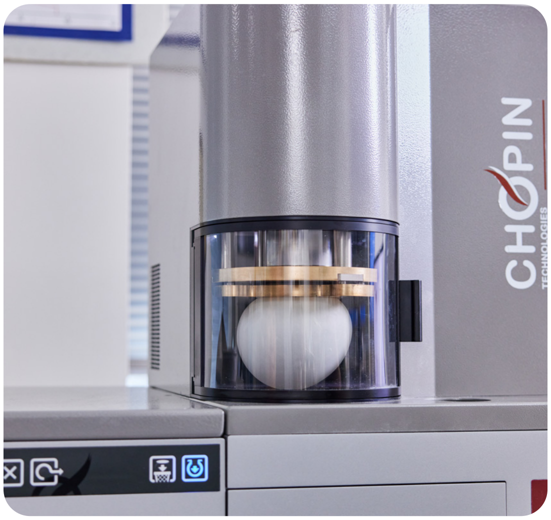
The amount of water (as a percent by weight on a 14% mb) required to center the curve peak on the 500-BU line.

- High water absorption in bread products provides economic advantages by producing more dough pieces with the same amount of flour compared to lower water absorption.
- Low water absorption is ideal for cookie and cracker products because water must be baked off for stable finished products.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Not tested.	Not tested.
AACCI 54-21.02, Constant Flour Weight Procedure.	AACCI 54-21.02, Constant Flour Weight Procedure.	AACCI 54-21.02, Constant Flour Weight Procedure. Modified with 50 g bowl; starting in 2023 only medium and high protein SW are tested.	AACCI 54-21.02, Constant Flour Weight Procedure.		

ALVEOGRAPH



Alveograph generates a curve indicating the air pressure necessary to inflate a piece of dough like a bubble to the point of rupture and indicates the gluten strength and extensibility of dough. This method determines deformation resistance of the dough through biaxial deformation, unlike the Extensograph which measures uniaxial dough deformation. The Alveograph is well-suited for measuring the dough characteristics of weaker gluten wheat and, with adapted hydration using a Consistograph, for stronger wheats including durum. Values reported include:

P (TENACITY)

The maximum pressure, measured in millimeters of water, required to deform the dough bubble. It corresponds to the maximum height of the curve and reflects dough resistance to extension.

- Higher P values may indicate stronger, more elastic dough.
- Lower P values may indicate weak dough.

L (EXTENSIBILITY)

The maximum length, measured in millimeters, the dough bubble stretches before rupture. It corresponds to the length of the curve and indicates dough extensibility.

- Higher L values may indicate a more extensible dough and are preferred for products that require high gluten strength.
- Lower L values are preferred in applications like cakes or confectionery, where minimal gluten development is desired.

W (STRENGTH)

The total area under the curve, measured in 10^{-4} J (joules). It represents the amount of energy needed to inflate the dough to the point of rupture.

- Higher W values may indicate stronger gluten and better fermentation tolerance.
- Lower W values are suitable where strong gluten is not needed such as cookies, crackers and cakes.

P/L (ELASTICITY RATIO)

The ratio of tenacity (P) to extensibility (L). It reflects the balance between elasticity (resistance to deformation) and extensibility (ability to stretch) of the dough.

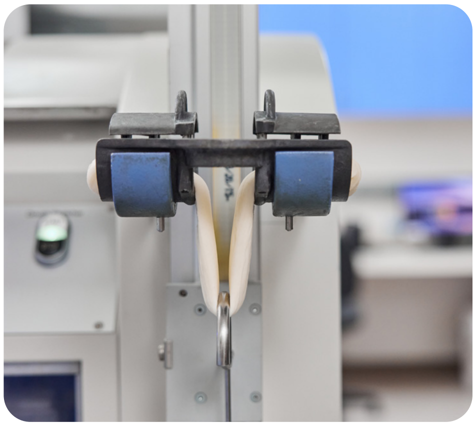
- Higher P/L values typically indicate a more elastic dough.
- Lower P/L values typically indicate a more extensible dough.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.
AACCI 54-30.02, constant hydration method, Chopin-Alveolab.	AACCI 54-30.02, constant hydration method, Chopin-Alveolab.	AACCI 54-30.02, constant hydration method, Chopin-Alveolab.	AACCI 54-30.02, constant hydration method, Chopin-Alveolab.	AACCI 54-30.02, constant hydration method, Chopin-Alveolab.	AACCI 54-30.02, constant hydration method, Chopin-Alveolab.

EXTENSOGRAPH

The Extensograph measures the elasticity and stretch resistance of dough, generating a force-time curve for a piece of dough that is unilaterally stretched until it breaks. This test provides insight into gluten strength, extensibility, and dough performance under rest and mechanical stress. It is also used to evaluate the effects of fermentation time and additives on dough performance. Results include:



RESISTANCE (R_{50})

The height of the curve 5 cm (50 mm) after it begins to rise, measured in Brabender Units (BU). It reflects the force counteracting the stretching.

- A higher resistance value usually indicates strong gluten and indicates the dough is stronger and harder to stretch (more resistance to extension).
- A lower resistance value usually indicates weak gluten and that the dough is more relaxed and easier to stretch.

RESISTANCE MAX (R_m)

The maximum height of the curve, measured in BU. It reflects the maximum force the dough can withstand before breaking.

- A higher R_m value usually indicates the dough is strong and elastic, which is good for bread and doughs that need to withstand long fermentation times while still being strong enough to capture the fermentation gas produced.
- A lower R_m value usually indicates the dough is not very strong and may not be capable of trapping gas produced during fermentation.

EXTENSIBILITY

The total length of the curve at the baseline measured in centimeters. It reflects how far the dough was stretched before breaking.

- A higher extensibility value usually means greater dough stretchability. This is preferred for products that require flexible, stretchable dough – such as pizza crusts, flatbreads, and laminated pastries. Higher extensibility is also desirable for products that require the ability to expand as gas is produced during fermentation, such as breads, rolls and buns.
- A lower extensibility value usually indicates limited stretching ability and that the dough may tear easily or be hard to shape. This is preferred for products that need shape retention and/or minimal spread, like cookies, crackers, and some types of pan breads.

AREA

The area under the curve, reported in cm^2, combines resistance and extensibility.

- A higher area value usually indicates the dough has a good balance of strength and extensibility. This is preferred for products that require strong gluten and good gas retention, such as pan breads and artisan loaves.
- A lower area value usually indicates a weak dough structure, which may collapse or underperform during baking. This is preferred for products that are better suited for tender or flaky products like cookies, crackers, pastries, and flatbreads, where minimal dough strength is desired.

R_{50}/E RATIO & R_m/E RATIO

The ratio is calculated by dividing the resistance at 50 mm by the extensibility. This ratio shows the balance between dough stiffness and stretchability.

- A higher ratio usually indicates the dough is stiff and elastic (high R, low E) and may resist shaping. This is preferred for products that need structure and volume.
- A lower ratio usually indicates the dough is soft and extensible (low R, high E) and may lack structure. This is preferred for products that need flexibility or minimal gluten strength.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW	NORTHERN DURUM	DESERT DURUM
Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Reported on a 14% mb.	Not tested.	Not tested.
AACCI 54-10.01, modified 45 and 135-min rest.	AACCI 54-10.01, modified 45 and 135-min rest.	AACCI 54-10.01, 45-min rest.	AACCI 54-10.01, 45-min rest.		

EVALUATION OF END-PRODUCTS

End-product tests are the final laboratory testing in the evaluation of wheat quality. Standardized methods are used to evaluate the suitability of the sample for that product or similar products.

BREAD (PUP LOAF)

The pup loaf or pan bread test provides an evaluation of wheat and flour quality characteristics. It helps determine the suitability of the wheat sample for baking by measuring attributes such as baking absorption, loaf volume and specific volume.

BAKING ABSORPTION

The water required for optimum dough mixing performance, expressed as a percentage of flour weight on a 14% mb. Higher absorption typically allows for greater dough yield and can improve bread volume, but excessive water may compromise dough structure or baking consistency.

VOLUME

The measured volume of a test loaf after baking. Higher loaf volumes indicate better baking performance for pan bread due to better gas retention and dough expansion.

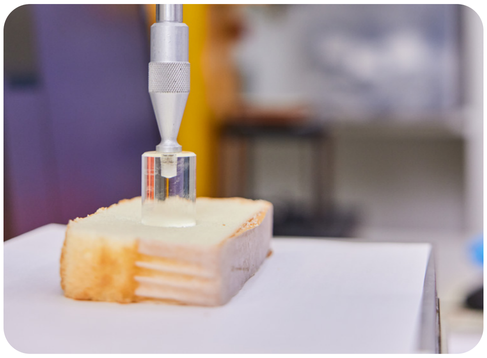
SPECIFIC VOLUME

The ratio of volume in milliliters to the weight in grams. Higher specific volume is generally preferred, as it indicates better gas retention and dough expansion.

The laboratory test method for each class is as follows:

HRW	HRS	SW	SRW
AACCI 10-10.03 (“pup loaf” method).	AACCI 10-09.01 (long fermentation method) modified.	AACCI 10-10.03 (“pup loaf” method).	AACCI 10-10.03 (“pup loaf” method).
100 g flour at 14% mb with optimized water absorption is mixed to optimum development with other ingredients (6% sugar, 3% shortening, 1.5% salt, 1.0% instant dry yeast, 50 ppm ascorbic acid and 0.25% malted barley flour) in a 100 g pin mixer with head speed of 100 to 125 rpm. The dough is fermented for 60 min, punched two times, then molded, panned and proofed for 60 min before baking at 218°C (425°F) for 18 min. Loaf volume is measured by rapeseed displacement immediately after baking.	15 SKB units (fungal amylase/100 g flour, 1.5% instant dry yeast, 10 ppm ammonium phosphate, 2% added shortening). Dough is mechanically punched, molded and baked in “Shogren-type” pans. Scoring is based on a 1 to 10 scale with higher numbers indicating preferred quality attributes.	180 min fermentation. Volume is measured by laser light using a Tex Vol Instrument (BVM-L370).	Producing two loaves per batch using dry yeast and ascorbic acid. After mixing, the dough is divided into two equal portions, fermented for 160 min, molded and panned in pup loaf pans before proofing and baking. Loaf volume is measured by Tex Vol Instrument (BVM-L370).

SPONGE CAKE



The sponge cake method assesses the performance of soft wheat flour in producing sponge cakes. It measures attributes such as cake volume and hardness which are indicators of the flour's baking quality. Flour with low protein content, weak gluten characteristics and low ash content make good quality sponge cake.

VOLUME

Sponge cake volume is measured by laser scanning topography using a Tex Vol Instrument (BVM-L370)). Larger volume indicates better flour, especially for soft wheat flours with low protein and weak gluten characteristics.

HARDNESS

Sponge cake hardness is measured using a TA-XT Plus texture analyzer, which quantifies the grams of resistance during compression. This number reflects the force required to compress the cake, with lower values indicating a softer texture.

Note: Total Score is a subjective measurement and as of 2023 is no longer reported.

The laboratory test method for each class is as follows:

SW	SRW
Mechanical folding method as described by Mense et al. in Cereal Chemistry https://doi.org/10.1002/cche.10791, 2024. Japanese standard method as described by Nagao in Cereal Chemistry 53:977-988, 1976. Sponge cake control flour is "western white."	Mechanical folding method as described by Mense et al. in Cereal Chemistry https://doi.org/10.1002/cche.10791, 2024.

SUGAR-SNAP COOKIES (BISCUITS)

The cookie method assesses the performance of soft wheat flour in producing cookies. It measures attributes such as cookie diameter (width), height (thickness), and spread factor, which are indicators of the flour's baking quality. Flour with low protein content and weak gluten characteristics is ideal for producing high-quality cookies.

DIAMETER

Cookie diameter (d), or width, is a static measurement of spread (in cm) and set time during baking and is an indicator of good pastry-making and specifically cookie-baking potential. Larger diameter is preferred.

HEIGHT

Cooking height (h), or thickness, is closely related to diameter with larger diameters (measured in cm) typically leading to reduced height.

SPREAD FACTOR

Cookie spread factor is determined by d/h ratio with adjustments to constant atmospheric pressure and conditions depending on elevation and barometric pressure reading corrected to sea level.

The laboratory test method for each class is as follows:

SW	SRW
AACCI 10-50.05, macro-method.	AACCI 10-50.05, macro-method.
Note: Prior to 2023, SW cookie testing was conducted according to micro-method AACCI 10-52.02. Diameter and height of cookies made with both AACCI 10-52.02 and 10-50.05 are different due to changes in formulation and procedure; however, the overall trend is similar.	

STEAMED BREAD (CHINESE SOUTHERN-TYPE)

The steamed bread method assesses the performance of wheat flour in producing Chinese southern-type steamed bread. It measures attributes such as specific volume and hardness which are indicators of the flour's steaming quality.

SPECIFIC VOLUME

The ratio of volume in milliliters to the weight in grams. Higher specific volume is generally preferred, as it indicates better gas retention and dough expansion.

HARDNESS

Steamed bread hardness is measured using a TA-XT Plus texture analyzer, which quantifies the grams of resistance during compression. This number reflects the force required to compress the steamed bread, with lower values indicating a softer texture.

The laboratory test method for each class is as follows:

SW
Reported on a 14% mb. Steamed bread was prepared using no-time dough methods (WMC procedures) • SW, white club (WC, Club): flour 100% (400 g), sugar 15%, shortening 4%, baking powder 1.2%, instant yeast 0.8%, nonfat dry milk powder 3% and water 39 to 43%. Yeast is dissolved in water before use.

SPAGHETTI (PASTA)

The spaghetti method assesses the performance of durum wheat flour in producing spaghetti. It measures attributes such as cooked weight, cooking loss, firmness, and color, which are indicators of the flour's quality.

Spaghetti (or pasta) was made using the laboratory procedure described by Walsh, Ebeling, and Dick, Cereal Sci. Today: 16(11) 385, 1971. A 1-kg semolina was mixed with the appropriate amount of water that gave a dough consistency of 30-32% total water absorption.

The other processing conditions used were:

NORTHERN DURUM & HRS	DESERT DURUM
Water temperature, 40 C, extruder shaft speed 25 rpm and vacuum, 18 in. Hg; the dough was pressed through an 84-strand teflon-coated spaghetti die with 1.57 mm openings. Semolina-water mixture is extruded using a DeMaco laboratory pasta extruder. The extruded spaghetti samples were dried at high temperature (70-90 C) for 12 hrs, using maximum temperature and relative humidity of 73 C and 83%, respectively.	Water temperature, 40 C, extruder shaft speed 29 rpm and vacuum, 18 in. Hg; the dough was pressed through an 96-strand teflon-coated spaghetti die with 1.78 mm openings. Semolina-water mixture is extruded using a Standard Industry laboratory pasta extruder. The extruded spaghetti samples were dried at low temperature (40 C) for 18 hrs, using maximum temperature and relative humidity of 40 C and 95%, respectively.

COOKED WEIGHT

Spaghetti cooked weight is the increase in weight of pasta by cooking and is often assessed alongside firmness values when evaluating the cooking qualities of a spaghetti sample. Typically, the cooking weight increases by about three times, or 300%.

NORTHERN DURUM & HRS	DESERT DURUM
10 g of dry spaghetti are placed in 300-350 ml boiling distilled water and cooked for 12 min. The cooked and drained spaghetti sample is weighed, and the results are reported in grams.	10 g of dry spaghetti are placed in 300-350 ml boiling distilled water and cooked for 12 min. The cooked and drained spaghetti sample is weighed, and the results are reported in grams.

COOKING LOSS

Spaghetti cooking loss is a measure of the amount of soluble components – such as starch, proteins and sugars – that leach from pasta during cooking.

NORTHERN DURUM & HRS	DESERT DURUM
AACC Method 66-50.01. After drying the residue is weighed and reported as percentage of the original dry sample.	AACC Method 66-50.01. After drying the residue is weighed and reported as percentage of the original dry sample.

FIRMNESS

Spaghetti firmness is a measure of the amount of work required to bite through a strand of spaghetti.

NORTHERN DURUM & HRS	DESERT DURUM
AACCI Method 66-50.01 with a Plexiglas tooth attached to a Texture Analyzer (Model TA-XT2, Texture Technology Corp., Scarsdale, New York). Firmness values will differ due to variance in dry spaghetti diameter ranges: Northern Durum is 1.35 to 1.45 mm.	AACCI Method 66-50.01 with a Plexiglas tooth attached to a Texture Analyzer (Model TA-XT2, Texture Technology Corp., Scarsdale, New York). Firmness values will differ due to variance in dry spaghetti diameter ranges: Desert Durum® is 1.60-1.65 mm.

COLOR

Spaghetti color is measured after drying using a CIE 1976 L*a*b* color system and provides color in three dimensions:

- L* represents lightness (brightness), where higher values indicate brighter pasta.
- a* represents the red-green axis and is not typically emphasized in pasta evaluation.
- b* represents yellowness, where higher values indicate more yellow pasta.

NORTHERN DURUM & HRS	DESERT DURUM
CIE 1976 L*a*b* color system. See "color" under Flour and Semolina Factors. Northern Durum and HRS are measured with a CR-410 colorimeter.	CIE 1976 L*a*b* color system. See "color" under Flour and Semolina Factors. Desert Durum® is measured with a CR-200 colorimeter.

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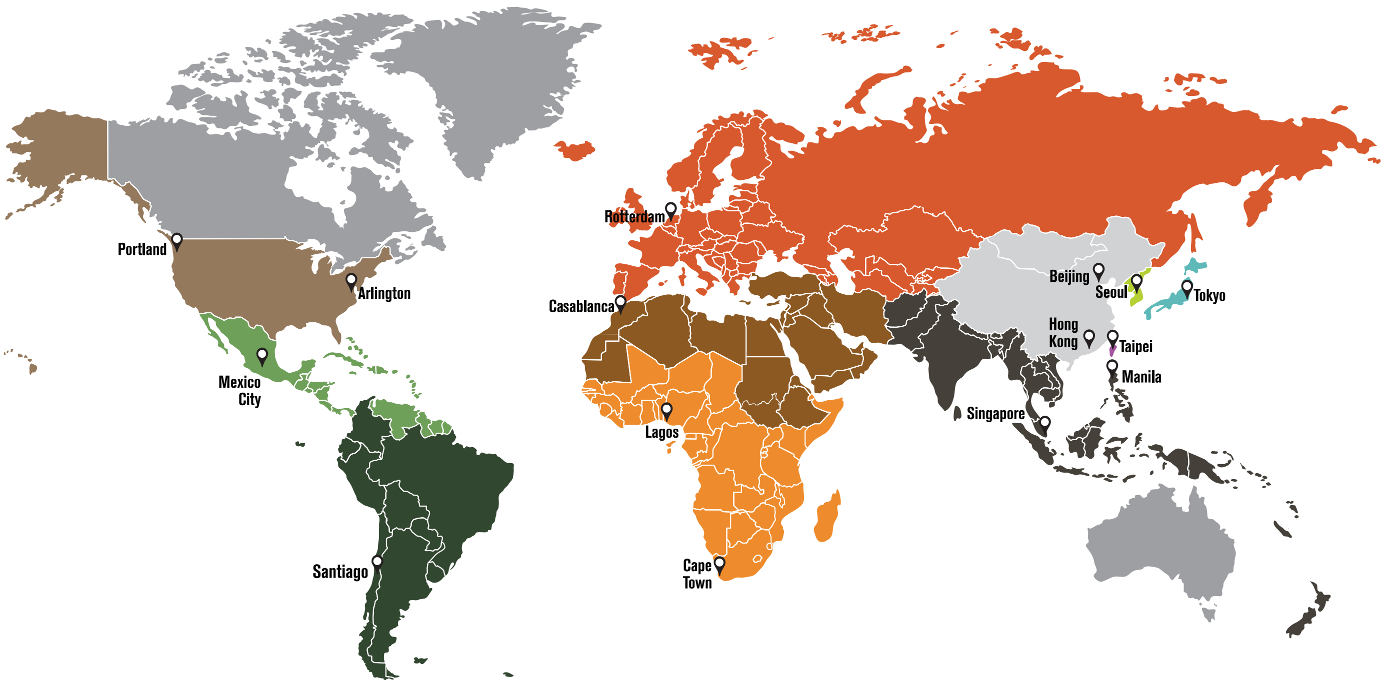

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