WHAT THE TESTS MEAN

WHEAT GRADE TESTS

Wheat Grade Tests reflect the physical quality and condition of a sample and thus may indicate the general suitability for milling. The U.S. grade for a sample is determined by measurement of such factors as test weight, damaged kernels, foreign material, shrunken and broken kernels and wheat of contrasting classes. (See table on page 44.) All numeric factors other than test weight are reported as a percentage by weight of the sample. Grade determining factors include:

- **TOTAL DEFECTS** is the sum of damaged kernels, foreign material and shrunken and broken kernels.
- **TEST WEIGHT** is a measure of the density of the sample and may be an indicator of milling yield and the general condition of the sample, as problems during growing season or at harvest often reduce test weight.
- **DAMAGED KERNELS** are kernels which may be undesirable for milling because of disease, insect activity, frost or sprout damage, etc.
- **FOREIGN MATERIAL** is any material other than wheat that remains after dockage is removed. Because foreign material may not be removed by normal cleaning equipment, it may have an adverse effect on milling and flour quality.
- **SHRUNKEN AND BROKEN KERNELS** are kernels that were insufficiently filled during growing and have a shrunken or shriveled appearance or were broken in handling. Such kernels may reduce milling yield.
- **VITREOUS KERNELS** in hard red spring wheat are kernels that are uniformly dark and have no spots that appear chalky or soft. In durum, vitreous kernels have a glassy and translucent appearance without any spots that appear chalky.

WHEAT NON-GRADE TESTS

DOCKAGE is the percentage by weight of any material easily removed from a wheat sample using the Carter Dockage Tester. Dockage, because it can be removed, should not have any affect on milling quality but may have other economic effects for buyers. Grade factors are determined only after dockage is removed.

MOISTURE content is the percentage of water by weight of 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 physically removed from a sample, other analysis results are often mathematically converted to a standard moisture basis (mb), such as 14%, 12% or dry matter, so results can be compared.

PROTEIN content is the percentage of protein by weight in a sample. Protein can be quickly and easily measured and therefore is an important factor in determining the value of wheat since it relates to many processing properties, such as water absorption and gluten strength. Low protein is desired for products such as snacks or cakes. High protein is desired for products such as pan breads, pasta, buns and frozen yeast-raised products.

ASH content is the percentage of minerals by weight in wheat or flour. In wheat, ash is primarily concentrated in the bran and is an indication of the flour yield that can be expected during milling. In flour, ash content indicates milling performance by indirectly revealing the amount of bran contamination in flour. Ash in flour can impart a darker color to finished products. Products requiring white flour call for low ash content, while whole wheat flour has higher ash content.

1000 KERNEL WEIGHT is the weight in grams of one thousand kernels of wheat and may indicate grain size and expected milling yield.

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

SINGLE KERNEL CHARACTERIZATION SYSTEM (SKCS) measures 300 individual kernels from a sample for size (diameter), weight, hardness (based on the force needed to crush) and moisture. Detailed SKCS results (not reported in this booklet) include the distribution of these factors, which may be an indicator of the uniformity of the sample and help millers experienced with the system optimize flour milling yields. Kernel characteristics are related to milling properties such as tempering, roll gap settings and flour starch damage content.

SEDIMENTATION value is a measure of the sediment that results when lactic acid is added to a sifted ground wheat sample and can be used as an indicator of gluten quality and thus the baking quality of wheat flour.

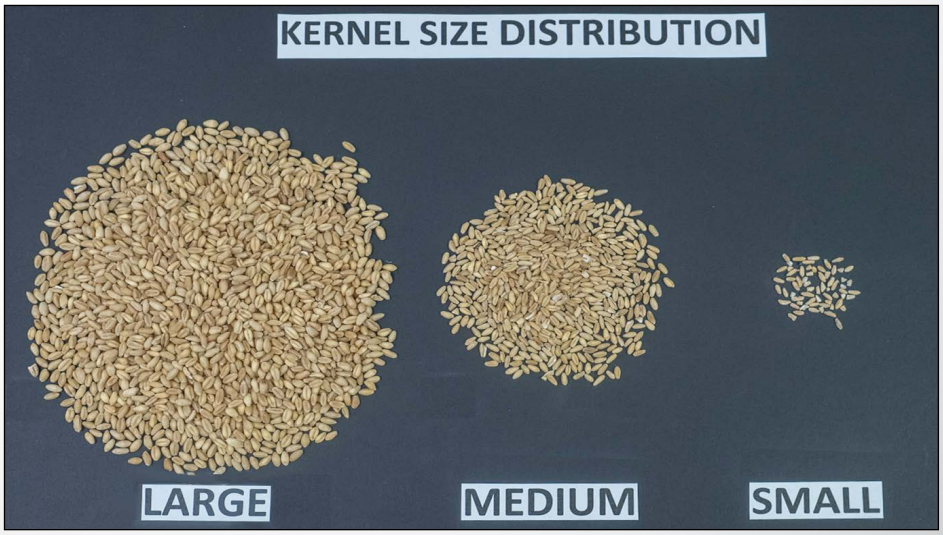
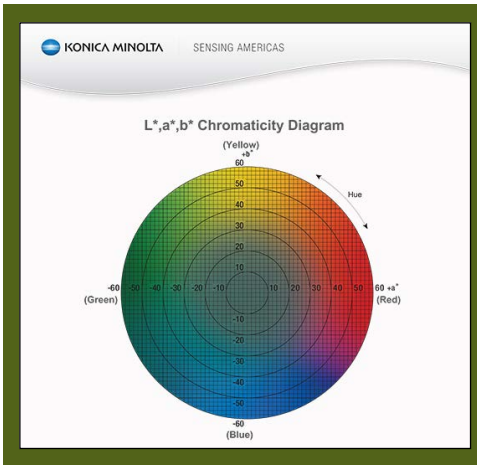


Photo courtesy of Wheat Marketing Center

FALLING NUMBER indirectly indicates alpha-amylase activity, which results from sprout damage. High falling number values indicate low alpha-amylase activity. Sufficient alpha-amylase activity is required in flour for some products such as yeast-raised bread. However, excessive alpha-amylase in wheat cannot be removed and it is difficult to blend to a lower alpha-amylase content. The resulting flour produces a sticky dough that can cause problems during processing and products with poor color and weak texture. Falling number usually correlates closely with amylograph.

DON (DEOXYNIVALENOL) is a mycotoxin produced by fusarium fungi in grain.



COLOR is a numerical system to measure a sample's lightness (L*) on a scale of 0 to 100 and "chromaticity" or hue on two scales each running from -60 to +60 for green-red (a*) and blue-yellow (b*). High L* values indicate a bright color, and higher b* values indicate more yellow. Flour color is influenced by the wheat's endosperm color particle size and the ash content of the flour and often affects the color of the finished product. Durum semolina color is heavily influenced by particle size.

FLOUR DATA

EXTRACTION is the percentage by weight of flour obtained from a wheat sample. In a commercial flour mill, the extraction rate is critically important to mill profitability. In a laboratory, milling with the Buhler Laboratory mill is mainly done to obtain flour for other tests. The Buhler Laboratory mill extraction rate is always significantly lower than the rate that can be obtained on a commercial mill, but may be useful for comparison between crop years.

WET GLUTEN is a measure of the quantity of gluten in wheat or flour samples as determined using the Glutomatic system. Gluten forms when water is added to the protein in wheat and is responsible for the elasticity and extensibility characteristics of flour dough.

GLUTEN INDEX is also determined by the Glutomatic system and is a measure of gluten strength regardless of the quantity of gluten present. Gluten index is used commercially to select durum samples with strong gluten characteristics. In bread wheat, a variety of factors other than gluten quality can affect the results though very low gluten index may be an indication of protein damage from insect or disease activity.

AMYLOGRAPH measures flour starch pasting properties that are important to end products such as sheeted Asian noodles. Amylograph also measures enzyme (alpha-amylase) activity which results from sprout damage. Amylograph results usually correlate closely with falling number results.

STARCH DAMAGE is the percentage by weight of damaged starch in a flour sample, which is a measure of the physical damage done to starch granules during milling. Bread (hard) wheat flour typically has higher starch damage than soft wheat flour. Highly damaged starch readily absorbs more water, which affects dough mixing and other processing properties. Because starch damage depends on how the sample was milled, starch damage is important for interpreting other results reported.

SOLVENT RETENTION CAPACITY (SRC) is the weight of solvent held by flour after centrifugation, expressed as a percent of the flour weight on a 14% mb. The results can be useful for predicting commercial baking performance, especially for low protein soft wheat flours. The different solvents used relate to the functionality of specific flour components as follows:

- **WATER –** Water absorption
- **SUCROSE –** Pentosans
- **LACTIC ACID –** Glutenins
- **SODIUM CARBONATE –** Damaged starch
- **GLUTEN PERFORMANCE INDEX (GPI) –** is defined as a ratio of three of the SRC values, lactic acid/(sodium carbonate + sucrose), and is a good predictor of overall performance of flour glutenins, especially for bread wheat flour.

EVALUATION OF END-PRODUCTS

BAKING ABSORPTION is the water required for optimum dough mixing performance, expressed as a percent of flour weight on a 14% mb.

CRUMB GRAIN AND TEXTURE is determined on a scale of 1 to 10 by visual comparison to a standard using a constant illumination source. Higher scores are preferred.

LOAF VOLUME is the volume of the test loaf after baking. Higher loaf volumes indicate better baking performance for pan breads.

SPECKS are small particles of bran or other material that escaped the wheat cleaning and semolina purifying process and thus depend on the milling process as well as the characteristics of the durum. Specks, which can detract from pasta appearance and desirability, are visually counted in a semolina sample and reported as the number in 10 square centimeters.

SUGAR SNAP COOKIE, SPONGE CAKE, CHINESE SOUTHERN-TYPE STEAMED BREAD, SPAGHETTI, AND HARD WHITE (HW) NOODLE AND STEAMED BREAD tests all use standardized methods to prepare specific end products to evaluate the suitability of the sample for that product or similar products. Details on many of these tests can be found in the Analysis Methods section of this booklet.

DOUGH PROPERTIES

FARINOGRAPH generates a curve that indicates the power used over time as flour and water are mixed into dough. The results describe the mixing properties of the dough and include:

- **PEAK TIME** is the time interval from the first addition of water to the maximum consistency immediately prior to the first indication of weakening. Long peak times indicate strong gluten and dough properties while short peak times may indicate weak gluten.
- **STABILITY** is the interval 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"). Long stability times also indicate strong gluten and dough properties, useful in products such as yeast-raised breads while short stability times indicate weaker gluten useful in many confectionary products.
- **ABSORPTION** is the amount of water (as a percent by weight of 14% moisture wheat flour) required to center the curve peak on the 500-BU line. High water absorption provides economic advantages for producing more dough pieces than flour with lower water absorption.

EXTENSOGRAPH generates a force-time curve for a piece of dough stretched until it breaks. Results include:

- **RESISTANCE**, measured at the maximum curve height in Brabender units (BU), reflects the maximum force applied and indicates the resistance of the dough to extension.
- **EXTENSIBILITY**, measured as the total length of the curve at the base line in centimeters, reflects how far the dough was stretched.
- **AREA** is the area under the curve reported in square centimeters.

These factors help describe the gluten strength and dough extensibility characteristics of flour for a wide range of end products. The extensograph can also evaluate the effects of fermentation time and additives on dough performance.

MIXOGRAPH generates a graph that records the force needed to mix flour or semolina and water into dough. The mixograph is similar to the farinograph but is quicker and uses a pin mixer and a smaller flour sample. Peak height and peak time are common mixing parameters that are determined from mixogram.

- **CLASSIFICATION** indicates dough characteristics for durum milled fractions on a scale of 1 to 8 with higher values indicating stronger dough properties.
- **PEAK TIME** is the interval from the first addition of water to when the curve peaks and is considered an indicator of both the rate of dough development and hydration rate. Short peak time indicates a quick hydration rate and long peak time a slow hydration rate.
- **PEAK HEIGHT** is the height of the curve at peak time measured from the bottom of the mixogram paper to the middle of the band width at the curve peak. Peak height is primarily a function of protein content, but is affected by water absorption and dough strength. Peak height increases with protein content and dough strength, decreases with water absorption and is measured in "Mixograph units (MU)". An MU is one rectangle on the mixogram.

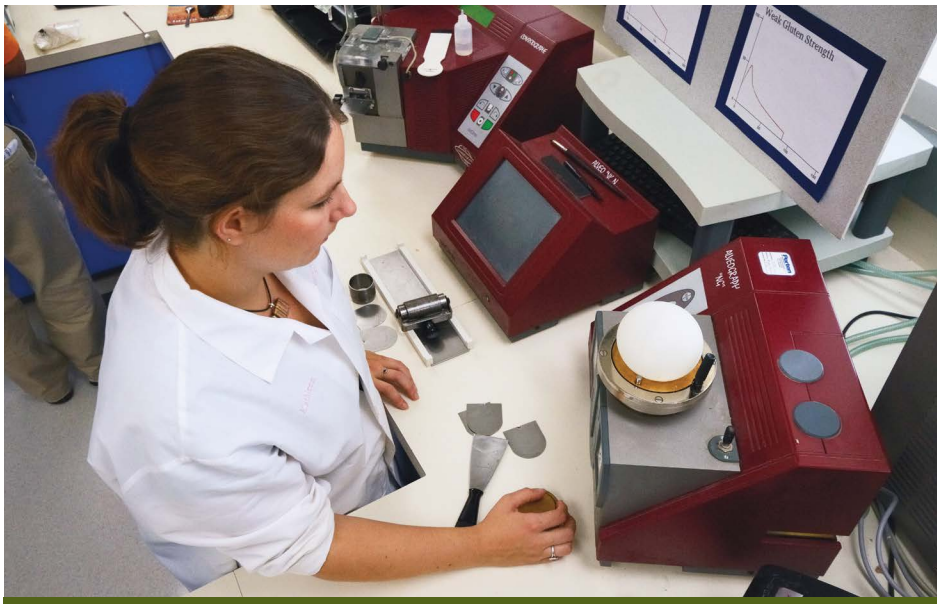


Photo courtesy of Wheat Marketing Center

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. Values reported include:

- **P** ("overpressure" or resistance), measured in millimeters to the maximum height of the curve, reflects the maximum pressure while blowing the bubble of dough and indicates dough resistance to extension.
- **L** (length), the length of the curve measured in millimeters, reflects the size of the bubble and indicates dough extensibility.
- **W** (the area under the curve) reflects the amount of energy needed to inflate the dough to the point of rupture and indicates dough strength.

The alveograph is well suited for measuring the dough characteristics of weaker gluten wheat and, with adaptive hydration and mix time, of stronger wheats including durum. Requirements differ depending on intended flour use. A low P value (indicating weak gluten) and long L value (high extensibility) are preferred for cakes and confectionery products; P/L close to 1 and high W values (strong gluten) are preferred for pan breads; and low P and long L values are favored for durum for pasta semolina.

Source: U.S. Wheat Associates