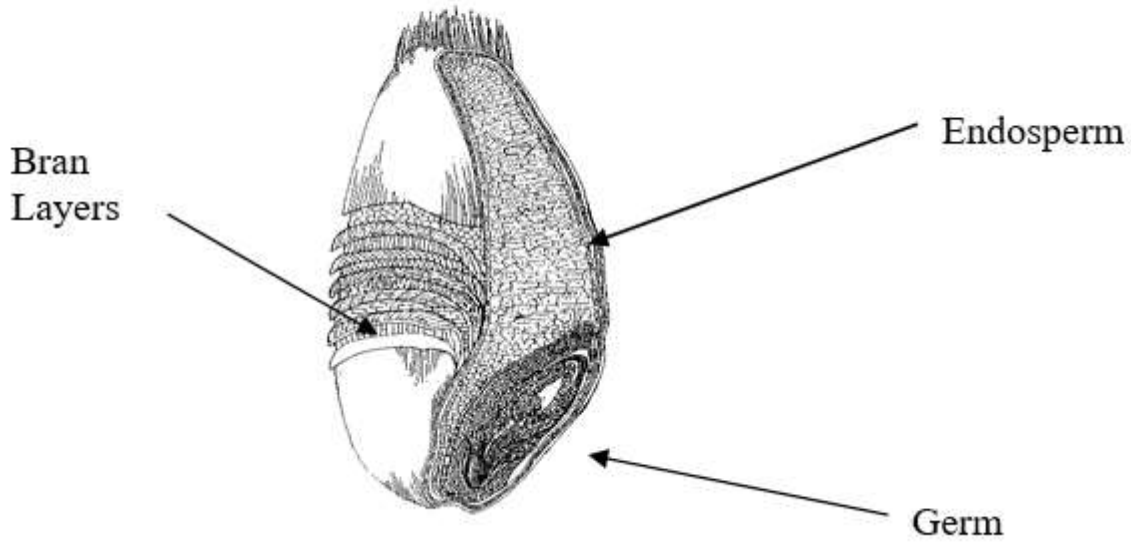
Flour Reports and Flour Testing

The Wheat Kernel



The wheat kernel is made up of three main parts; the Bran, which is the outer protective layers of the grain, the Endosperm which provides the food for the grain when allowed to grow and the Germ is the embryonic part which is responsible for the reproduction and growth of the new plant.

The process of making flour begins with the miller receiving the grain, cleaning it, then conditioning it. When the grain has been conditioned to the right moisture content, the milling process begins with the removal of the bran and germ from the Endosperm. This is done through sets of break rolls which are fluted and designed to tear open the grain. As the grain passes through each set of break rolls, more endosperm is scaped from the bran. After each pass of the rolls the flour and bran stocks are passed through large sifters which grade the stocks and move them onto the next stage of the process until the bran is fully removed. With the bran removed, the endosperm now passes through the reduction rolls which are smooth and designed to grind the remaining stocks into a white flour.

The miller is charged with milling the flour to meet a specification for the end user. This is achieved by either milling single wheats then blending them into a flour or blending different grades of wheat into a grist then milling them to meet the specification. At the end of the milling process the flour is tested to make sure it meets the customers expectation. The testing of the flour covers several specific characteristics which gives the baker an indication of the flour's strength and stability, and this is done on several different machines.

The Farinograph tests for strength, stability, development time and the water absorption of the flour. The falling number of the flour is a measure of the enzymic activity, and this is tested on a falling number machine. The moisture content and protein levels are tested on a NIR or Near Infrared machine. The Extensograph machine tests for elasticity and extensibility of the dough which also equates to the strength of the flour as well.

Once these tests are completed, a flour report or a COA (Certificate of analysis) is produced for that load or batch of flour.

Wheat Requirements

Bread Making Wheat:
Bread making wheat sourced from New Zealand / Australian with a minimum protein level of 11.5%

Bread Making Flour:
Milled from sound bread making wheats with strong dough making properties. Flour is typically used for bread making but also suitable for cakes and pastry where strength is needed to support and carry other ingredients.

Pastry Making Wheat:
Milled from New Zealand / Australian bread wheats with a minimum protein level of 11.5%

Pastry Making Flour:
This is a low extraction flour using similar grist's of wheat to make bread flour. Due to the lower extraction rate, this gives a lower ash content and a higher Minolta light index, recommended for pastry. The extraction rate / lower ash content ensures a lower level of bran in the flour.

Biscuit Making Wheat:
Milled from Soft local or Australian wheats. Maximum protein level of 10.5%, ideal level around 9.5% with weak dough properties and low water absorption. Falling number around 300 seconds, ideal 350 seconds.

Biscuit Making Flour:
A white, low protein soft flour milled from sound milling grade wheat with weak dough qualities. Flour is typically used for biscuits, cones and general carriers where baking qualities are not important.

Flour Report

Metric Name	**Unit of Measure**	**Parameter Range**			
		Bread	Pastry	Streamed Pastry	Biscuit
Moisture	%	13 – 14.9	13 – 14.9	13 – 14.9	13 – 14.9
Protein	%	11 - 13	7 - 10	9 – 10.5	9 – 10.5%
Water Absorption	%	63 - 66	63 - 66	63 - 66	54 - 58
Colour - Minolta	L Value	79.5 – 84	82 -	84 -	79.5 - 82
Falling number	Seconds	300 -			300 -
Development Time	Time	4.00 – 7.50	5.00 -	5.00 -	1.5 - 3
Stability	Time	5.00 -	5.00 -	5.00 -	
Resistance / Height	BU	250 - 500			
Extensibility	Centimeters	17 – 22.5			
Ash Content	%		0.37 – 0.50	0.37 – 0.50	

The resistance is measure in Brabender Units or Extensograph units

North and South Island Flour

The North Island (NI) flour is milled from white wheats grown in Australia; the South Island (SI) flour is milled from red wheats grown in the South Island.

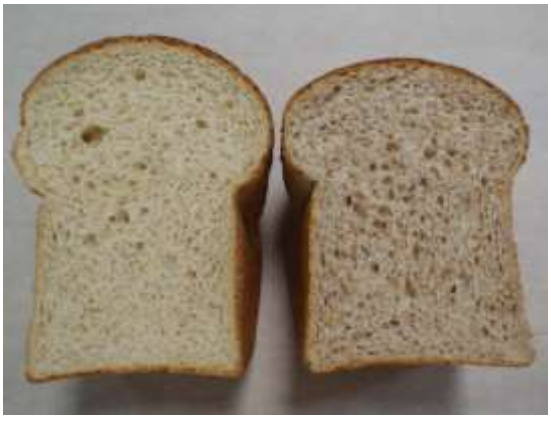
The Australian white wheat has less bran layers compared to the New Zealand red wheat which has more layers for more protection for the harsher winter conditions. The bran layers are also thicker.

Wholemeal dough made with the different flours, NI on the left, SI on the right.

The Australian wheat produces a white bread with a yellowish tint to the crumb and wholemeal bread with a golden yellow crumb, this colour is produced from the colour of the bran.

The South Island wheat produces bread with a whiter appearance to the crumb but the wholemeal bread has a darker reddish-brown colour to the crumb.

Wholemeal bread made with the different flours, NI on the left, SI on the right.



Moisture and Protein Test

NIR – Near Infrared Machine

Moisture - Protein

Moisture levels in flour are controlled by the level of water added to the conditioning of the wheat prior to milling and allow for moisture that is lost during the milling process. Water is also added to assist in the removal of the bran layers. If the wheat is low in moisture, then the bran will fractionate, causing small pieces of bran to remain in the flour. This can reduce the strength of the flour and make the flour look specky. The moisture level is tested on an NIR or Near Infrared measuring machine. Legally a flour must not exceed a moisture level of 15%

Protein is also tested on the NIR and measures the level within the flour.
LECO is the most accurate method for testing Protein content, which is a nitrogen-based test and is expressed as a percentage on flour weight. The protein quality and quantity in a flour is controlled by the selection and blending of different grist's of wheat.

Starch Damage

This test measures the percentage of damaged starch. Damaged starch are cells that are ruptured during the milling process and react more rapidly with enzymes and have a greater water absorption capacity. Higher starch damage will result in a higher water absorption but will also cause a problem with sticky doughs. The mills typically target a figure between 7 to 8%. Lower starch damage will result in lower water absorption and can reduce the keeping qualities by less enzymic activity on the starch. This measure can now be carried out on a NIR machine.
Solvent Retention Capacity is the most accurate method to test for the Starch Damage percentage.

Falling Number Test

The Falling Number Test Machine

The test:

A sample of flour is mixed with water and put into a hot water bath. A plunger is used to blend the flour and water mixture until the starch in the flour has gelatinized. The plunger is then suspended at the top of the mixture and allowed to drop. As the plunger falls through the mixture, the process is timed and measured in seconds, this becomes the Falling Number.

We know that the alpha amylase will digest or break down the gelatinised starch, making it thinner. The thinner slurry will not be able to hold the weight of the plunger and therefore the more the enzymes present the faster the plunger will fall.

The falling number test is used to measure the alpha amylase or enzymic activity of wheat or flour. Alpha amylase is an enzyme that is naturally present in flour and is active in breaking down the starch into simpler sugars. Fortunately, the enzyme is only active when high amounts of water are present and this is the case in most batters and doughs. Wheat in good condition will naturally contain a small quantity of alpha amylase.

If the wheat has been through wet conditions before harvest, then it may begin to germinate and sprout, which increases the amount of alpha amylase. This is part of the reproduction process of the wheat kernel. Once the kernel has begun to germinate, the enzymes are released. The enzymes break down the starch into sugars so that the plant can use them for growth until it starts producing energy through photosynthesis. Although it is good for seed wheat, the enzymes released is a bad for milling or bread making wheat as it will produce a flour with a lower falling number.

If the falling number is low, then this can cause a sticky crumb, the collapsing of the bread out of the oven and on a plant scale, a great deal of damage with the gumming up of the slicing blades. A low falling number is a figure below 250. A low falling number flour cannot be fixed. Baking the product at a higher temperature for longer will only help to a certain degree.

If the number is too high, above 500 then there's the possibility of a lack of fermentable sugars for the yeast to feed on which will reduce the gassing power and result in low volume bread from the oven. This may also cause premature staling of the finished product as well. Improvers are now equipped with amylases to help with the keeping qualities of the loaf and this will help with a high falling number flour. If an improver system is not being used, then a Diastatic malt flour will be needed. Diastatic malt flour is made from germinated barley, then milled into a flour. This flour is high in enzymic activity and will help with breaking down the starch for the yeast to feed on. An ideal falling number is between 300 and 400 seconds.

Flour Colour Grading - Minolta – Light Index (Pictured)

Minolta – Light Index - colour grading machine

Colour Grade is the measure of the whiteness of the flour and can be linked to the amount of bran that is present and the efficiency of the milling process. It can also be a characteristic of the type of wheat being used. The higher the number, the whiter the flour; our standard bread making flour sits between 79.5 and 81. Premium pastry flours should have a reading of 84 and higher as bran particles will oxidise in the made-up dough, making them and go grey during storage in the fridge or freezer.

The Brabender Farinograph Machine

The Farinograph Machine

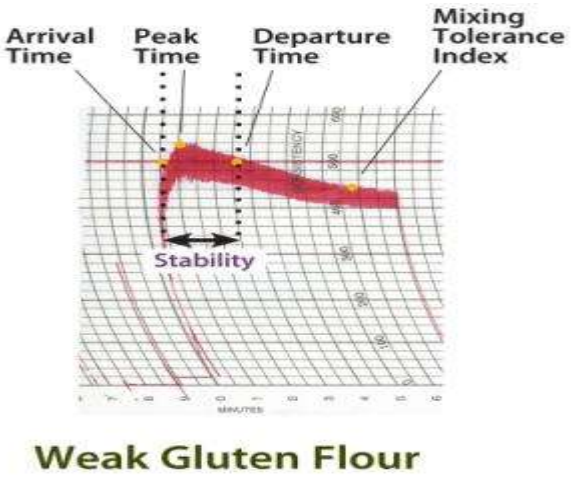
Z arm mixer

Dough Mixing

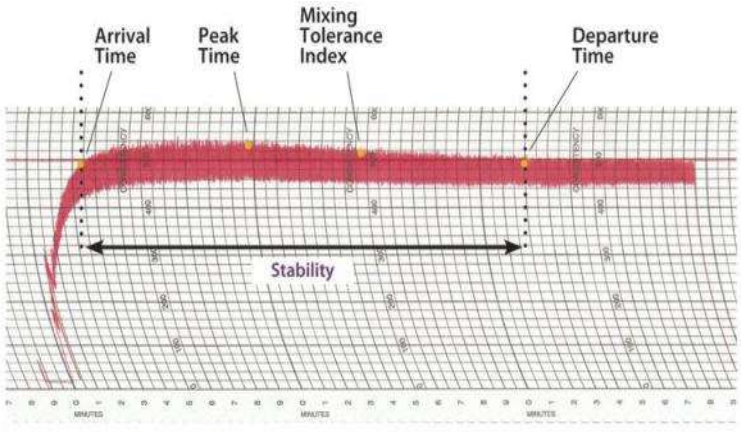
The test:

A measured amount of flour is placed in the mixing chamber. The mixer is started then the water is added until the measuring unit reaches the 500 line on the graph. The mixer continues to mix the dough until the measuring unit has dropped under the 500 line.

As the dough is being mixed, the machine is measuring the amount of resistance exerted on the mixing blades and this is displayed in graphical form. The machine also measures the time it takes for the dough to reach full development and the time the dough is stable for.



Weak Gluten Flour



Strong Gluten Flour

The farinograph is commonly used throughout the world for testing the quality of a flour. The test results are used to estimate the optimum amount of water required to make a dough, to evaluate blending requirements for flour grist's and to check on flour consistency. The results are also used to predict a flours tolerance or intolerance to mixing and dough development. The resulting flour report gives the baker an indication of the strength and characteristics of the flour.

Water Absorption
The water absorption is given as a percentage of flour weight and is taken when the graphed line centres on the 500 Brabender unit line.

Arrival Time
This is the time when the top of the curve touches the 500-BU line. This indicates the rate of flour hydration (the rate at which the water is taken up by the flour). Arrival time is expressed in minutes.

Peak Time / Development Time
Peak time: is the measure of when the development of the dough reaches its peak then begins to drop off.
Development time: is taken from the start of the mixing to the time when the graph leaves the 500 line. This gives an indication of optimum mixing time under standardised conditions.
Peak or Development time is expressed in minutes.

Stability
This measures the time that a dough is stable for during the mixing in the Farinograph. It is measured from the time the graph reaches the 500 line until the time it leaves the 500 line. This figure gives an indication of the tolerance of the flour.

Departure Time
This is the time when the top of the curve leaves the 500-BU line. This indicates the time when the dough is beginning to break down and is an indication of dough consistency during processing. Departure time is expressed in minutes.

Mixing Tolerance Index (MTI) is the difference in Brabender Units from the top of the curve at the peak to the top of the curve measured five minutes after the peak is reached. This is an indication of the mixing tolerance of flour. A value of 30 B.U. or less is rated very good to excellent for hard wheat flours. A flour with a value greater than 50 B.U. indicates less tolerance and often indicates more difficulties during mechanical handling and makeup of the dough.

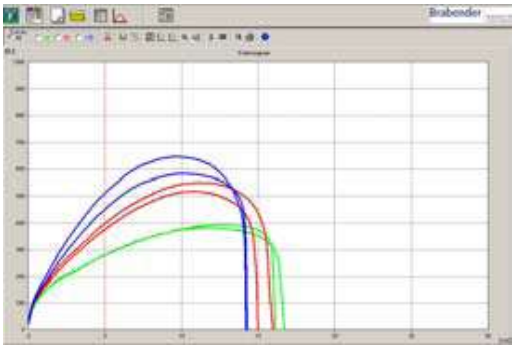
The Extensograph Machine

The test:
A dough is prepared from flour, distilled water, and salt in the Farinograph mixer. This ensures consistent dough preparation, objectivity, and reproducibility.

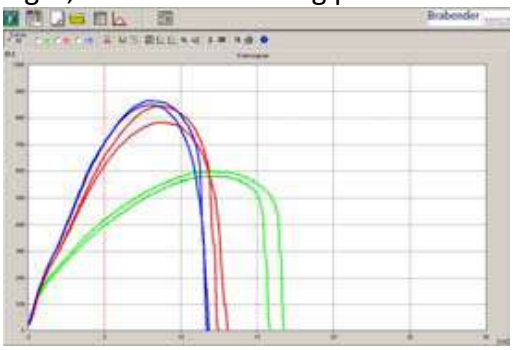
After mixing the dough piece is clamped then rested for a fixed amount of time. Then the dough is stretched until it breaks, the results are recorded on the Extensograph graph. This procedure is repeated three times.

Extensibility
The measurement is expressed in centimetres and measures of how far the dough will stretch before breaking. This gives a good indication of the extensibility of the flour. A developed dough needs a good balance between elasticity and extensibility.

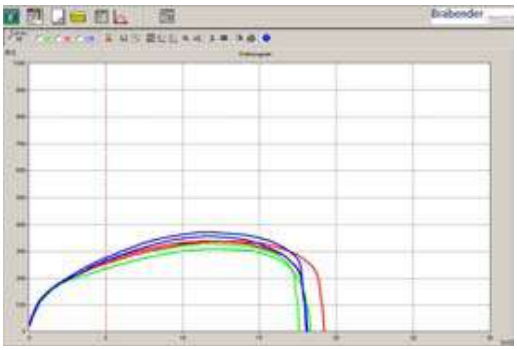
Resistance / Height
The measurement is taken from the amount of resistance it takes to stretch the dough before it breaks. The figure produced is taken from the height of the curve and the value is expressed in BU or Extensograph units. This is a good indication of the strength or elasticity of the flour.



Strong flour - Extensible, elastic dough. Suited for long fermentation processes, large proving tolerance. Light, voluminous baking products with a good volume



Rigid, tough dough structure with poor extensibility
Dough hardly rises during proving. Small bread with poor oven spring



Flour producing a soft, slack, plastic dough. Low fermentation tolerance, dough tends to spread, small baking volume.

Ash Content - Test

This test is carried out by taking a sample of flour and heating it in a furnace for two hours at 500° C. The majority of the flour is burnt off and the grey ash that is left is what is known as the ash content. This ash comes from the bran within the flour.

This is also a measure of the mineral content of the flour, the outer layers of bran contain a high mineral content, so this is also a measure of milling efficiency. Ash levels can also be influenced by variety and growing conditions.