Wheat Quality Attributes and their Implications

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Wheat Quality Attributes

Wheat quality is a function of:

- Genetics (variety)
- Environment

Wheat Quality Attributes

Wheat quality is a function of:

- Genetics (variety) → Intrinsic quality
- Environment → Physical condition

Intrinsic Quality

Examples:

- Protein content
- Protein quality
- Starch quality
- Kernel texture
- Color
    - Endosperm
    - Bran

Protein Content

Intrinsic Quality - Protein

Protein content – Wet Gluten

Protein content is important for good endues functionality. For example, baking performance in terms of processing properties and end product quality. There is strong correlation between protein cintent and wet gluten

Parameter	No. 1	No. 2	No. 3
Protein, %	13.4	12.7	13.1
Wet gluten, %	39.2	34.9	38.4

Protein Content

Intrinsic Quality - Protein

Protein content - Water Absorption

Protein content is important for good endues functionality. For example, baking properties in terms of high water absorption.

Parameter	No. 1	No. 2	No. 3
Protein, %	13.4	12.7	13.1
Wet gluten, %	39.2	34.9	38.4
Absorption, %	62.0	60.3	61.6

Protein Content

Intrinsic Quality - Protein

Protein content - Loaf Volume

Protein content is important for good endues functionality. For example, baking performance in terms of processing properties and end product quality such as high loaf volume

High Medium Low

Protein Content

Intrinsic Quality - Protein

Protein content – Texture & firmness in Pasta & Noodles

It also provides firmness and tolerance to overcooking both in pasta and noodles.

Protein Content

Intrinsic Quality - Protein

Protein content - Noodle Texture

Protein content is important for good endues functionality. For example, noodle firmness and texture. Texture retention as well may be influenced by protein content. The data shows with increased cooking time firmness is decreased when measured with a texture analyzer. Higher protein shows firmer texture for all the cooking times compared to lower protein

Protein High Low

Maximum Cutting Stress (grams/mm^2)		
Parameter	No. 1 CWRS 2018	No. 1 CWRS 2017
	60%	60%
Protein, %	13.2	12.4
Cooking Time (min)		
2.5	50.8	44.5
3.5	40.2	35.6
5.0	30.1	28.0

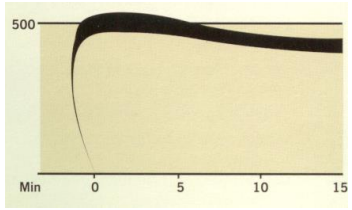
Protein Quality

Intrinsic Quality - Protein

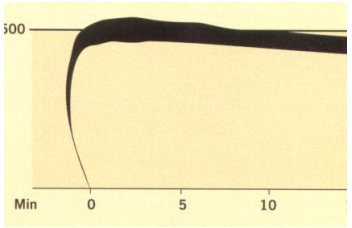
Farinograph Curves

Protein content & Protein quality

Protein quality is just as important of not more for processing and endues functionality. Protein quality influences properties related to physical handling of the dough. High volume pan bread using long fermentation process requires adequate tolerance with respect to mixing and fermentation. Farinograph mimics the mixing properties as in the bakery mixer



Strong



Stronger

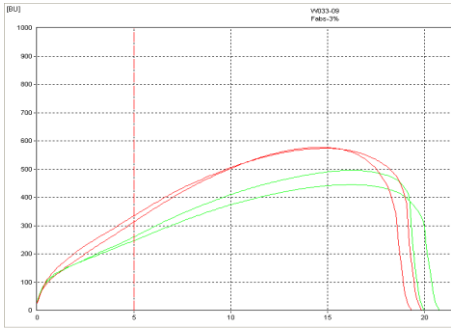
Protein Quality

Intrinsic Quality - Protein

Extensograms Curves

Protein content & Protein quality

The Extensograph curves show the difference in resistance (height) and extensibility (length) thereby indicating differences in their dough handling properties. Good dough handling properties are characterized by appropriate balance between resistance and extensibility



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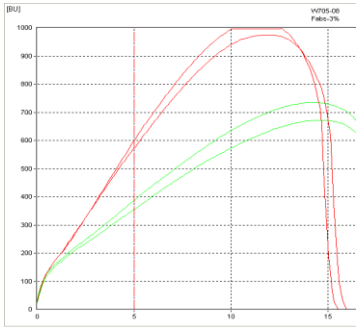


Stronger

Protein Quality

Intrinsic Quality - Protein

Protein content & Protein quality

Good dough development is important for gas retention during baking and is a function of both protein quality and optimum dough development during mixing. Under or overdeveloped doughs will perform poorly in terms of overall performance.

Impact of Wheat Protein on Bread Quality

Protein Content – Bread Quality

Intrinsic Quality - Protein

Protein content & Protein quality

The protein content provides increased loaf volume everything else being equal The adjacent diagram is showing increased specific volume for increase in protein content.

Wheat Protein, %

11.4

5.9

14.1

7.1

Specific Volume, cm^3/g

Protein Content – Bread Quality

Intrinsic Quality - Protein

Protein content & Protein quality

Protein content alone is not going to provide acceptable bread with decent loaf volume. The picture of the two breads indicate poor loaf volume for higher protein content wheat. This means poor protein quality with perhaps weaker dough properties resulting in poor volume . It is not uncommon to see higher protein content with non functional protein.

Wheat Protein, %

11.9 14.5

6.4 6.3

Specific Volume, cm^3/g

Different Types of Wheat

Wheat quality differentiation through classification

Protein content & Protein quality

Protein content and quality differs in different types of wheat. In defining wheat quality for specific end use requirement these properties are used along with wheat hard ness to assign distinct application based on these differences.

CWRS

CWHWS

CPSR

CWAD

CWRW

CPSW

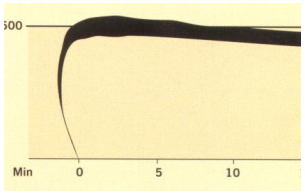
CWSWS

Differing Physical Dough Properties

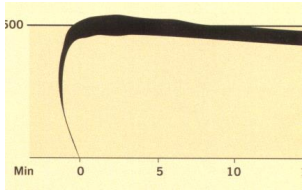
Wheat quality differentiation through classification

Protein content & Protein quality

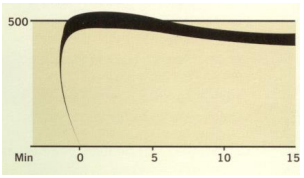
To am untrained eye when looking at various types of wheat the appearance may seem close but the differences in their functionality becomes obvious when ovserving their physical dough properties measure through Farinograph, Extensograph and Alveograph data.



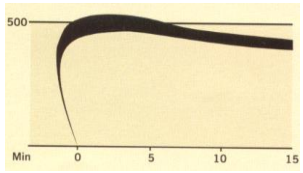
CWHWS



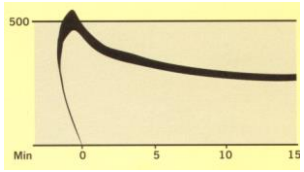
CWRS



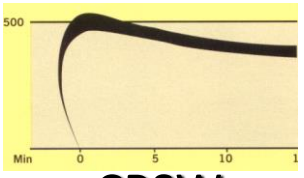
CPSR



CWRW



CWSWS



CPSW

Wheat Quality Attributes

Protein quality is often the basis of establishing wheat classification system based on the differences in physical dough properties.

This allows classification of strong , medium and weak or soft wheat based on their corresponding physical dough properties.

Starch Quality

Intrinsic Quality - Starch

Starch quality influences textural properties of noodles and other end products. Low amylose starch is preferred for certain types of noodles to impart desired texture with softer outer core and firmer inner core..

Kernel Hardness

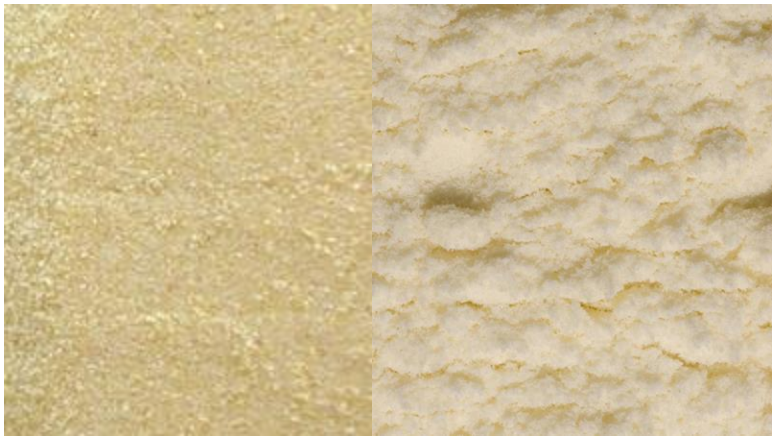
Intrinsic Quality – Kernel Hardness

Harder kernel is desirable for hard wheat used for bread making purposes requiring high water absorption. Hard wheat generates higher starch damage levels during milling which helps in increasing water absorption in bread doughs.

Kernel Hardness

Intrinsic Quality – Kernel Hardness

Harder wheat kernel is particularly important for durum as the finished product is granular semolina and any flour produced is of much lower value



Endosperm Color

Intrinsic Quality – Color

Endosperm
In common wheat pigment color is desired to be low as possible.

Yellower the color of the endosperm better will be the color of the semolina and potential color of pasta.

Endosperm Color

Intrinsic Quality – Color

Endosperm

Yellower the pigment color of the endosperm better will be the color of the semolina.

Durum Wheat Semolina

Common Wheat Semolina

Endosperm Color

Intrinsic Quality – Color

Endosperm

The enhanced yellow color of the semolina is generally reflected appropriately in pasta products.

Durum Wheat Pasta

Common Wheat Pasta

Intrinsic Quality – Bran Color

Intrinsic Quality – Color

Bran

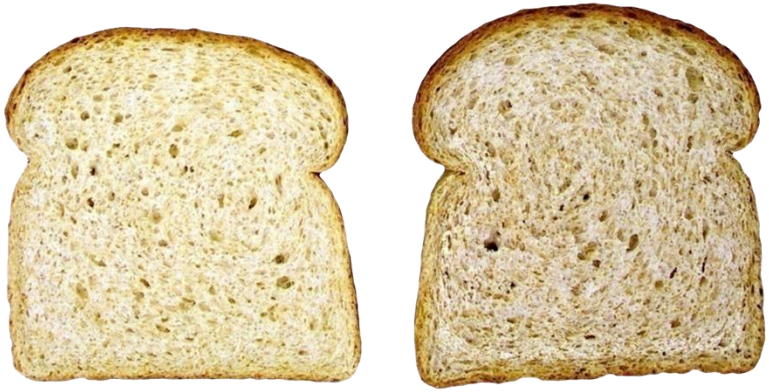
The natural color of the bran comes from the color of the wheat. The common color of wheat is *Red* or *White*. For most refined flour color of the wheat does not have an impact as the bran is all removed. It is the pigment color of the endosperm that has greater bearing on flour color.

Intrinsic Quality – Bran Color

Intrinsic Quality – Color

Bran

Bran color does have an impact in products that are produced from higher extraction flours and whole wheat flours where a portion of bran or all of it is included. There may be a preference in some markets for white wheat for such products but it may also be dependent on traditional practices as to what the consumers are used to.



Intrinsic Quality – Bran Color

Intrinsic Quality – Color

Bran

White bran is often considered to be more pleasant in appearance as upon baking it provides a golden brown color to the end products as compared to red bran producing a dark mahogany color that may be considered as less attractive.

Wheat Quality Attributes

Most quality traits that are intrinsically built in through conventional variety development processes are also often influenced to a lesser or greater degree by environmental influences.

However, environmental influences generally result in impacting physical condition/appearance of the wheat. This allows visual grading system to function reasonably well as the extent of damage relates well to the visual assessment. The tolerance levels for damaged and diseased wheat kernels are based on scientific tests to determine their impact level for assigning of appropriate numerical grade. Thus a grade is associated with level of damage that is impacting the quality.

Wheat Quality Attributes

Quality is given by:

- Intrinsic Quality
- Physical Condition

Wheat Quality – Physical condition

Damaged and Diseased Kernels

Midge:

Loss of flour yield

Impact on color & specks

Weakening influence on dough properties

Wheat Quality – Physical condition

Damaged and Diseased Kernels

Frost / Heat stress

Kernel texture becomes harder resulting in higher starch damage, reduced flour yield and poor flour color

Wheat Quality – Physical condition

Damaged and Diseased Kernels

Smudge:

A discoloration that spreads widely on the surface of the kernel and can also penetrate into the endosperm

Wheat Quality – Physical condition

Damaged and Diseased Kernels

Sprout damage causes:

Sticky dough,

dark crust color,

higher gas production &

reduced loaf volume

Wheat Quality

- Foreign Material
- Test Weight
- Damaged
  and Diseased Kernels
- Shrunken and Broken Kernels
- Contrasting Classes
- Protein Quality
- Protein Content

Wheat Quality

- Foreign Material
- Test Weight
- Damaged and Diseased Kernels
- Shrunken and Broken Kernels
- Contrasting Classes

→ Grade

- Protein Quality

→ Class

- Protein Content

→ Protein Segregation

Production of Flour/Semolina

Meeting

Specifications and performance

Common Commercial Flours and their Specifications*

Flour	Ash	Protein
Household	0.37 - 0.39	11.5 – 1.8
Large bakers	0.48 - 0.50	12.4 - 12.6
Strong bakers	0.52 - 0.53	13.4 – 13.6
Fancy clear	0.58	14.0
Whole wheat flour	1.2 – 1.3	13.5

*made from hard red spring wheat

Tools available to millers

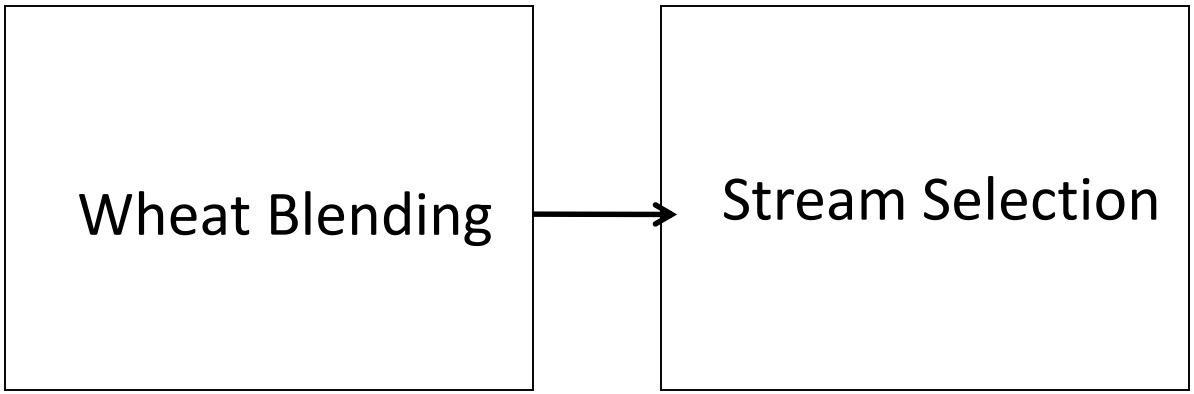
Production of Flour

Wheat Blending
(Grades & Protein)

Cost of Flour due to Wheat Cost

Cost of a bag of flour is 80% - 85% due to cost of wheat therefore blending is done carefully to meet quality at a reasonable cost.

Production of Flour



Example of Flour Streams in a Mill[1]

Flour Stream	Proporton of Total Flour %	Ash[2] %	Combined Ash %	Protein[2] %	Combined Protein %
1 Reduction	32.00	0.37	0.37	11.80	11.80
2 Reduction	13.00	0.38	0.37	11.70	11.77
3 Reduction	9.00	0.39	0.38	11.60	11.74
Sizing	3.80	0.46	0.38	12.10	11.77
2 Break	7.70	0.48	0.39	15.20	12.17
4 Reduction	4.60	0.50	0.40	12.30	12.18
1 Break	4.50	0.52	0.41	14.50	12.32
1 Coarse Reduction	4.10	0.53	0.41	12.20	12.31
Grader	4.50	0.58	0.42	14.40	12.43
3 Break	4.20	0.63	0.43	17.80	12.68
5 Reduction	2.80	0.68	0.44	12.80	12.69
Filter	2.80	0.70	0.45	14.90	12.75
2 Coarse Reduction	1.00	0.79	0.45	12.50	12.75
4 Break	2.10	0.93	0.46	18.30	12.87
Bran Duster	0.95	1.20	0.47	18.60	12.93
6 Reduction	1.05	1.35	0.48	13.20	12.93
Shorts Duster	1.10	1.50	0.49	16.30	12.97
7 Reduction	0.80	1.62	0.50	13.20	12.97

[1] From wheat of 13.6% protein content (at 13.5% moisture content).

[2] Ash and protein contents are based on 14% flour moisture.

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2 Break	7.70	0.48	0.39	15.20	12.17
4 Reduction	4.60	0.50	0.40	12.30	12.18
1 Break	4.50	0.52	0.41	14.50	12.32
1 Coarse Reduction	4.10	0.53	0.41	12.20	12.31
Grader	4.50	0.58	0.42	14.40	12.43
3 Break	4.20	0.63	0.43	17.80	12.68
5 Reduction	2.80	0.68	0.44	12.80	12.69
Filter	2.80	0.70	0.45	14.90	12.75
2 Coarse Reduction	1.00	0.79	0.45	12.50	12.75
4 Break	2.10	0.93	0.46	18.30	12.87
Bran Duster	0.95	1.20	0.47	18.60	12.93
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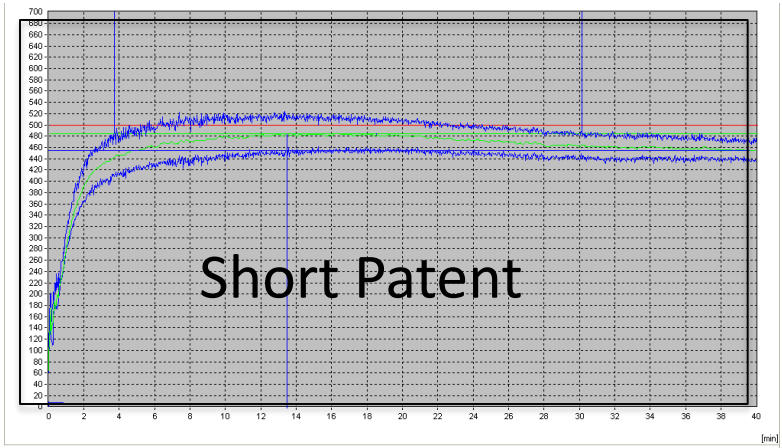
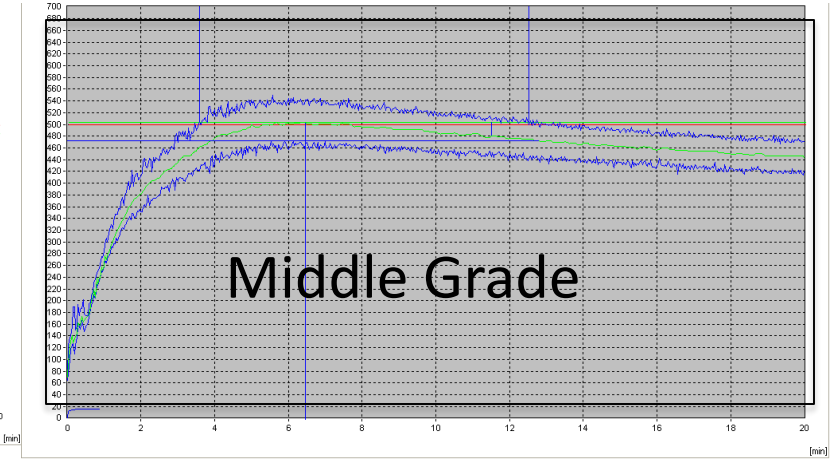
[2] Ash and protein contents are based on 14% flour moisture.

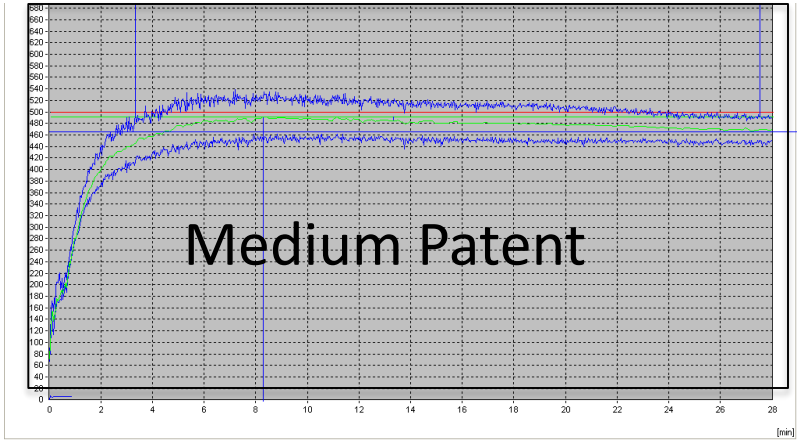
Flour Grades - CWRS Wheat Blend Protein 13.7%

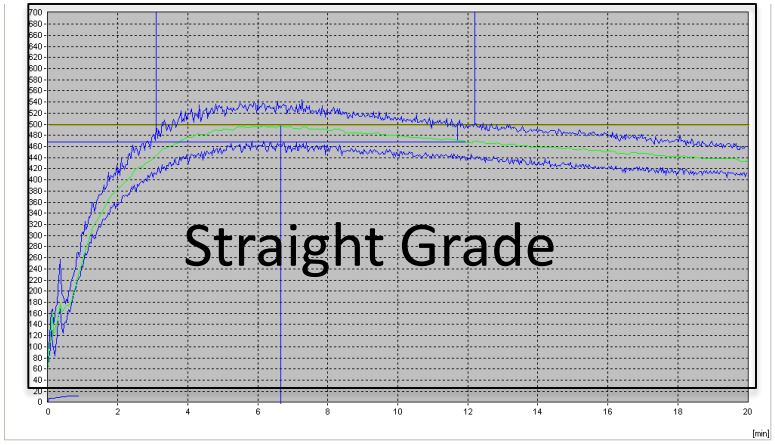
Flour conveyor	Flour, %	Ash, %	Protein, %
F1	57.8	0.38	11.8
F2	32.4	0.55	14.3
F3	5.9	0.77	15.9
F4	3.9	1.49	14.7

Flour Extraction Influences Farinograph Results

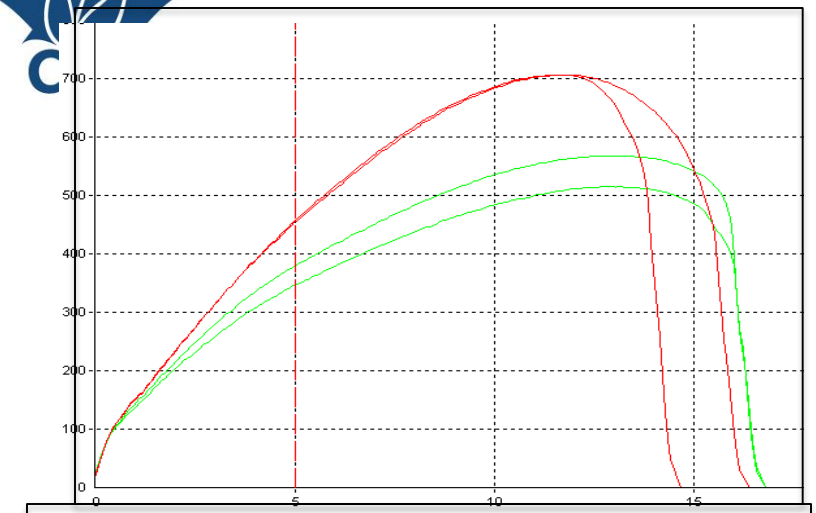


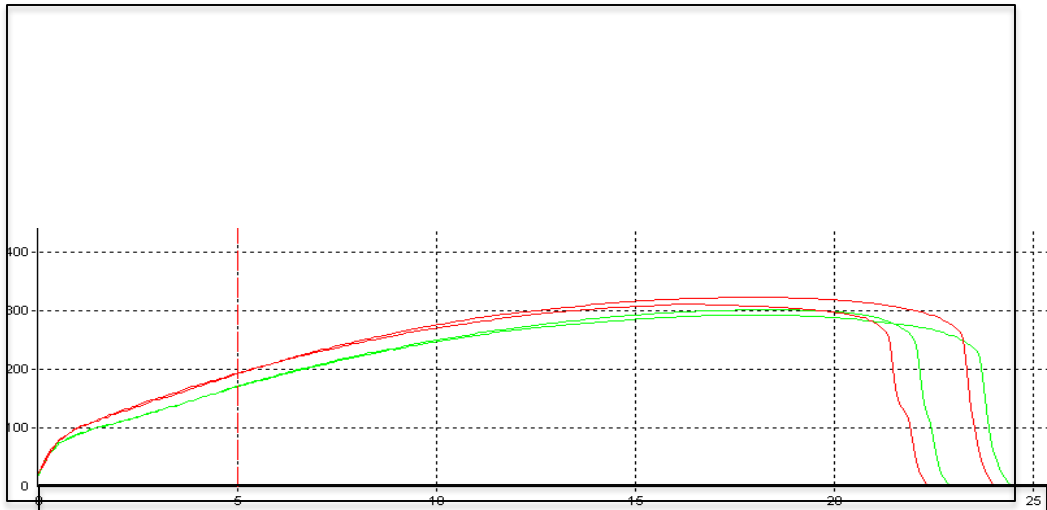


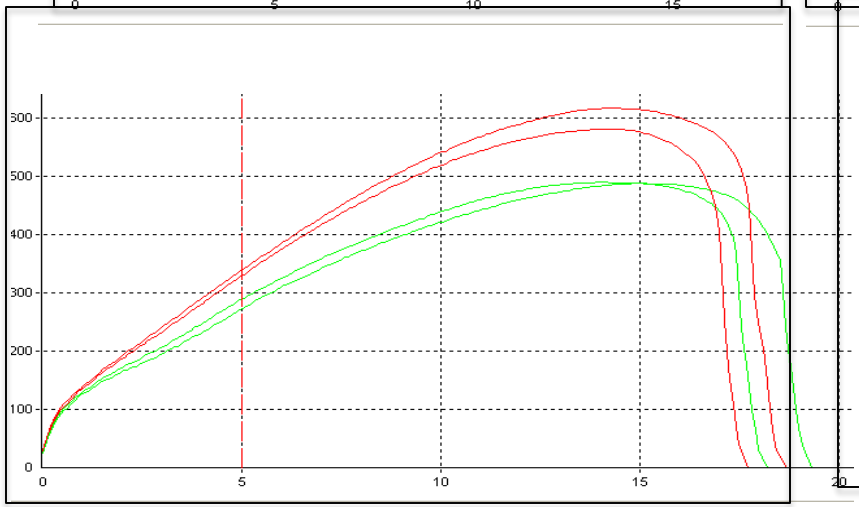


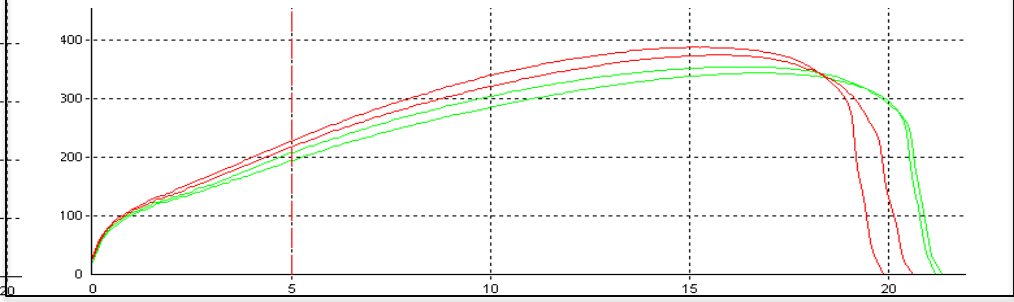


Flour Extraction Influences Extensograph Results



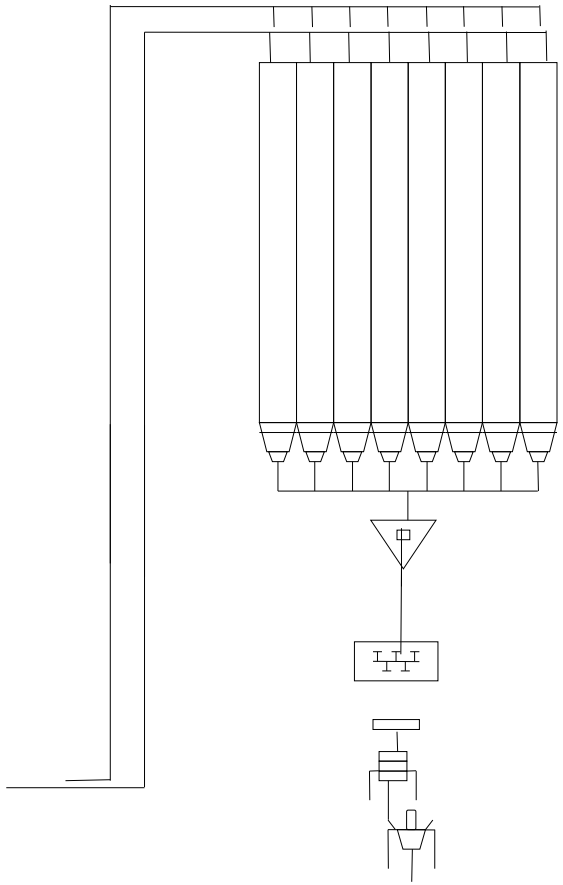






Flour Blending

Judicious blending of flour grades and various types of flour help generate specific desired flour quality at a reasonable cost.

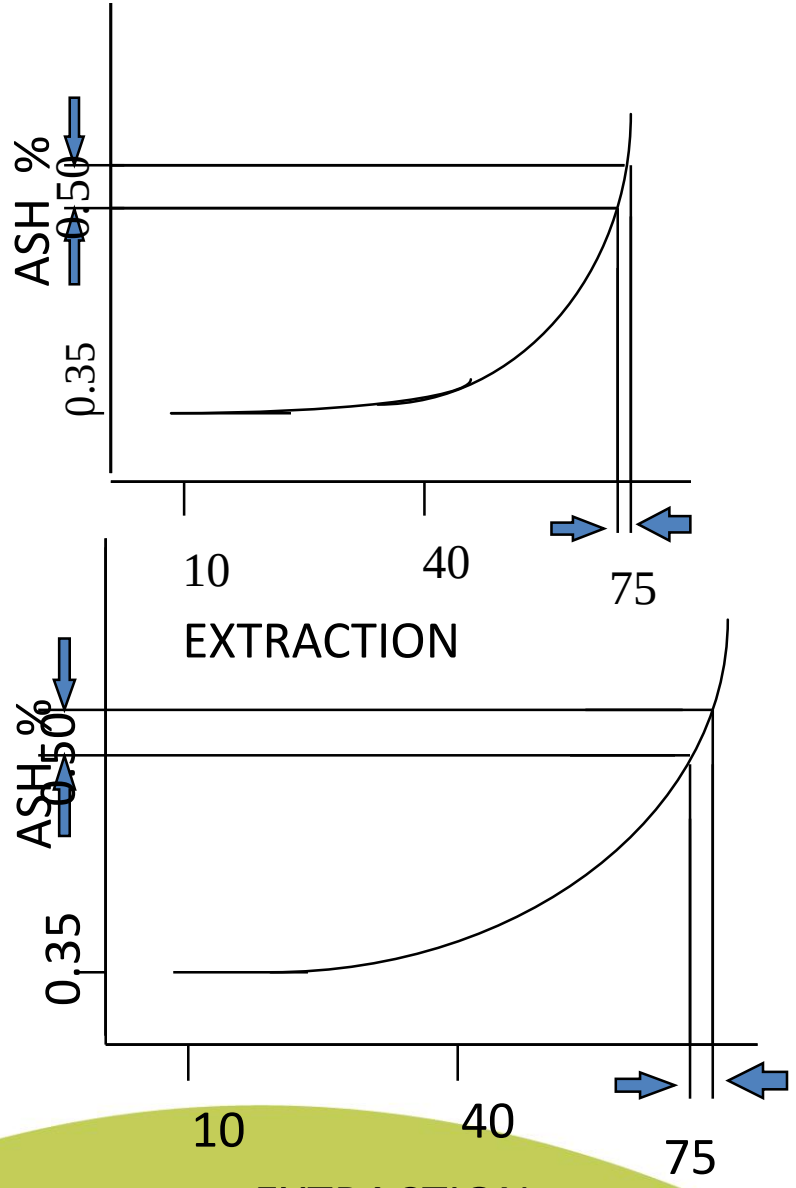


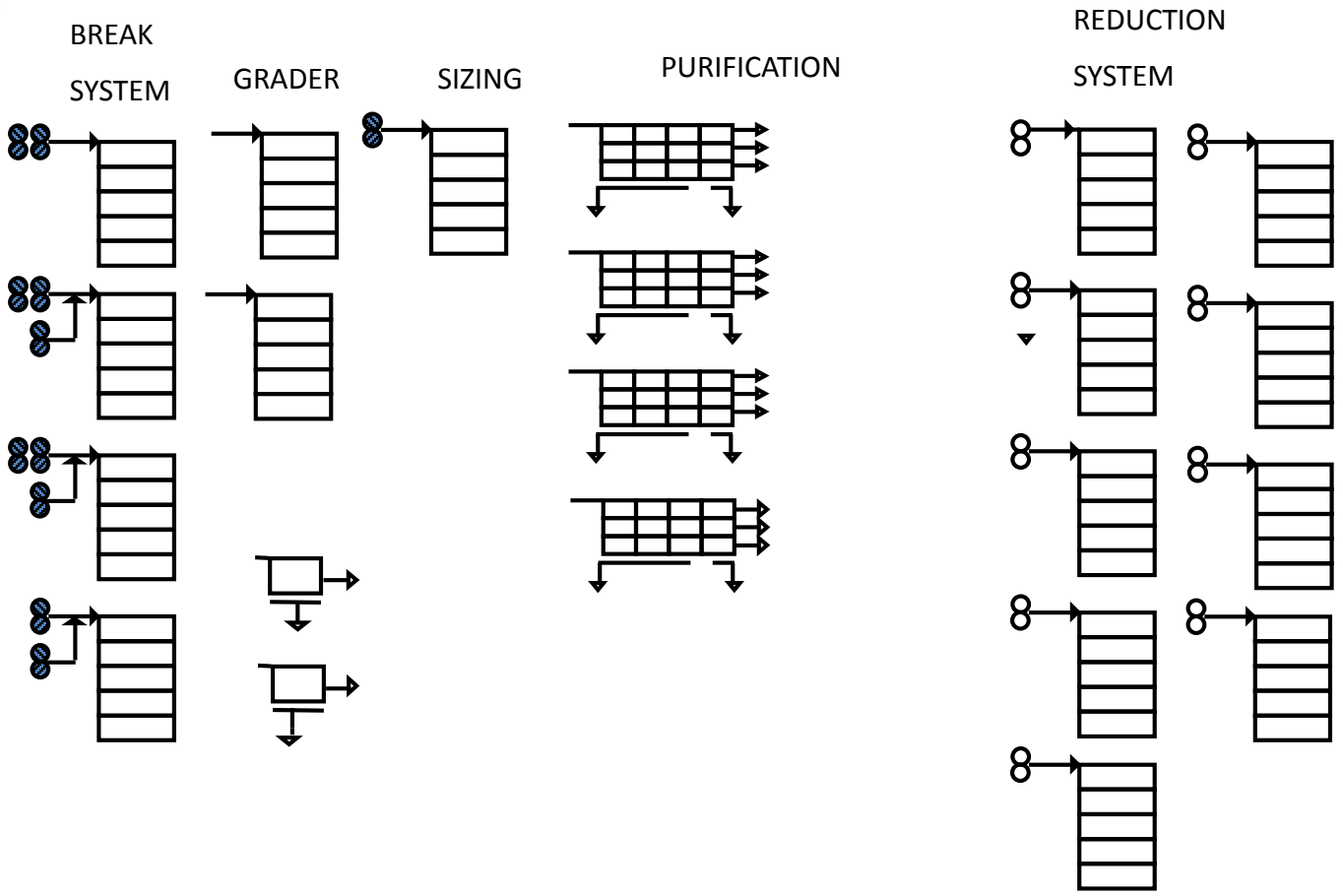
Cumulative Ash Curves

Specifications & Performance – tools available to millers

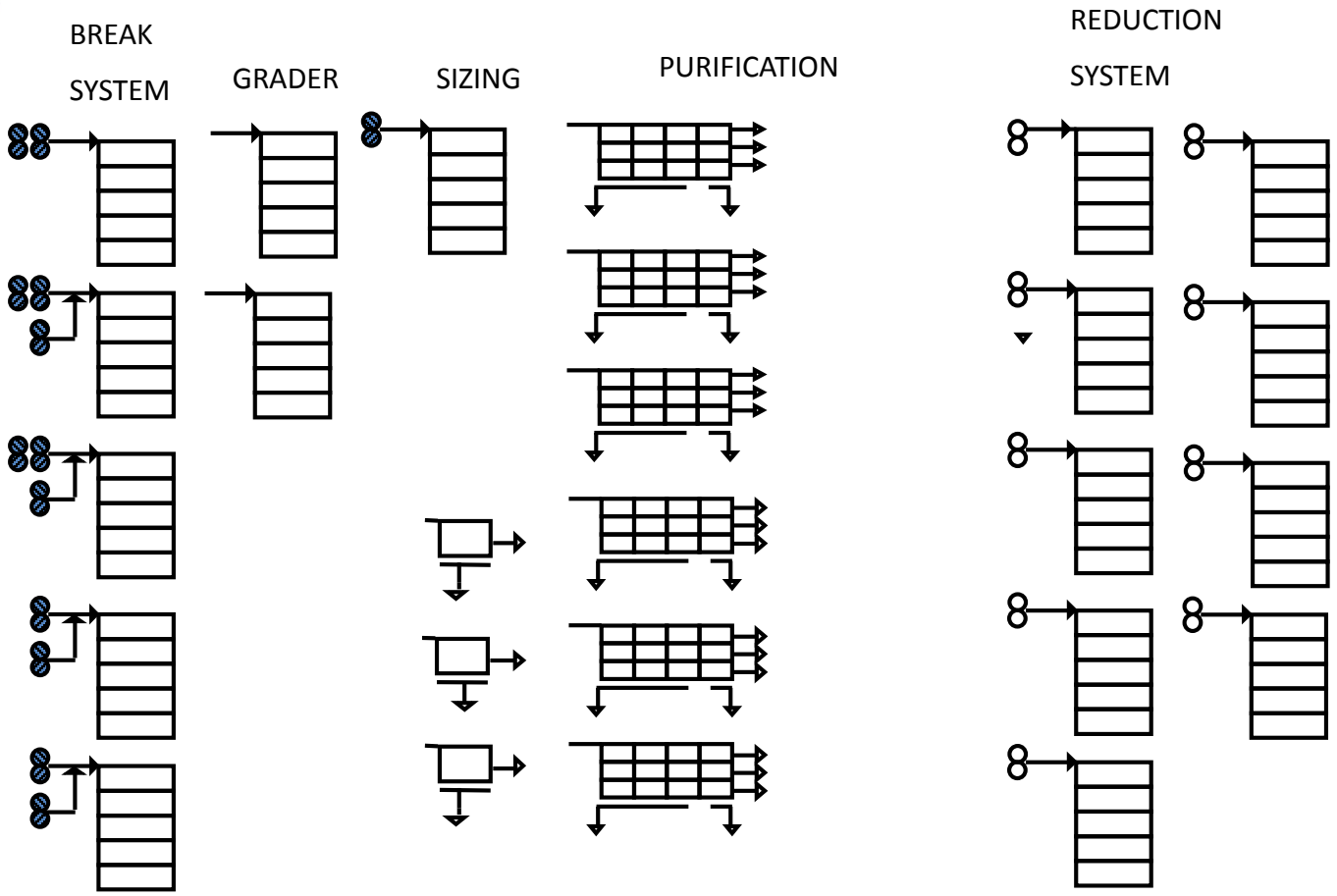
Cumulative Ash curves and Flow Diagrams

Often these challenges are overcome by having an appropriate flow diagram to begin with in order to cater to highly refined flour with low ash. Adjacent curves show better curve for the lower one as more comprehensive purification has been used in this case on the same wheat blend.





Flows Diagram Typical

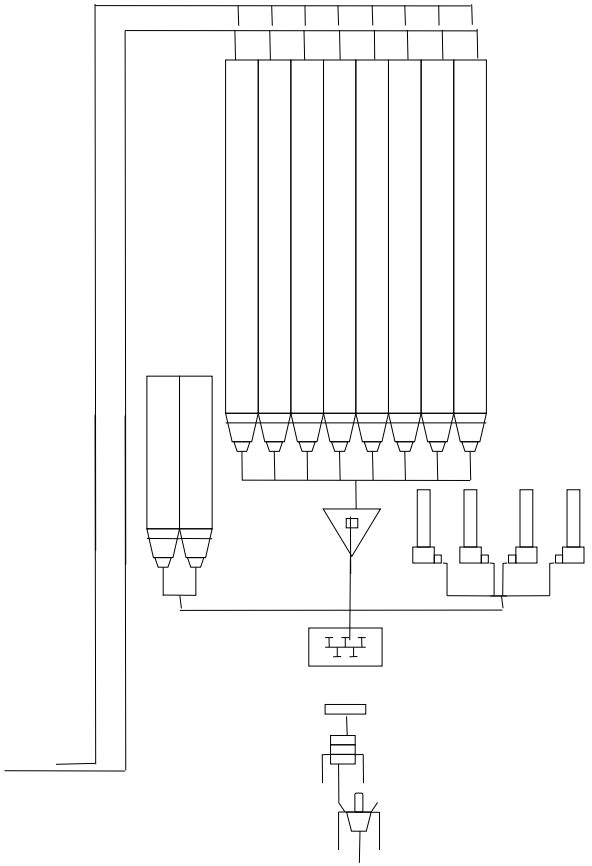


Flow Diagram - Comprehensive Purification System

Tools available to Millers
Production of Flour

Flour Blending and Treatment

Often appropriate flour treatment with improvers may help produce flour quality to suit individual customer requirements. Flour treatment may vary depending on the process and formulation used by the end user.



Bread Quality

Improvers used for oxidation to improve gluten functionality and also addition of fungal alpha amylase to generate gas production levels can be used to great advantage in order to obtain desirable bread quality

- Gas Production
- Gas Retention

Balance between gas production and gas retention

Optimum