What DO All Those Numbers Mean?

Musings on a Malt COA

Malteurop

Brewers' Requirements

High extract / High alcohol yield

- Proper carbohydrate modification
- Proper protein modification - maltster needs to take care of this
- Choice of variety - 2-row gives higher extract but comes at a higher price

Brewers' Requirements

- Ease of milling
  - Uniform size distribution
  - Good cell wall modification
  - Husk retention

Brewers' Requirements

Good wort separation

- Husk adherence that provides filter bed
- Hydration of entire kernel - no steely distal ends
- Proper endo-beta-glucanase action (do not give solubilase another chance)

Brewers' Requirements

Low DMS potential

- Select 2-row if this is important to your beer
- Use good kiln airflow
- If desired malt color allows, use higher kiln temperature

Brewers' Requirements

Good attenuation/ Rapid Diacetyl removal

- Requires good fermentability, but this is not a typical malt analysis
- Good carbohydrate profile that will promote desired fermentable/non-fermentable ratio
- Premature flocculation or sluggish fermentation will not allow yeast to reduce Diacetyl properly

Brewers' Requirements

Good filterability

- Low viscosity and beta-glucan
- Small starch granules broken down during malting to avoid alpha-dextrin haze
- Proper proteolysis so protein haze does not develop

Good foam potential

- Proteins of the proper sizes

Brewers' Requirements

Long clarity and flavor stability

- Do not malt barley with excessive protein
- Good protein modification
- Good beta-glucan and pentosan modification
- Good carbohydrate modification
- Normal lipoxygenase synthesis

Brewers' Requirements

- Low initial haze
  - Proper post-malting aging

Malt analysis - the basis for:

Commercial decisions

Specifications to suit plant and product type

Predict malt input to achieve brew-length

Predict color and taste profile

Malt Analysis

U.S. Governed by ASBC

Criticized for failure to predict brewing performance

Research to find new methods

Exacerbated by lack of understanding

Fatal to look at one analysis in isolation

Useful hints !

Recognize varietal and crop year influence

Find varieties that best serve your needs

Study relationship between analysis and performance over several years

Understand accuracy limitations of lab tests

Comparison: lab to brewery

	Congress	Plant
Water to grist	8:1	4:1
Beta-glucan rest	45°C	None
Protein rest 56°C	Ramping	None
Conversion temp	70°C	65-70°C

Analyses

Fine Grind Extract:

- Indicator of carbohydrate modification
- Gives maximum extract potential- real grist would never be this fine if lautering will be used for wort separation

Coarse Grind Extract:

- More representative of realized brewery extract

Analyses

Fine - Coarse Difference:

- Condition of cell walls that prevent ingress of enzymes
- Good indicator if malt is evenly modified
- Small difference between 2 large numbers, therefore not very accurate at lower levels

Analyses

Friability

Complements F-C, indicating evenness

Variety and Protein have strong impact

Useful to maltster for :

- Appropriateness of steeping
- Barley procurement QA

Beta-glucan and Viscosity

High numbers caused by:
- Dead kernels
- Distal ends

May result in:
- Slow lauter run-off
- Blocked beer filter
- Unfilterable haze

Use data in conjunction with Fine/Coarse Difference and Friability

Beta-glucan and Viscosity

Brewers have the option to add exogenous glucanases if the malt is not properly modified.

Caution with enzyme addition:

- Seldom pure
- Cell walls removed from under-modified kernels: release contents
- Small starch granules exposed: unfilterable alpha-dextrin haze
- Protein released may cause clarity/ stability problems

Saccharification - amylases

	Alpha	Beta
Produced	Malting	In barley
Peak Activity	65°C	55°C
Deactivation	75°C	65°C
pH optimum	5.3	5.7

Growth Counts

0 - 1/4	Unmodified (dead)
1/4 - 1/2	Under-modified
1/2 - 1	Well-modified
>1	Over-modified

But a good growth count does not always mean proper modification

Total Protein

Variety, crop year and soil dependent

Inverse relationship with extract

Direct relationship with DP

Protein modification

Specified as: Soluble protein

Kolbach Index (S/T)

85% takes place during malting process

Optimum temp 56^{o}C - seldom used in brewhouse

Importance in Brewing

Protein → Amino acids → Yeast regeneration

A. acids → Synthesis → Alpha-acetolactate → Diacetyl

12, 40 KDa = foam components

Protein haze

Free Amino Nitrogen

Means of amino acid measurement - Ninhydrin

Importance:

- Foam and foam stability
- Richness of taste
- Yeast- growth, fermentation profile, flocculation
- Haze stability

Level very important if brewing with high adjunct

Moisture

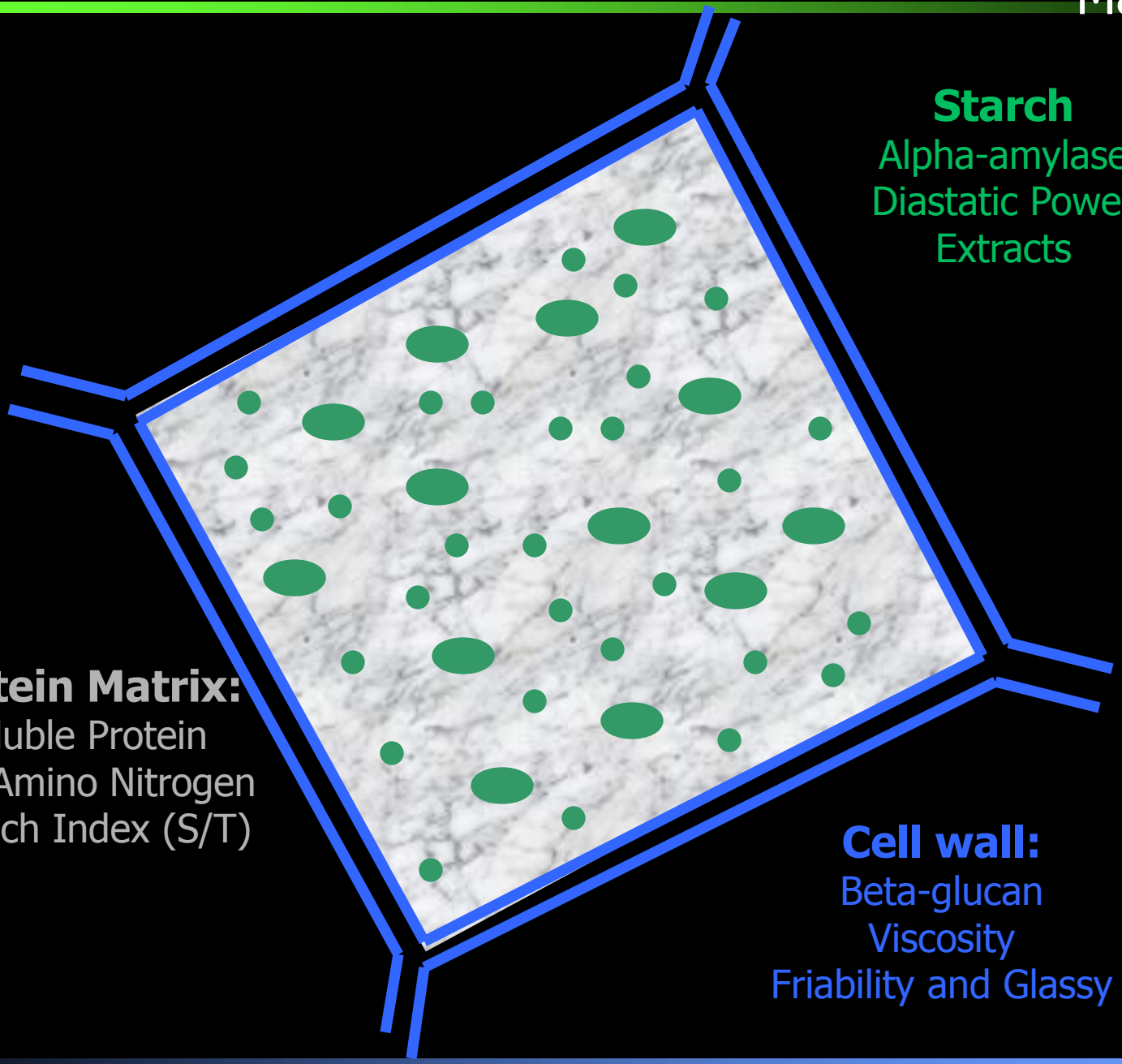
Why buy and transport water ?

Can you accept...

…excessive destruction of enzymes ?

…excessive breakage ?

…excessive color?



Starch
Alpha-amylase
Diastatic Power
Extracts

Protein Matrix:
Soluble Protein
Free Amino Nitrogen
Kolbach Index (S/T)

Cell wall:
Beta-glucan
Viscosity
Friability and Glassy

Standard Deviation

On 7/64	2.4	Diastatic Power	2.3
Moisture	0.3	Alpha-amylase	1.3
CG-dry	0.3	Total Protein	0.3
F-C	0.3	Soluble Protein	0.08
Color	0.06	Beta-glucan	8
Viscosity	0.02	DON	0.04

Data taken from MENA Corporate Laboratory

Things to remember

Variety selection is important:

- Protein
- Enzyme package
- Extract potential
- Color potential
- DMS potential
- Flavor potential

Things to remember

"Oppositional" specs:

- Low moisture with high DP
- Low moisture with low color
- Low color and very high soluble protein
- High FAN and low soluble protein
- Low total protein and high enzymes
- High total protein and high extract
- High friability and high moisture
- Low NDMA and low SO_2

Typical specs: US 6-row

Assortment	on 7/64”	45 min
	thru 5/64”	1.6 max
Moisture		4.3 max
FG- dry		78.5 min
F-C		1.5 max
Color (brewery-dependent)		1.9 to 2.5
Diastatic Power		145 and up

Typical specs: US 6-row

Alpha-amylase	50 and up
Clarity	10 NTU max
Wort pH	Report
Beta-glucan	150 max
Total protein	13.4 max
Soluble protein	5.2 to 5.6
FAN	200 min
DON	0.7 max

Typical specs: US 2-row

Assortment	on 7/64”	60 min
	thru 5/64”	1.5 max
Moisture		4.3 max
FG- dry		80 min
F-C		1.4 max
Color (brewery-dependent)		1.7 to 2.1
Diastatic Power		140 and up

Typical specs: US 2-row

Alpha-amylase	55 and up
Clarity	10 NTU max
Wort pH	Report
Beta-glucan	130 max
Total protein	12.0 max
Soluble protein	4.5 to 5.3
FAN	180 min
DON	n/a

Malt analysis

	A	B	C
Moisture	4.3	4.3	4.3
FG-dry	78.7	78.7	78.1
F-C	1.3	1.3	1.9
Color	2.21	3.43	2.21
DP	154	136	136
Alpha-amylase	48.1	48.1	38.1
Total protein	12.9	12.9	12.9
Soluble protein	5.43	5.43	5.03
S/T	42.1	42.1	39.0
Beta-glucan	131	131	211
Friability	72.5	72.5	62.5

Malt analysis

	D	E
Moisture	4.1	4.2
FG-dry	80.2	80.8
F-C	1.2	1.2
Color	1.81	1.71
DP	126	106
Alpha-amylase	53.1	43.1
Total protein	12.2	11.3
Soluble protein	5.13	4.13
S/T	42.0	36.5
Beta-glucan	111	88
Friability	81.5	87.5