Measuring Starch Damage as a Mill Optimization Technique

Shawn Thiele
Milling Operations Manager
IGP Institute
Department of Grain Science and Industry
Kansas State University

Special thanks to Kyle McCormack and Mark Fowler for developing the test protocol, collecting, and running samples!

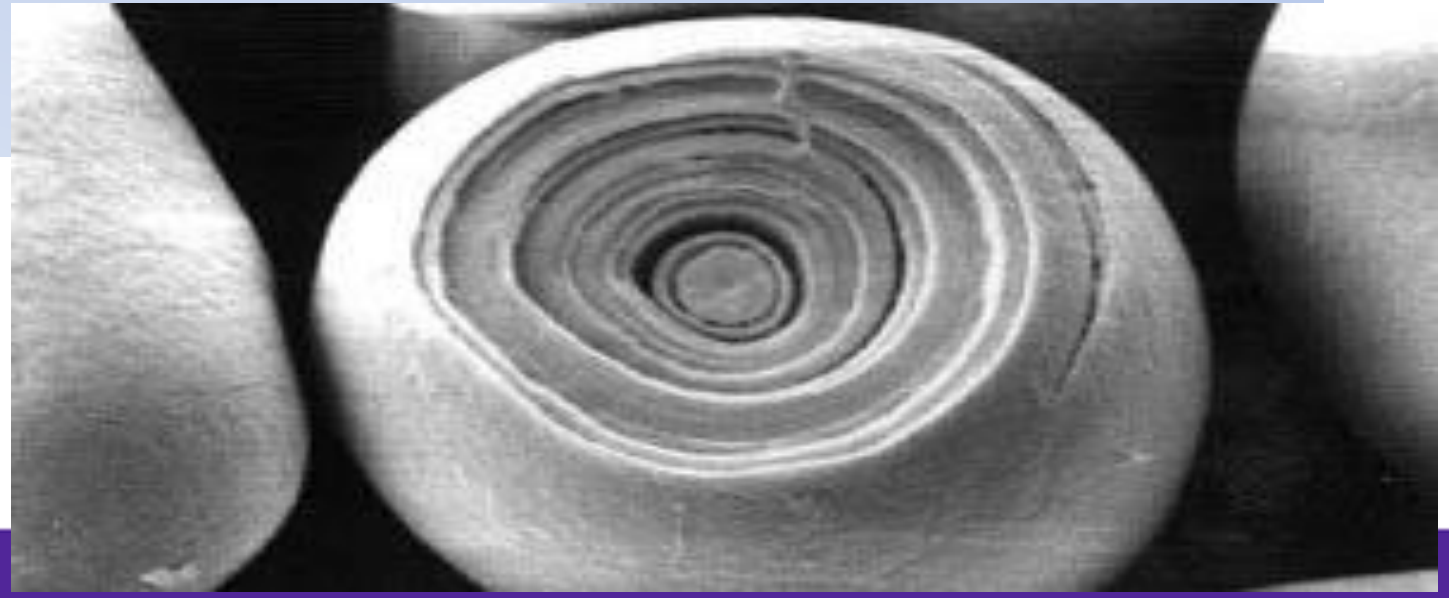
Testing Objective

The objective of this project was to determine the optimal grinding pressure for each reduction passage in the Hal Ross flour mill using the amount of starch damage as the indicator.

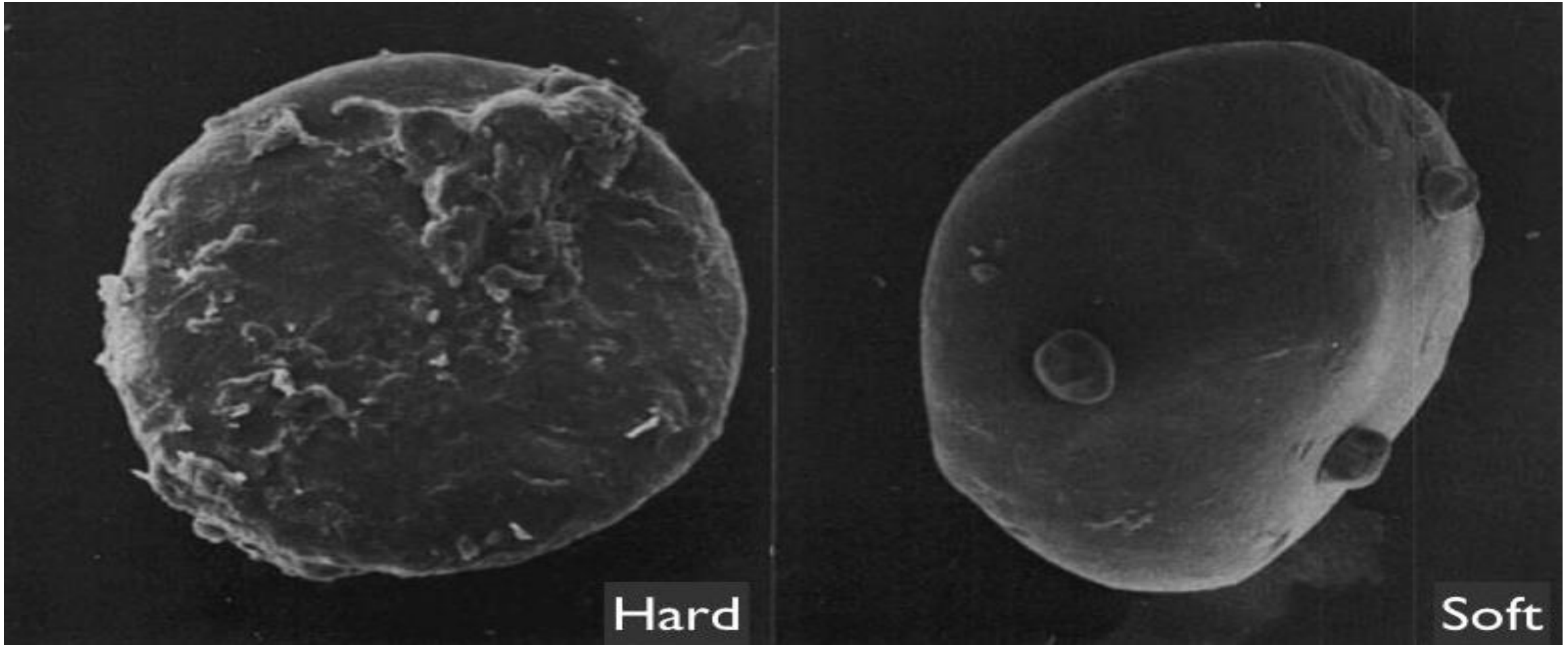
- Look at different grinding practices and their effect on flour starch damage and quantity.
  - Determine optimum grinding pressure on reduction rolls

Starch Damage

- Starch damage is described as the physical rupture or breakage of starch granules.
- Contributors to starch damage
  - Genetics (hard wheat, soft wheat, durum wheat)
  - Protein content
  - Grinding forces in the mill

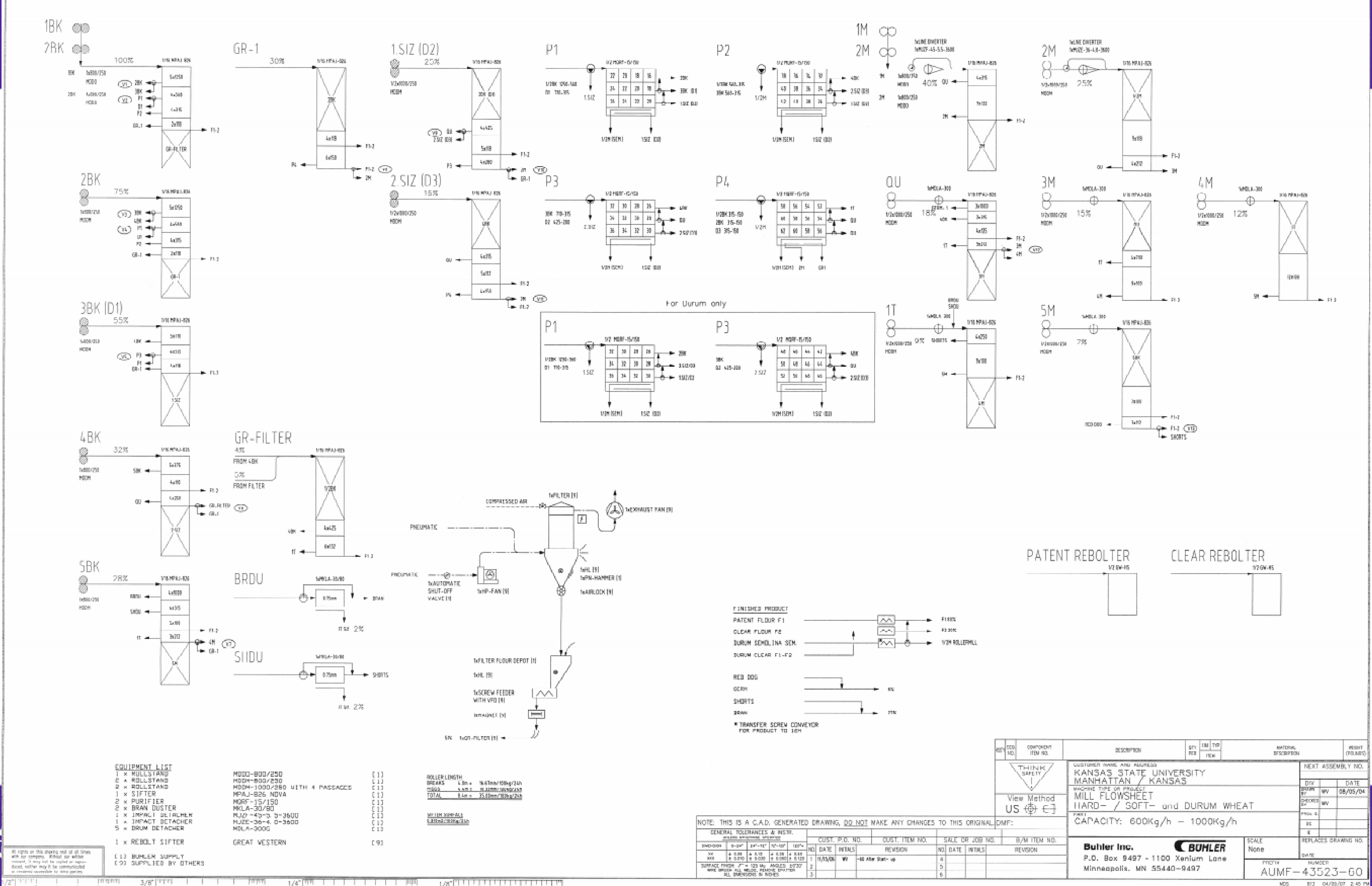


Genetic Differences in Starch



Damaged Starch

- Why is this important to Millers?
  - Flour Consistency
    - consistent starch damage = consistent water absorption for bakers
    - Damaged starch is probably the most important quality attribute of flour that typically is not listed on a flour contract.
  - Water absorption
    - Increased starch damage = increased water absorption for bakers
  - Rate of fermentation
    - Sugars become available easier to the yeast speeding up fermentation
  - Possibility to optimize reduction rolls?



1BK
2BK
GR-1
1.SIZ (D2)
P1
P2
1M
2M
3BK (D1)
2.SIZ (D3)
P3
P4
QU
3M
4M
For Durum only
1T
5M
4BK
GR-FILTER
5BK
BRDU
SHDU
PATENT REBOLTER
CLEAR REBOLTER
FINISHED PRODUCT
PATENT FLOUR F1
CLEAR FLOUR F2
DURUM SEMOLINA SEM.
DURUM CLEAR F1-F2
RED DOG
GERM
SHORTS
BRAN
EQUIPMENT LIST
1 x ROLLSTAND
2 x ROLLSTAND
2 x ROLLSTAND
1 x SIFTER
2 x PURIFIER
2 x BRAN DUSTER
1 x IMPACT DETACHER
1 x IMPACT DETACHER
5 x DRUM DETACHER
1 x REBOLT SIFTER
MDDO-800/250
MDDM-800/250
MDDM-1000/250 WITH 4 PASSAGES
MPAJ-826 NOVA
MQRF-15/150
MKLA-30/80
MJZF-45-5.5-3600
MJZE-36-4.0-3600
MDLA-300G
GREAT WESTERN
[1] BUHLER SUPPLY
[2] SUPPLIED BY OTHERS
NOTE: THIS IS A C.A.D. GENERATED DRAWING, DO NOT MAKE ANY CHANGES TO THIS ORIGINAL.
KANSAS STATE UNIVERSITY
MANHATTAN / KANSAS
MILL FLOWSHEET
HARD- / SOFT- and DURUM WHEAT
CAPACITY: 600Kg/h - 1000Kg/h
Buhler Inc.
BUHLER
P.O. Box 9497 - 1100 Xenium Lane
Minneapolis, MN 55440-9497
AUMF-43523-60

Hal Ross Flour Mill Equipment Allocation

- 1 MT/HR Wheat Swing Mill
- Metric Measurements
  - Roll Surface 38.33 mm/100kg/24 hr
  - Sifter Surface 0.213 m^2/100kg/24 hr
- US Measurements
  - Roll Surface 0.9125 in/CWT/ 24 hr
  - Sifter Surface 1.37 ft^2/ CWT/ 24 hr

Data collection

Data was collected during a full day mill run with the same wheat (HRW)

- First collected a baseline ash curve after the mill warmed up with reduction rolls set at an operator determined optimum setting.
- Then decreased the grinding pressure on all reduction rolls and collected three ash curves on the soft grind.
- Next increased the grinding pressure on all reduction rolls and collected three ash curves on the hard grind.
- Lastly, reset the mill to baseline settings and collected an additional ash curve for the operator determined optimum setting.

Decreased Pressure (Light Grind)

- Increased gap one (1) hour from optimum setting 1 full rotation
- 4M and 5M were only adjusted 30 minutes
- One hour equals .16mm
  - 0.0063 inches
- Allow mill to reach equilibrium
- Collect the sample set

Increased Pressure (Hard Grind)

- Decreased gap one (1) hour from optimum setting 1 full rotation
- 4M and 5M were only adjusted 30 minutes
- One hour equals .16mm
  - 0.0063 Inches
- Allow mill to reach equilibrium
- Collect the sample set

Sample Set

- The complete sample set consists of 16 individual flour streams
  - 15 individual flour streams
    - Collected at patent flour screw
  - Straight grade flour sample
    - Collected below rebolt sifter

Measuring Starch Damage

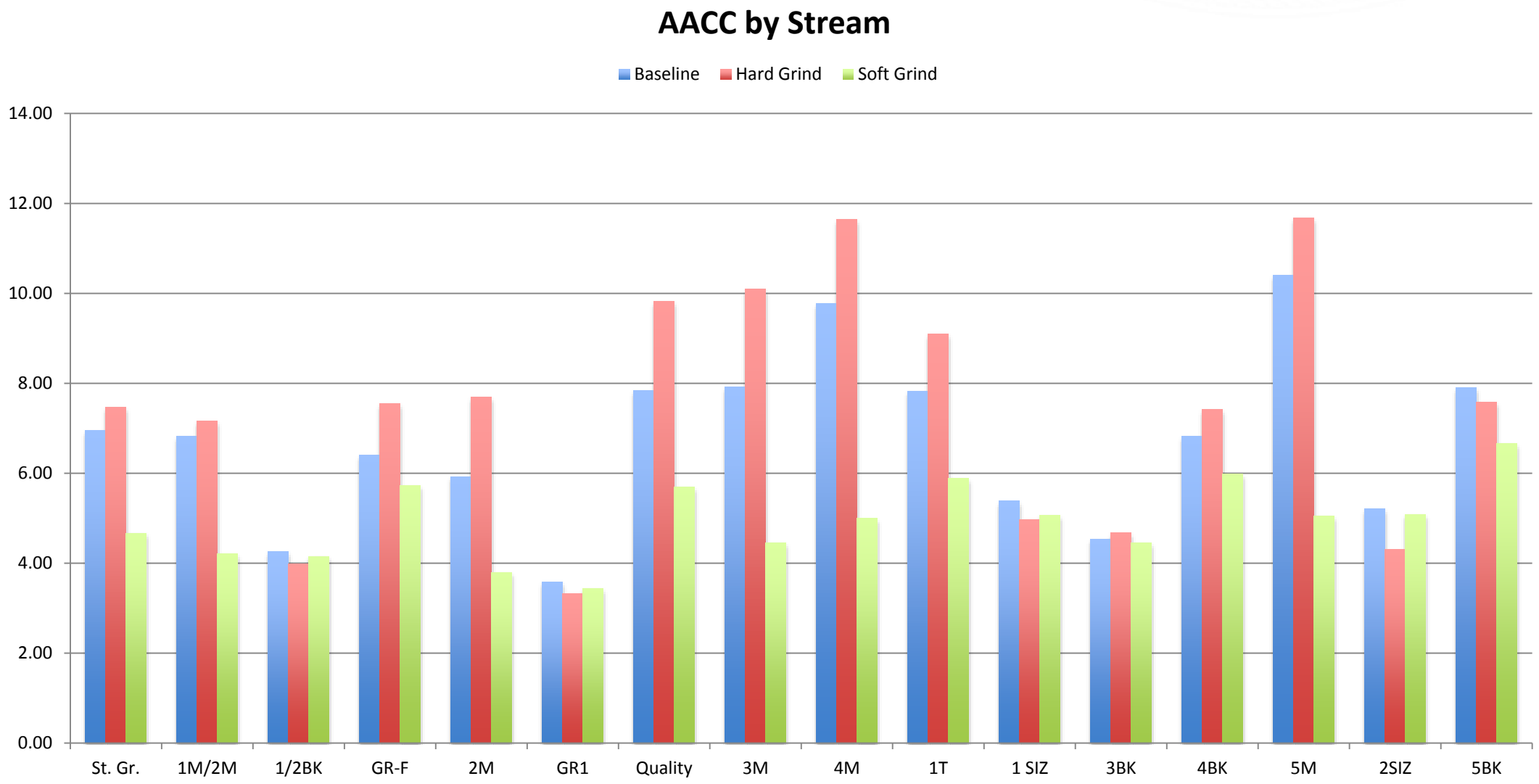
- Starch damage can be measured by enzymatic digestion.
- Amperometric measurement of iodine absorption.
  - SDmatic rapid measurement of iodine absorption

SDmatic was discounted by Chopin Technologies for Milling Practices to Improve Flour Quality Short Course at IGP Institute and to help with this project research

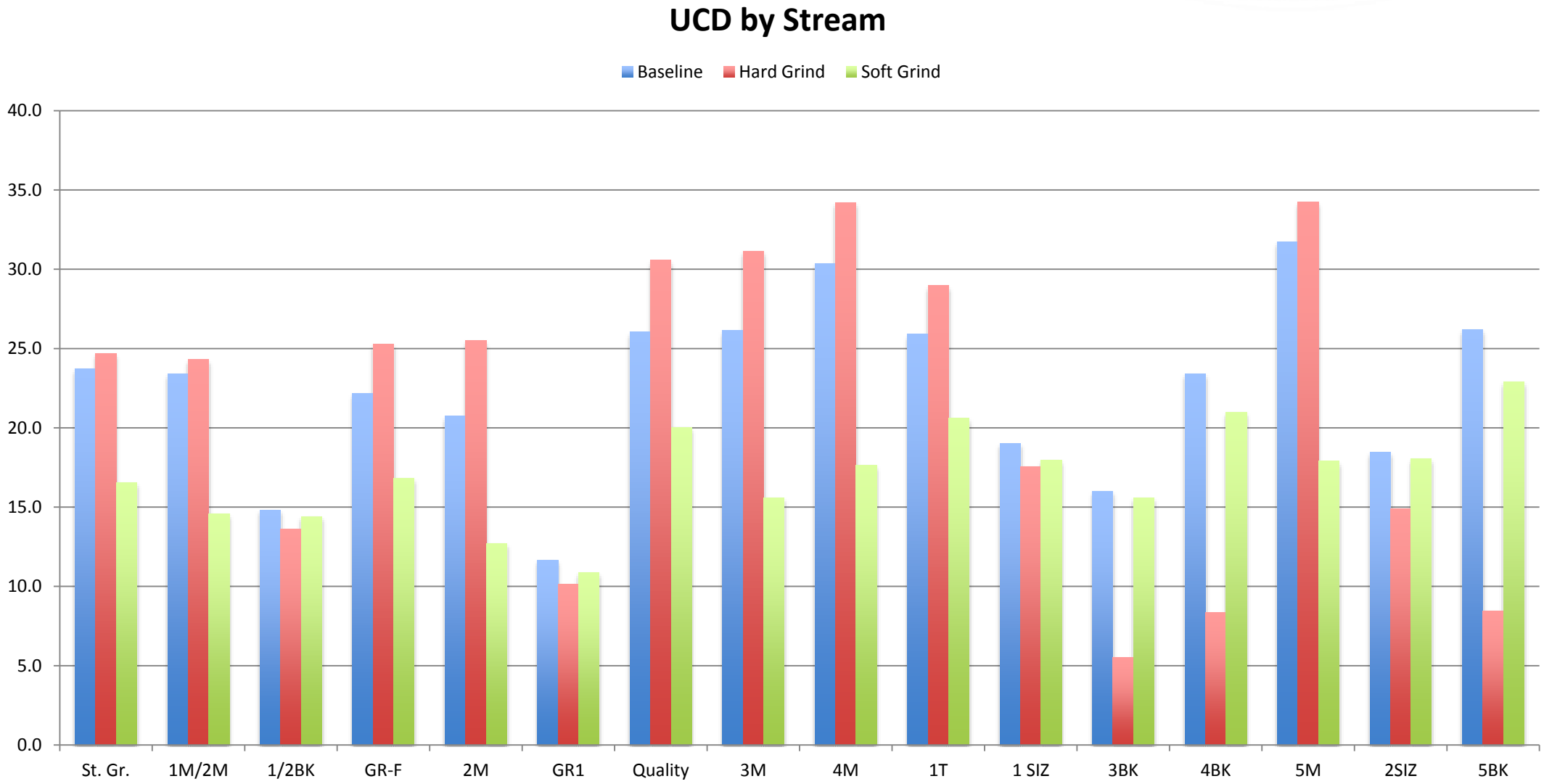
SDmatic

- AACC Method 76.31
- Approximately 25 Minutes for first sample
- 10-12 minutes for each additional sample
- Reagents
  - Boric Acid Powder
  - Potassium Iodide Powder
  - Sodium Thiosulfate
  - Distilled Water

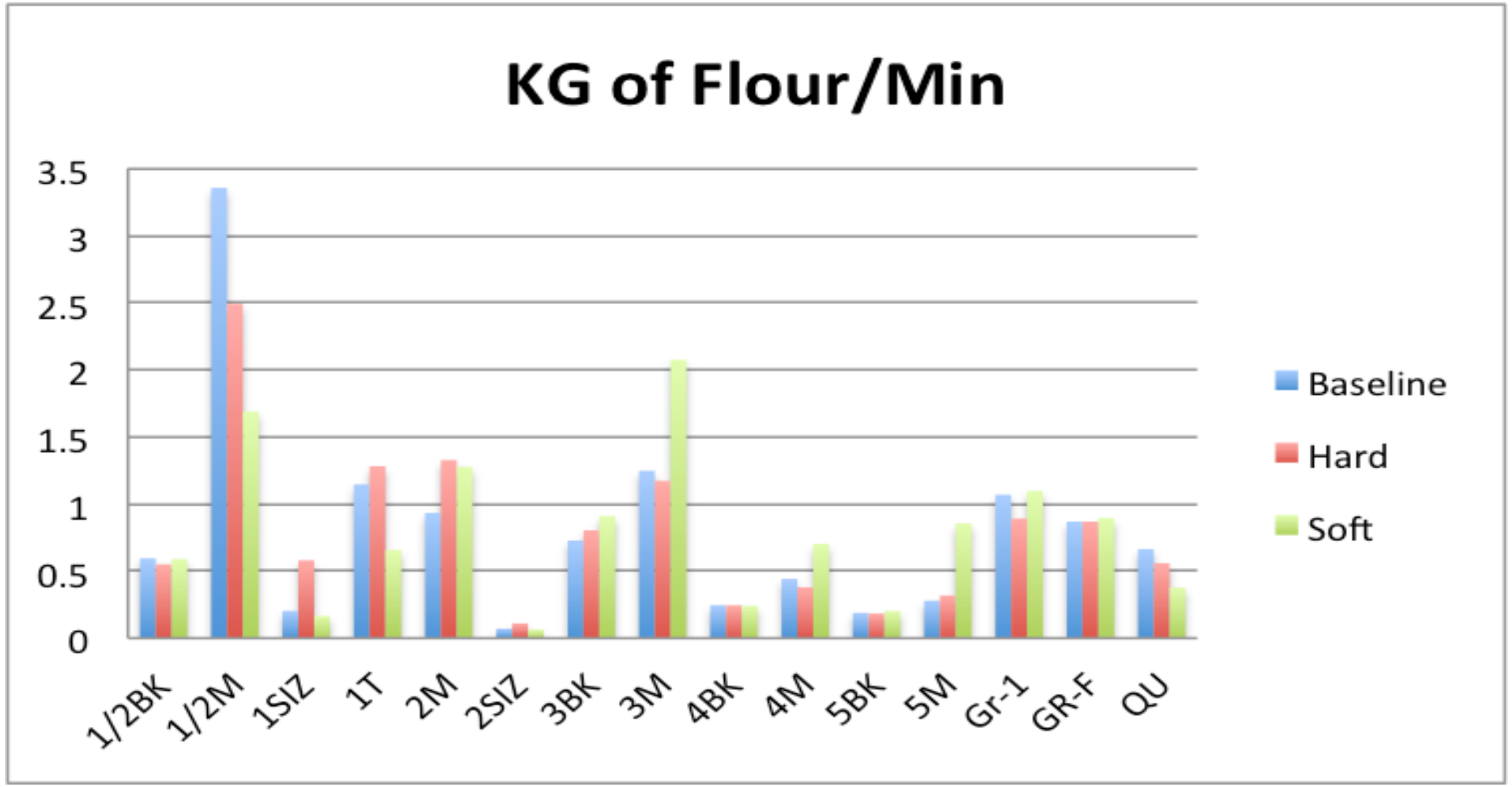
AACC Starch Damage by Flour Stream



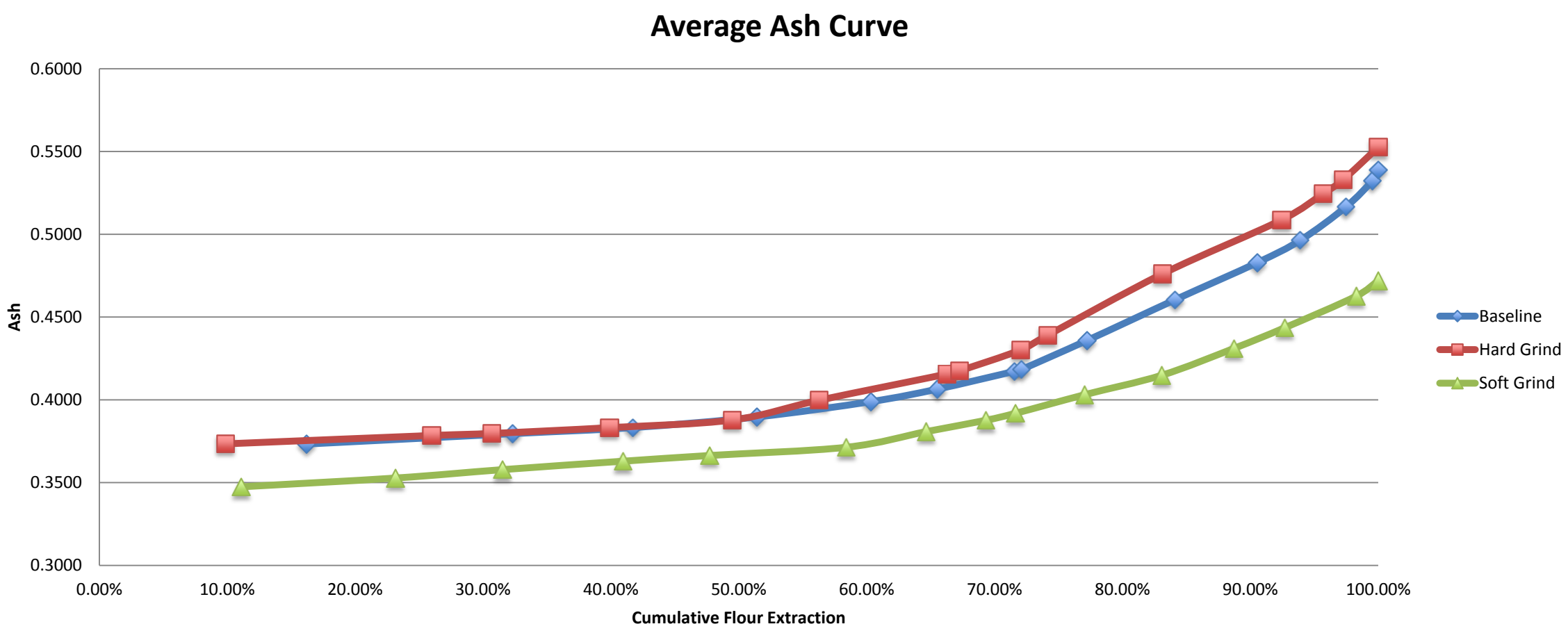
UCD Starch Damage by Flour Stream



Flour Produced



Average Ash Curve



Flour Produced

Conclusions

- No significant gain in flour production from baseline to hard grind, just increased amount of starch damage.
- The possibility to optimize midds rolls using a combination of flour release and starch damage does exist.
- Starch damage and ash results were correlated, especially towards the tail end of the mill, however, they don’t have a direct effect on one another.
- Measuring starch damage on reduction rolls could ensure a more consistent grind between shifts and help monitor excess grinding pressure.
- Next steps would be to measure energy usage compared to flour released and starch damage to determine savings.

Questions