MILLING COLLABORATIVE

CINCINNATI SECTION
of the
AMERICAN ASSOCIATION OF CEREAL CHEMISTS, INC.

For the 1st Annual
Soft Wheat Flour Analytical Methods Workshop

USDA Soft Wheat Quality Laboratory
Wooster, OH

March 21, 2006

Pendleton Flour Mills in Blackfoot, Idaho graciously provided a sample of soft white grain for this collaborative. A sample of commercial flour milled from this grain lot and a sample of Buhler experimental milled flour from the Quality Assurance Laboratory also were obtained from Pendleton Flour Mills, courtesy of Mr. Reuben McLean. The Pendleton mill has a capacity of 16,500 cwt/day, and mills white, whole wheat and cracked wheat flours. Approximately 15% of production is soft and 85% is hard. Based on the production in the draw area of the mill, the predominant cultivar in the sample is the soft white winter wheat 'Brundage.'

The grain sample was distributed to the collaborators, each of whom milled the grain sample on their experimental mill as per their standard procedures. Some of these procedures are included in this report. Collaborators then sent flour to Mr. Lon Andrews of the USDA Soft Wheat Quality Laboratory.

The ten flour samples were distributed among three laboratories for analysis: Mennel Milling, Kraft Toledo Flour Mill, and the USDA Soft Wheat Quality Laboratory.

The Soft Wheat Methods Workshop Planning Committee wishes to thank those who milled and analyzed these samples in preparation for this workshop.

Soft Wheat Methods Workshop Planning Committee
Jan Levenhagen and Dave Braun: Mennel Milling
Diane Gannon and Brent Gradishar: Kraft-Nabisco Toledo Mill
Mary Guttieri: University of Idaho
Ed Souza, Lonnie Andrews, Georgianna Kirchofer, Meera Kweon: Wooster SWQL

Cincinnati Section & USDA Soft Wheat Quality Laboratory Presents
1st Wheat Flour Analytical Methods Workshop

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Provided by Lon Andrews, Soft Wheat Quality Lab

Soft Wheat Quality Laboratory Milling Protocols

Miag Multomat

The Miag mill was built about 1963 (?) and was donated to the SWQL by Pillsbury. Originally, metal chains and cotton pads were used to facilitate stock and flour movement in the plansifter. The metal chains were removed and screw balls replaced the cotton pads. The third-break sieving unit was modified. The sieving unit arrangement was altered so that four scalp screens were utilized for bran sifting rather than the factory-designed two scalp screens. Additionally, the middling stock from the third break was diverted away from the third reduction and directed into the duster sieving unit. Stock material from the duster unit feeds into the second reduction.

Soft wheat is usually tempered to 14% for a minimum of one day. 1.5 kg wheat can be milled resulting in about 97% recovery. The feed rate follows Miag recommendations (27.5lbs/inch roll width/hr). Break-flour yield for soft wheat varies from 21% to 34%. Straight-grade flour yield averages around 73% with .43% ash and with a flour particle size about 45 microns mean volume diameter (MVD).

Quadrumat Junior

Two Quadrumat Junior mills were purchased in the early 1960's. In 1980 the factory-installed corrugated rolls were replaced with very finely corrugated rolls in one of the mills. The door was replaced with a ½" Plexiglas sheet and air tubes were affixed to holes drilled in the Plexiglas. Air is blown through the connected tubes to facilitate clean-out. The bottom of the mill that houses the reel-type sifter was removed. The mill body was elevated to aid in capturing the milled material. The feed roller was removed and a vibratory feeder unit installed. The roller brushes were removed. The mill is preheated to about 34 degrees Centigrade prior to milling. (That is the operating temperature of the mill.) A Great Western sieving unit was added to sift the milled stock.

A few entries in a set are analyzed for grain moisture to ascertain an average moisture level. Soft wheat is tempered to about 15% for a minimum of two days. Flour yield and softness equivalence (SE or break flour) are determined. Three regression equations were developed to adjust flour yield and SE to 15% moisture basis. A fourth regression equation adjusts flour yields for softness differences. (Because of the short-flow system, granularity differences will influence milling yield.) The "straight-grade" flour yield will average 71% from soft wheat having an SE ranging between 44% and 65%. There will be a wide range in the size of flour particles within any given sample.

Provided by Lon Andrews, Soft Wheat Quality Lab

Quadrumat Advanced (Laboratory Constructed Quadrumat Senior)

The break-head is the same as described for the Quadrumat Junior. The second Quadrumat Junior was transformed to be a reduction mill. The factory-installed corrugated rolls were replaced in 1980 with three SWQL-machined smooth rolls and a finely corrugated fourth roll. At the same time a Plexiglas sheet replaced the door, air clean-out tubes were installed, feed roller was removed, vibratory feeder was added, and the reel-type sifter unit and roller brushes were removed.

Grain moistures are determined so the wheat can be tempered to exactly 15%. Only the flour-yield adjustment for softness-variation regression is utilized for advanced samples. Straight-grade flour yield will average 72% with .34% ash and will have flour particle size of about 55 microns (MVD).

Allis-Chalmers Milling System

The Allis-Chalmers mill was apparently obtained by the Ohio Agricultural Experiment Station in 1909. In the mid 1970's the Allis mill was extensively modified including replacement of the Babbitt bearings with double-row roller bearings. Roll spacings can now be replicated with precision. The Allis mill incorporates six breaks and usually seven reductions. Very poor milling wheat may require additional reduction passes. The reduction process finalizes once the middling stock percentage falls below 2% of the wheat weight. Break-flour yield averages 32%. Straight-grade flour yield averages 77% with .40% ash and flour particle size of about 65 microns (MVD). Standard deviation for replicability of flour yield is .15%.

Most soft wheats are tempered to 15%. Extremely soft wheats are tempered to 14% while very coarse soft wheats are tempered to 16%.

The Allis-Chalmers data base representing nearly 800 soft wheat cultivars is the basis for evaluating Quadrumat-milled soft wheat breeding lines grown throughout the eastern United States and southeastern Canada.

Provided by Doug Engle, Western Wheat Quality Lab

March 7, 2006

Western Wheat Quality Laboratory Milling Protocols

Modified Quadrumat Milling Procedure

Note: 4 to 5 samples are removed from sample bottles and worked with simultaneously during this procedure. It is important to be systematic in handling materials to eliminate errors due to accidental mixing of samples.

Mill heaters should be left on continuously. If left off heaters need at least 45 minutes to reach stable temperatures. Temperatures should read approximately 33+/- 1 degrees C on the break side and 35 +/- 1 degrees C on reduction side.

Tempering:

The day before milling samples are tempered to 13.0% for soft wheat and 14.5% for hard wheat with water containing a wetting agent (0.1% Aerosol OT) and allowed to sit overnight. The amount of solution to add is listed on the mill form.

Pour sample into 1 pound coffee can. Add the correct amount of temper water with automatic fill buret. Quickly replace plastic lid on coffee can and shake vigorously several times by hand. Put rubber band over can and lid and place on blender. Allow to tumble grain until grain no longer clings to interior of can, approximately 20 minutes for hard wheat, 15 minutes for soft wheat.

When sample is finished tumbling, pour into original bottle and set aside until milled.

Temper one 500g warm-up sample to be milled first thing the next day.

Inspect sieves for holes and repair with hot glue if necessary. Replace screens if damage is too severe.

Milling:

1) Be sure mills are warm by observing and recording temperature on read out.

2) Turn on break and reduction units first thing upon entering room and allow to run while getting set up. Be sure rolls are turning in proper direction, towards one another feeding into the nip of the roll. Turn vibratory feeder on. Turn on computer and start Quad application in balance program.

3) Place sieves under break unit (deep #32 sieve over shallow #100 sieve over deep pan). Always put five plastic figure 8 sieve cleaners on #100 sieve for both break and reduction units.

4) Weigh tempered grain into balance program. This verifies that the correct temper water

amount was added. Set feeder rate to prescribed line for hard or soft wheat. Target feed rate is approximately 160g/min for break side and 50g/min for reduction side. If rolls tend to jam while milling reduce feed rate.

5) Pour first sample into vibratory feeder while mill is running. If grain enters roll nips while mill is stopped the mill will jam immediately. If rolls jam, turn mill on forward and backward rapidly to try and start it again. If this doesn't work, turn off mill and remove face place and clear stock from between rolls, saving as much material as possible.

6) When sample is ground, rap plastic face plate with rawhide hammer to loosen any flour sticking to it. Do not hammer directly on rolls as this may drive them back and change the gap between them. Use central vacuum to clear remaining loose flour before starting next sample

7) Place lid on stack of sieves and place on sifter for 1 minute.

8) Remove top sieve containing bran and sift remaining stock (middlings on #100 sieve) for another 2 minutes. Weigh bran into balance program and discard bran.

9) After break stock is finished sifting, remove top sieve containing middlings. Weigh break flour on balance program then place beak flour (throughs of #100 sieve) into holding pan beside reduction unit.

10) Pour middlings from break unit into vibratory feeder.

11) After all stock has passed through reduction unit, use hammer and vacuum hose to clean as much stock as possible out of mill rolls.

12) Pour output from reduction unit into #100 sieve above holding pan with break flour. Sift 3 minutes.

13) After reduction stock has sifted, remove top sieve containing shorts weigh using balance program and discard.

14) Weigh total flour and record using balance program. Place flour in 1 pound coffee can with rubber band holding lid on and put on blender next to sample bottle that the grain came from. Blend at least 15 minutes.

15) After the procedure has been learned, several samples can be run simultaneously. 32-40 500g samples can be milled each day.

16) Record any abnormal behavior or errors in comments section of balance program.

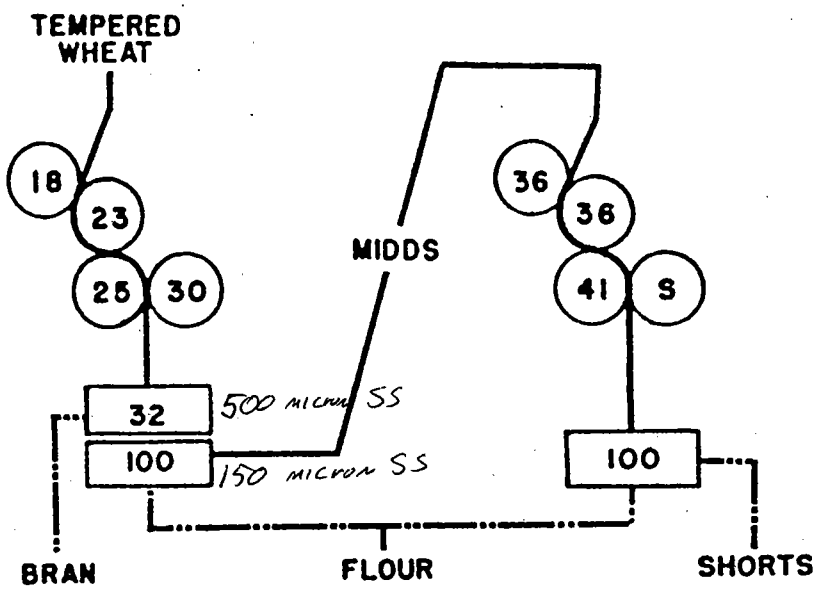
Provided by Doug Engle, Western Wheat Quality Lab

Setting Omega Temperature Controller:

Resetting Temperature Control for Quad Mills
(Omega controller)

1. Press ↻ one time to get menu to SPI.
2. Press ↵ to get to current temperature setting.
3. Press ▲ or ▼ to increase or decrease temperature setting.
4. Press ↵ to save new setting.
5. Press ▼ twice to exit set-up menu and run program.

MODIFIED QUADRUMAT SR. MILLING PROCEDURE



BREAK UNIT	REDUCTION UNIT
BRABENDER QUADRUMAT JR. WITH QUADRUMAT SR. BREAK ROLLS	BRABENDER QUADRUMAT SR. REDUCTION HEAD

ROLLS:

Diameters: 2.8 inches

Speed:
Fast rolls: 1200 RPM
Slow rolls: 560 RPM

Differential: 2.14 to 1

SIFTERS:

8 and 12 inch Tyler testing sieves on strand sifter

SIFTING SCHEDULE: Break Stock:
Bran: Removed after 1 min.
Middlings: Removed after an additional 2 min. (3 min. total)

TEMPER:

Soft wheats 13%
Hard wheats 14.5%

Reduction Stock: 3 min

SAMPLE SIZE: 100-500 grams tempered wheat (held constant within each comparison group)

OUTPUT: 5-7 samples per hour

Figure 2. Semi-micro experimental mill flow with the roll corrugations per inch. The break rolls have corrugation spirals of 1.25, 1.75, 1.88, and 1.25 inch/ft. in progressive order, and the middling reduction roll spirals are 1.25, 1.25, 1.25, and frosted smooth. Roll spacings for first, second and third break are 0.035, 0.0035, and 0.002 inch respectively. The middling rolls are set at 0.0015, 0.0020 and 0.0015 inch respectively.

Provided by Doug Engle, Western Wheat Quality Lab

Buhler Mill Procedure

Model MLU-202

The Buhler mill procedure was modified in 1995 to help remove differences between Quad and Buhler milled flours. Flour cloths were changed from 145ss to 120ss to match flour opening of Quad. Also grinding pressure on reduction side was reduced to decrease level of starch damage observed on the Buler and make it more comparable to levels observed from the Quad.

Figure 8 sieve cleaners were attached to cleaning chains in 1990. This helped material pass through sieves more easily. Tennis balls were also added to bottom of sieve boxes to aid in flour transport.

Tempering:

The day before milling, samples are tempered to 14.0% for soft wheat and 16.0% for hard wheat with water containing a wetting agent (0.1% Aerosol OT) and allowed to sit overnight. The amount of solution to add is listed on the mill form. An additional 0.5% pre-temper is added to the grain 5-10 minutes prior to milling.

Pour sample into tumbler bins and turn on unit. Measure the correct amount of temper water using a graduated cylinder. Pour the contents of the graduated cylinder directly into the tumbling grain. Place lid on tumbler. Blend until wheat stops sticking to side of unit. This will take approximately 10 minutes for hard wheat, 5 minutes for soft wheat.

When sample is finished tumbling, pour into original bottle and set aside until milled.

Temper one 2000 gram warm-up sample to be milled first thing the next day.

Place mill heating units on rolls and plug into temperature control apparatus. Leave on overnight. Heaters will heat break side to approximately 32 degrees C and reduction side to 40 degrees C. Rolls take several hours to heat.

Grease all fittings in grinding unit approximately once per month when mill is in continuous use. Sifter box counter weight system should be greased weekly.

Remove and inspect bolting cloths weekly. Patch small holes with hot glue and replace screen if necessary.

Milling:

1) Be sure mills are warm by observation of roll temperature. Turn on computer and start Buhler application in balance program. Remove heating apparatus.
2) Turn off main power supply to mill. Check roll settings with 0.1mm feeler gauge. Set left and right indicators to 10 on both break and reduction sides. Verify that left and right hand sides of roll read 10 on the scale. If not, move adjusting knob until rolls are parallel at 0.1mm and move pointers until they indicate 10 on the scale. Turn power supply back on.

WHENEVER MACHINERY IS WORKED ON ALWAYS TURN POWER SUPPLY OFF!

3) Start mill and allow to run while getting set up. When starting mill, turn on air lift and allow fan to come up to speed. Turn on rolls next. Often times the sifter boxes will start out of sync with the boxes. Stand in front of mill and dampen shaking of boxes with one knee until boxes are shaking normally. If this operation gets difficult to perform, tighten leather drive belts.

4) Place boxes under flour sieve box in front of mill and under bran and short outlets in back of mill.

5) 5 minutes before milling, put sample into grain tumbler and add 0.5% temper water. Weigh tempered grain into balance program. This verifies that the correct temper water amount was added.

6) Pour first sample into vibratory feeder while mill is running. Set feeder rate at 55g per 30 seconds +/- 5g for soft wheat and 60g per 30 seconds +/- 5g for hard wheat. If wheat is plugging at intake clean sock and make sure break side air flow control valve on top of mill are set to 1/4 closed.

7) Set break rolls to achieve good bran clean up without excessive bran shattering. If small chunks of endosperm are observed exiting the bran chute break rolls need to be tightened. This will reduce these particles enough to be transported to the reduction side. Set rolls by loosening hold nuts on left and right hand sides, moving gauge then re-tightening nuts.

8) The reduction rolls are set to settings of 10 and 4 on left and right hand setting for soft wheat. Further tightening of reduction rolls will result in excessive starch damage. Hard wheats can be milled with tighter settings although 10 and 4 often works well.

9) When sample is ground, rap boxes and roll area lightly with rawhide hammer to loosen any flour sticking to the areas. Turn on vibrator for 5 minutes to further assist in clean out. Several minutes into clean out cycle use bottle brush and sweep down top and bottom of roll area. **DO NOT PUT FINGERS INTO LOOP AT END OF BRUSH.** ALSO, DO NOT ALLOW END OF BRUSH TO COME CLOSER THAN 3" FROM NIP OF ROLLS OR AIR LOCK FEED LOCATED AT UPPER PART OF MILL FEED CHAMBER.

10) When clean out is completed turn off mill. Remove flour boxes and weigh products into balance program placing flour into sifter box. Replace boxes, remove bran & shorts boxes and weigh into program placing product into garbage can. Replace boxes, tap dust collector sock, remove dust collector pan and weigh material into suction column of program. Replace pan.

11) Sift flour on 100ss clean up screen to remove any impurities. A few grams of sizing particles will leak through box system and be deposited into flour. Place sifted flour into tumbler and run at least 10 minutes before removing.

12) After blending flour streams, put into original jar.

13) Start pre-temper of next sample approximately 3 minutes before previous sample finishes milling to be ready to mill after weigh up is complete.

15) After the procedure has been learned, approximately 12-15 test samples can be run each day.

16) Record any abnormal behavior or errors in comments section of balance program.

Buhler mill is clothed with the following sieves:

W=wire Micron opening
SS=stainless steel Micron openiing

1B	2B	3B	1R	2R	3R
44W	44W	64W	54W	72W	–
363 micron	363 micron	275 micron	316 micron	243 micron	
120SS	120SS	120SS	120SS	120SS	120SS
145 micron	145 micron	145 micron	145 micron	145 micron	145 micron

Break rolls corrugations per inch are: 16 20 24
Reduction rolls are: smooth frosted

Provided by James Elkins, Jr. Mennel Milling Co.

MMC Experimental Milling

Buhler Cleanout Method

July, 2005

Milling Method Selection Notes

Much stock is retained within the mill, and a thorough cleanout between samples is essential to avoid cross-contamination between samples and to maximize yield precision. Where precise measurements of flour properties and milling yield are desired, the ***Cleanout Method (i.e. this method)*** should be used. For less precise work, the ***Continuous Method*** has the advantage of greater sample throughput. Thorough cleaning down of the mill is necessary when an extreme difference exists in milling properties of wheats from sample to sample, and following samples that contain sprout-damaged kernels. If neither is the case, satisfactory results can be obtained by running the mill for ***12*** minutes after the feed hopper has emptied while following the cleanout procedure, eliminating the need to stop the mill to brush down sieves.

Objective

To test wheat milling properties and produce flour for further quality analysis.

Apparatus

1. Buhler laboratory mill fitted with 6" diameter sock (helps with aspiration).
2. Other laboratory facilities.

Wheat Tempering

1. Wheat sample should be thoroughly cleaned before tempering.
2. Soft Wheat: Temper sample (at least ***1.5*** kg, better ***2.5-3.0*** kg) to 14.5% moisture and let stay 12-18 hours before milling.
3. Hard Wheat: Temper sample (at least ***1.5*** kg, better ***2.5-3.0*** kg) to 15.0% moisture and let stay 16-24 hours before milling.
4. If the original wheat is too dry (such as less than 10.0% moisture), two-stage temper may be necessary.

Operation Procedure

1. Set Up Mill: Both the sieves and rolls are already pre-set up and ready to use. If some adjustments are necessary, please refer to AACC Methods 26-10A, 26-21A, 26-30A, and 26-31.
2. Check all the feeding/flour chambers. Turn the mill on and do the checking run with keeping the rolls disengaged, without any sample feeding. Ensure the proper pneumatic airflow.
3. Turn the mill off; make sure the wheat feeder is closed. Engage the rolls.
4. Mill about 1 kg wheat to warm up the rolls. Control the feeding rate around 100 g/min (at 1.0 feeder marks for Roanoke's mill). If there is stock retained in any of the stream feeding chambers, slowly and carefully release it. Feed at a rate depending on type of wheat, kernel size, etc. Feed to avoid a choke.
5. After essentially all the stock has passed through mill, close feeder. Disengage rolls and begin cleanout in sequences with mill still running empty. At the end of adding

the tempered wheat, allow the mill to run an additional 15 minutes while we brush, clean out, etc. We then weight the resulting streams.

6. Tap and brush air locks and areas above break rolls. Open doors and brush down thoroughly underneath rolls, both front and back. Lift front sifter cover and, with long-handled brush, reach to back of each stock channel and draw stock forward onto sifter.
7. Clean down reduction side in same sequences. Repeat again for both break and reduction sides.
8. Tap sifter boxes lightly with either soft rubber mallet or flexible hose approximately 3.0 cm in diameter.
9. Turn mill off and remove sieves. Recover flour adhering to stock channel below sieves with light trapping and brushing. Brush down sieves and place them back in mill in preparation for milling next sample.
10. Discard warm-up sample products.
11. Repeat step 2 to step 9 for the properly tempered wheat sample milling.
12. If it is necessary, weight all six (6) flour streams, bran, and short separately; store each product individually. If the target flour grade is known, follow the table below to collect milling products.

Flour Grade	Straight Grade	Long-Patent	Short-Patent
White Flour	1B, 2B, 3B, 1M, 2M, 3M	1B, 2B, 1M, 2M	2B 1M
Milling By-Product	Bran, Short	Bran, Short 3B, 3M	Bran, Short 1B, 3B, 2M, 3M

13. Calculation of Flour Milling/ Extraction Yield
    Without Moisture Correction

$$\% \text{ Flour Yield} = \frac{\text{White Flour Weight (g)}}{\text{White Flour Weight (g)} + \text{Milling By-Product Weight (g)}} \times 100$$

    With Moisture Correction:

$$\% \text{ Flour Yield} = \frac{\text{WFW} \times (100 - \text{WFM})}{\text{WFW} \times (100 - \text{WFM}) + \text{MBPW} \times (100 - \text{MBPM})} \times 100$$

    Where:
    WFW = White Flour Weight (g); WFM = % White Flour Moisture;
    MBPW = Milling By-Product Weight (g); MBPM - % Milling By-Product Moisture

14. Record date and all sample information. Report both amounts / grams of white flour and milling by-product, and the flour milling / extraction yield.
15. After mill all the samples each day, clean the mill and the whole laboratory thoroughly.
16. To ensure proper pneumatic airflow, filter bag should be vigorously shaken after each sample and periodically cleaned.

Safety Caution!!!

1. Prevent your clothes and long hairs rolling into the rolls.

Provided by James Elkins, Jr. Mennel Milling Co.

2. Never tough top areas of the rolls with your figure(s) and / or any cleaning tools(s) when the mill is running.
3. In case something accidentally gets into the running rolls, stop the mill immediately and do not try to pull it out with your hand(s).
4. When anything unusual incurs, turn mill off immediately and ask for help.

MENNEL MILLING

	Fostoria	*Roanoke*
SAMPLE	buhler#6	
LOCATION	swql w.s	
DATE	02/28/06	03/02/06
X-MILL #	87	
WHEAT	co lab	
MOISTURE	7.89	7.91
PROTEIN @12%	10.47	10.44
FALLING NO.	401	398
MILLING		
DRY DIRTY WHEAT WT.	2023	
DRY CLEAN WHEAT WT.	2000	2059
% DOCKAGE	1.14%	
TARGET MOISTURE	14.5	
WATER ADDED (ML)	154.6	
MILLING WEIGHT	1500	2059
MILLING MOISTURE	14.61	14.30
PRODUCT YIELD	76.67%	67.55%
BU/CWT	2.18	2.47
1 BK	232	202.7
%	14.6	20.6
2 BK	327	40.7
%	20.6	4.1
3 BK		51.1
%	0.0	5.2
TOTAL BREAK FL	559	294.5
%	35.3	29.9
1 M	1025	430.6
%	64.7	43.8
2M		162.2
%	0.0	16.5
3M		96.1
%	0.0	9.8
TOTAL MIDDS	1025	688.9
%	64.7	70.1
TOTAL FLOUR	1584	983.4
%	76.7	67.5
BRAN	328	317.8
%	68.0	67.3
SHORTS	154	154.7
%	32.0	32.7
TOTAL FEED	482	472.5
%	23.3	32.5
TOTAL PRODUCT	2066	1455.9
FLOUR		
MOISTURE	11.60	
PROTEIN @14%	9.35	
ASH	0.595	
FN	417	

Comments from Fostoria:

The wheat sample milled fairly normal. We had a slightly higher product yield than what we see with eastern soft wheat. Our average product yield from our X-mill is 72% for soft wheat. With this wheat being so dry, we probably should have done a second temper immediately prior to milling to get the flour moisture up closer to 13.5%. This would have also helped the ash. I'm sure the ash was higher than normal due to the lower moisture.

Comments from Roanoke:

Roanoke reported that they had to cut back the load due to the plump kernels. Their 67% product yield is normal for their soft wheats.

Mennel Milling, Fostoria

76.67% Straight Grade Flour Yield

Milling Equipment		Buhler		Mfg in 1948. Reconditioned in 1996. Non-pneumatic (mechanical conveying & grinding)	
Tempering Moisture		14.5%			
Tempering Duration		24 hr			
Clean Out Method		We run a 3000g "dummy" batch before beginning milling each day to warm up the mill. 1000g of the sample being milled is then run through the mill prior to milling the actual sample to clean out the mill.			
Rolls:	6" dia	Differential 2:1	Surface = 300 sq. in.	Grinding dull to dull	
		Corrugation	Gap settings	Sifter clothing	Bolting surface = 288 sq. in.
	B1	16	0.43 mm	44W/135SS	
	B2	20		44W/135SS	
	B3	24	0.38 mm	54SS/135SS	
	1M		0.05 mm	54SS/135SS	
	2M			62SS/135SS	
	3M		0.01 mm	135SS	

Mennel Milling, Roanoke

67.55 % Straight Grade Flour Yield

Milling Equipment	Buhler (Pneumatic)	Mfg. 1962.	
Wheat Cleaning Method	Sift fines over FGIS screen, aspirate		
Tempering Moisture	14.5%		
Clean Out Method	1000g of the sample being milled is then run through the mill prior to milling the actual sample to clean out the mill.		

Wheat Marketing Center, Portland, OR.

72.3% Straight Grade Extraction

Milling Equipment		Buhler MLU-202		S/N 130788.	~ 40 yrs old	
Wheat Cleaning Method		Carter Day Dockage Tester				
Wheat Moisture Method		GAC 2000				
Tempering Moisture		-14.5%-soft wheat -16.0%-HRS 1st -15.0%-HRW 1st -0.5%-hard wheat 2nd				
Tempering Method		Cement Mixer with plastic cover 10-15min				
Tempering Duration		-18 ± 3 hrs-soft wheat -24 ± 3 hrs-hard wheat				
Feed Rate		-80-90g / min-soft wheat -90-100g / min-hard wheat				
B1 Break Release		46-53% thru 24SSBC (869micron) using Great Western Oscilating Sifter (12"x12") for 2min				
B2 Break Release		N/A				
Flour Extraction Calculation		$\frac{\text{All Flour Streams x 100}}{\text{Total Output}}$				
Clean Out Method		Start cleaning first pass immediately after feeding wheat using faint air. Let stand for 1min between passes. Let run for 10min after last pass.				
Wheat Class		SWH	Hard Wheat			
Sieve Size (micron)	B1	437, 119	437, 145			
	B2	437, 119	437, 145			
	GR	N/A	N/A			
	B3	368, 119	368, 145			
	1M	368, 119 x 2	368, 145 x 2			
	2M	308, 119 x 2	308, 145 x 2			
	3M	119 x 2	145 x 2			

Table 1. Flour extraction and ash concentration.

			Yield (% of recovery)			
	Laboratory	Mill Type	Break Flour	Reduction Flour	Straight Grade	Flour ash (%)
1	Pendleton Flour Mills	Buhler X Mill	NA	NA	NA	0.464
2	Pendleton Flour Mills	Buhler Commercial. Mill	NA	NA	NA	0.534
3	Univ. of Idaho	Quad Sr.	52.9	14.6	67.5	0.366
4	Kraft; Toledo	Chopin	24.7	27.7	55.4	0.451
5	Soft Wheat Lab	Miag Multomat	24.4	50.9	75.2	0.443
6	Mennel Milling	Buhler (non-pneumatic)	27.1	49.6	76.7	0.594
7	Mennel Milling	Buhler (pneumatic)	20.2	47.3	67.6	0.472
8	PNWWQL	Quad Sr.	50.2	18.2	68.4	0.433
9	PNWWQL	Buhler	25.2	43.6	68.9	0.458
10	Wheat Marketing Ctr.	Buhler MLU-202			72.3	0.442
						555C, 15 h SWQL

Table 2. Flour protein and moisture.

			Protein (%)			Moisture (%)		
	Laboratory	Mill Type	Dumas	Unity	Mennel	Oven	Unity	Mennel
1	Pendleton Flour Mills	Buhler X Mill	9.9	8.7	9.6	10.2	10.0	10.1
2	Pendleton Flour Mills	Buhler Commercial. Mill	9.8	8.9	9.3	11.6	11.8	11.4
3	Univ. of Idaho	Quad Sr.	8.4	7.9	8.4	12.8	12.9	12.5
4	Kraft; Toledo	Chopin	8.4	7.5	8.2	13.1	13.2	12.6
5	Soft Wheat Lab	Miag Multomat	9.4	8.7	9.0	13.3	13.4	12.9
6	Mennel Milling	Buhler (non-pneumatic)	9.9	8.8	9.5	11.5	11.8	11.3
7	Mennel Milling	Buhler (pneumatic)	9.9	8.9	9.5	11.3	11.4	11.2
8	PNWWQL	Quad Sr.	9.1	8.1	8.8	12.7	12.8	12.5
9	PNWWQL	Buhler	9.4	8.5	9.1	12.1	12.3	12.1
10	Wheat Marketing Ctr.	Buhler MLU-202	9.1	8.3	8.9	12.1	12.4	12.0
						140 C, 15 min		

Dumas and Unity measured at SWQL.

Table 3. Flour softness and damaged starch.

	Laboratory	Mill Type	Softness (%)	Damaged starch (%)
1	Pendleton Flour Mills	Buhler X Mill	48	3.93
2	Pendleton Flour Mills	Buhler Commercial. Mill	62	4.98
3	Univ. of Idaho	Quad Sr.	54	3.55
4	Kraft; Toledo	Chopin	48	2.92
5	Soft Wheat Lab	Miag Multomat	66	3.41
6	Mennel Milling	Buhler (non-pneumatic)	65	4.57
7	Mennel Milling	Buhler (pneumatic)	55	3.99
8	PNWWQL	Quad Sr.	46	3.76
9	PNWWQL	Buhler	45	3.82
10	Wheat Marketing Ctr.	Buhler MLU-202	80	4.89

Softness = % through 230 mesh SS, 74 micron opening, SWQL

Damaged starch conducted in triplicate, Mennel Milling.

Table 4. Flour solvent retention capacities (SWQL and Kraft Toledo).

			Solvent retention capacity (%)							
			Water		Sodium carbonate		Sucrose		Lactic acid	
	Laboratory	Mill Type	SWQL	Toledo	SWQL	Toledo	SWQL	Toledo	SWQL	Toledo
1	Pendleton Flour Mills	Buhler X Mill	54.4	55.0	72.2	71.1	96.5	101.4	78.9	78.1
2	Pendleton Flour Mills	Buhler Commercial. Mill	60.8	62.7	83.7	83.5	104.0	110.2	81.6	82.6
3	Univ. of Idaho	Quad Sr.	51.0	52.2	66.5	66.2	89.1	93.6	73.8	70.2
4	Kraft; Toledo	Chopin	51.2	49.4	65.1	63.3	86.7	83.5	63.4	63.5
5	Soft Wheat Lab	Miag Multomat	53.4	52.2	70.5	69.9	92.5	97.8	79.3	79.3
6	Mennel Milling	Buhler (non-pneumatic)	57.0	55.9	78.8	77.3	99.2	103.6	75.0	76.6
7	Mennel Milling	Buhler (pneumatic)	54.1	53.5	71.0	70.4	93.3	97.7	76.0	76.9
8	PNWWQL	Quad Sr.	53.4	52.6	69.4	69.0	90.5	93.4	72.7	72.0
9	PNWWQL	Buhler	55.2	55.1	71.0	70.2	93.3	98.6	77.5	77.9
10	Wheat Marketing Ctr.	Buhler MLU-202	56.9	55.2	79.9	80.0	99.7	110.0	81.0	79.5

Table 5. Alveograph parameters (Kraft Toledo).

	Laboratory	Mill Type	P	L	W	W @ L=100	P/L
1	Pendleton Flour Mills	Buhler X Mill	35	94	75	77	0.37
2	Pendleton Flour Mills	Buhler Commercial. Mill	47	81	89	96	0.58
3	Univ. of Idaho	Quad Sr.	29	88	56	58	0.33
4	Kraft; Toledo	Chopin	19	88	33	34	0.22
5	Soft Wheat Lab	Miag Multomat	33	92	39	45	0.36
6	Mennel Milling	Buhler (non-pneumatic)	34	89	66	69	0.38
7	Mennel Milling	Buhler (pneumatic)	29	112	66	63	0.26
8	PNWWQL	Quad Sr.	33	88	64	69	0.38
9	PNWWQL	Buhler	35	100	81	81	0.35
10	Wheat Marketing Ctr.	Buhler MLU-202	34	80	61	69	0.43

Table 6. Sugar snap cookie bake (SWQL).

	Laboratory	Mill Type	Diameter 2 cookies (cm)	Top grain score	Unity predicted dia (cm)
1	Pendleton Flour Mills	Buhler X Mill	17.8	7	17.5
2	Pendleton Flour Mills	Buhler Commercial. Mill	17.1	3	16.9
3	Univ. of Idaho	Quad Sr.	18.4	6	17.9
4	Kraft; Toledo	Chopin	19.2	7	18.2
5	Soft Wheat Lab	Miag Multomat	17.7	4	17.4
6	Mennel Milling	Buhler (non-pneumatic)	17.0	4	17.2
7	Mennel Milling	Buhler (pneumatic)	17.9	5	17.4
8	PNWWQL	Quad Sr.	18.5	5	17.8
9	PNWWQL	Buhler	17.7	7	17.6
10	Wheat Marketing Ctr.	Buhler MLU-202	16.9	4	17.6

Table 7. Protein concentration of flour samples, sorted low to high.

Flour #	Dumas %	Unity %	Mennel %		
4	8.43	7.52	8.20	Kraft; Toledo	Chopin
3	8.44	7.91	8.37	Univ. of Idaho	Quad Sr.
8	9.05	8.13	8.75	PNWWQL	Quad Sr.
10	9.08	8.25	8.92	Wheat Marketing Ctr.	Buhler MLU-202
5	9.35	8.71	8.99	Soft Wheat Lab	Miag Multomat
9	9.38	8.52	9.13	PNWWQL	Buhler
2	9.76	8.94	9.32	Pendleton Flour Mills	Buhler Commercial. Mill
6	9.89	8.83	9.53	Mennel; Fostoria	Buhler (non-pneumatic)
1	9.90	8.66	9.55	Pendleton Flour Mills	Buhler X Mill
7	9.94	8.92	9.47	Mennel; Roanoke	Buhler
	8.43	7.52	8.20	Min	
	9.94	8.94	9.55	Max	
	1.51	1.42	1.35	Range	

Figure 1. Relationship among measures of flour protein concentration.

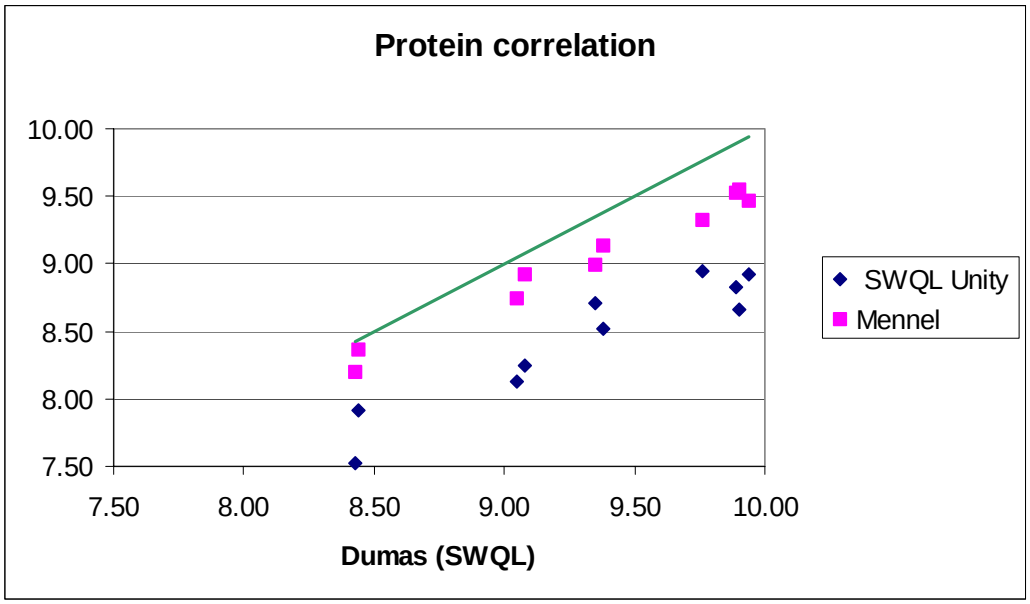


Table 8. Damaged starch, sodium carbonate SRC, flour ash, and softness values.

			Starch Dmg.	Sodium carbonate SRC	Flour ash	Softness
			%	%	%	%
4	Kraft; Toledo	Chopin	2.92	63.3	0.451	48
5	Soft Wheat Lab	Miag Multomat	3.41	69.9	0.443	66
3	Univ. of Idaho	Quad Sr.	3.55	66.2	0.366	54
8	PNWWQL	Quad Sr.	3.76	69.0	0.433	46
9	PNWWQL	Buhler	3.82	70.2	0.458	45
1	Pendleton Flour Mills	Buhler X Mill	3.93	71.1	0.464	48
7	Mennel; Roanoke	Buhler	3.99	70.4	0.472	55
6	Mennel; Fostoria	Buhler (non-pneumatic)	4.57	77.3	0.594	65
10	Wheat Marketing Ctr.	Buhler MLU-202	4.89	80.0	**0.442**	**80**
2	Pendleton Flour Mills	Buhler Commercial. Mill	4.98	83.5	0.534	62

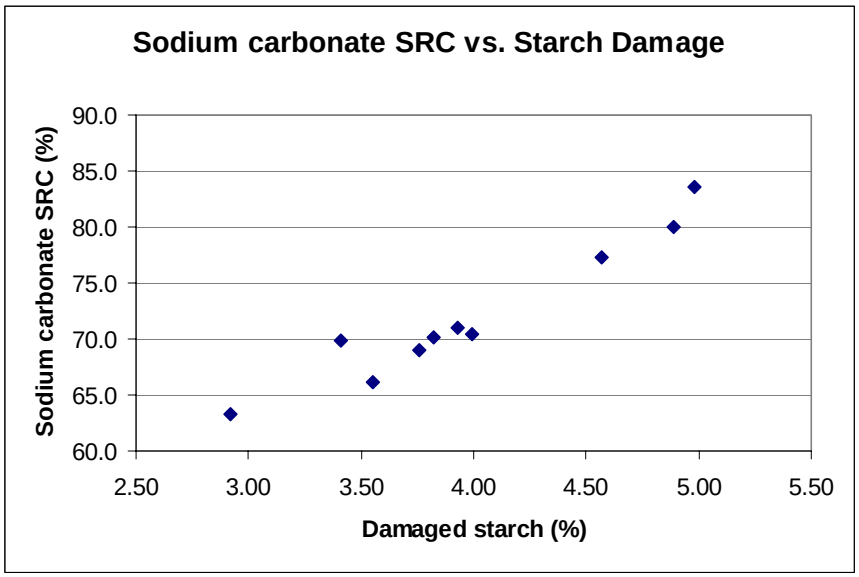


Figure 2. Relationship between sodium carbonate SRC and starch damage.

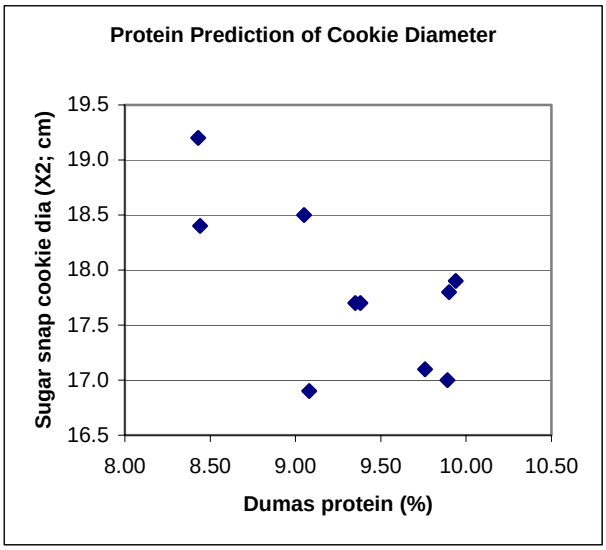


Figure 3. Protein prediction of cookie diameter.

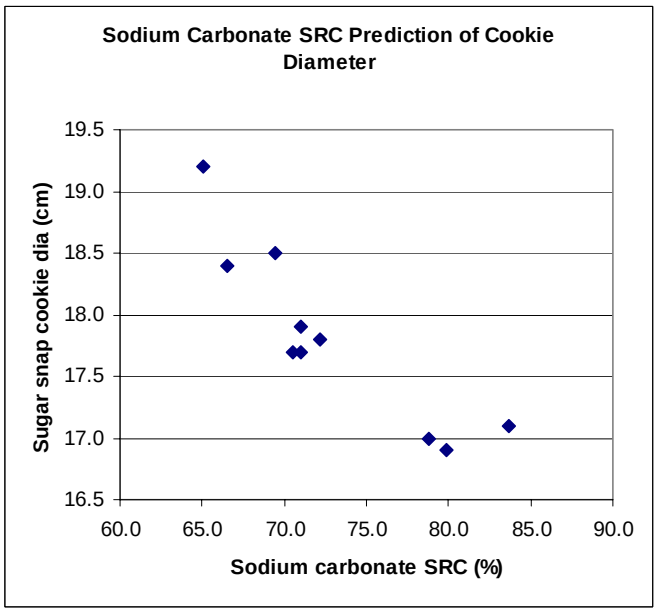


Figure 4. Sodium carbonate SRC prediction of cookie diameter.

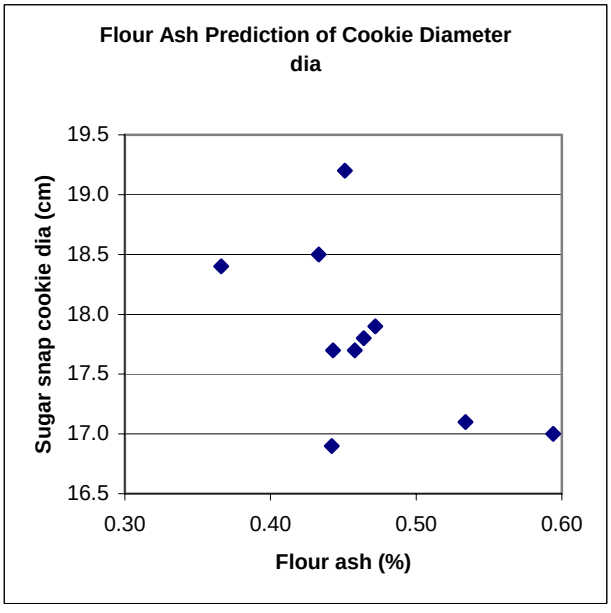
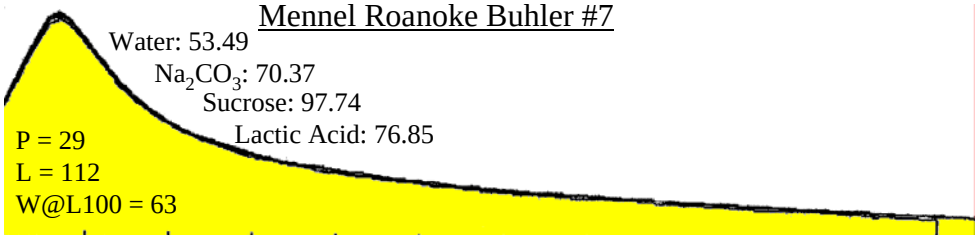
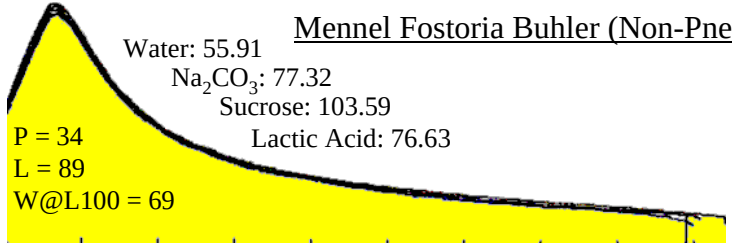


Figure 5. Flour ash prediction of cookie diameter

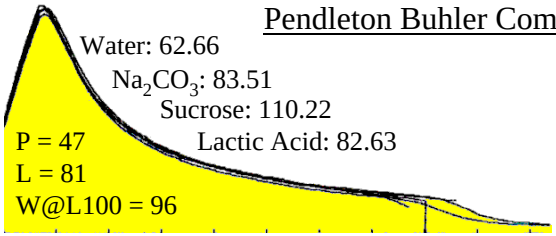
Mennel Roanoke Buhler #7



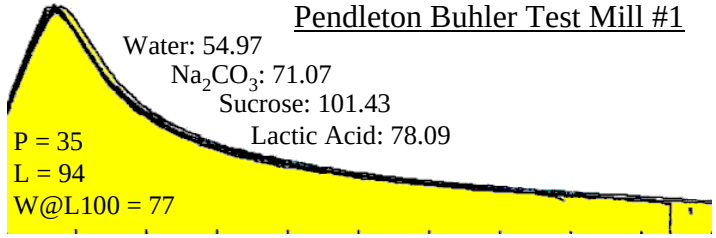
Mennel Fostoria Buhler (Non-Pneumatic) #6



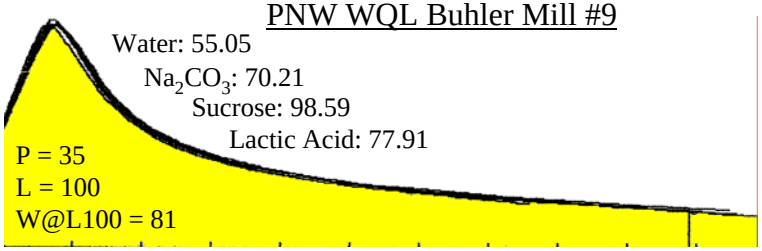
Pendleton Buhler Commercial #2



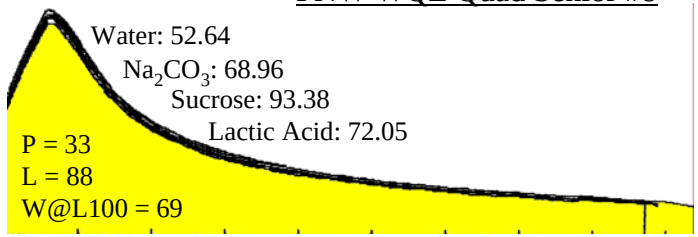
Pendleton Buhler Test Mill #1



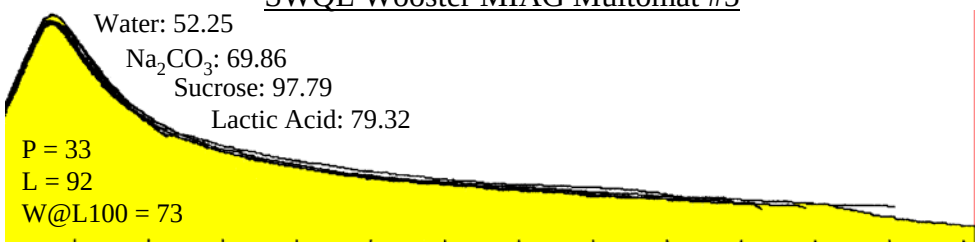
PNW WQL Buhler Mill #9



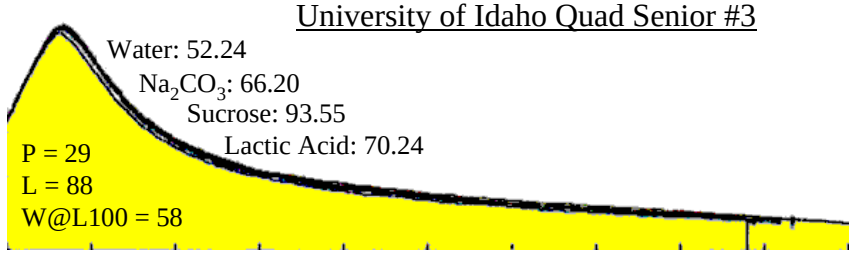
PNW WQL Quad Senior #8



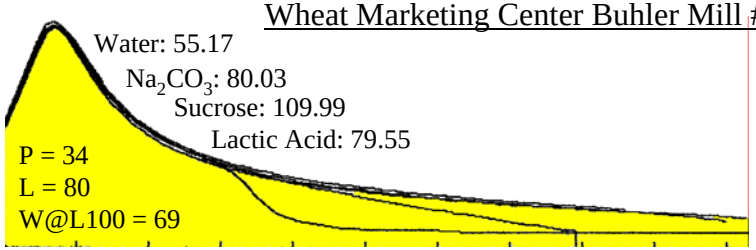
SWQL Wooster MIAG Multomat #5



University of Idaho Quad Senior #3



Wheat Marketing Center Buhler Mill #10



Toledo Chopin Mill #4