Selecting Nebraska Wheat for Processing Needs

of Domestic and Foreign Markets

To: Nebraska Wheat Board
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1. 2009 S4R8

In 2009 S4R8 study, four hundred eleven wheat samples were analyzed in wheat quality characteristics. The flour yield was from 59.6% to 79.4% (average 67.8%). Most samples (89.3%) had flour yield in range from 65% to 75%. Flour yield was not influenced by flour protein statistically significantly.

The protein content of flour at 14% mb was from 8.83% to 14.08% (average 11.02%). Most samples (86.3%) had protein in range from 10% to 13%. Flour protein was affected on dough strength statistically significantly. It was correlated to mixograph peak value and area positively and peak time negatively.

The peak time of mixograph was from 1.9 to 8.0 min (average 4.2 min). Most samples (84.7%) had peak time between 3 and 7 min. The peak value of mixograph was from 37.1 to 61.4%TQ (average 47.4%TQ). Most samples (78.1%) had peak value in range from 44 to 56%TQ. The area within eight minutes of mixograph was from 63.8 to 211.1%TQ.min (average 132.0%TQ.min). Most samples (97.8%) had area in range from 80 to 200%TQ.min. Therefore, most samples had fair to strong dough strength.

2. 2009 Organic Wheat in Two Locations

In 2009 Organic Wheat, thirty-seven organic wheat varieties, which were composite was from Mead and Sidney two Locations, was characterized in wheat quality. 77.5% of samples were classified as HARD in kernel hardness. 85% samples had kernel diameter from 2.3 to 2.6 mm. All samples have kernel weigh from 30 to 40 mg. The single kernel characteristics were not affected on milling properties statistically significantly. The milling properties were not correlated with wheat protein statistically significantly. All samples had flour yield in range from 70% to 80% with bran rate from 3 to 4.

The flour ash content at 14% mb was from 0.341% to 0.529% (average 0.456%). Most (86.9%) samples had ash in range from 0.35% to 0.45%. Flour ash was correlated with protein, but not with dough strength statistically significantly.

The flour protein content at 14% mb was from 9.5% to 12.2% (average 10.7%). Most (81.6%) samples had protein in range from 10% to 12%. Flour protein was affected on dough strength statistically significantly. However, flour protein and ash were not affected on baking performance statistically significantly. It was due to averagely lower flour protein and higher ash in these organic wheat cultivars.

All samples had mixograph peak value in range from 40 to 52 %TQ. Most (76.3%) samples had peak time between 3 and 5 min. Most (71.2%) samples had peak area in range from 120 to 160 %TQ.min. Most (65.8%) samples had tolerance between 4 and 5. Therefore, most samples had strong dough strength. Dough strength was affected on baking performance statistically significantly.

There was significant difference in baking performance of organic wheat samples. The water absorption at 14% mb was from 60.0% to 64.0% (average 62.1%). Water absorption was correlated positively with protein statistically significantly. Water absorption was not affected on baking properties statistically significantly because all samples had normal water absorption. Mixing time was from 3.7 to 8.6 min (average 5.9 min). Most (94.7%) samples had mixing time between 3 and 8 min. Mixing time was correlated with mixograph characteristics (tolerance, peak time and area) statistically significantly. Mixing time was correlated with other baking properties (loaf volume, loaf density, texture, slice area, cell number, elongation and bread rate) statistically significantly. The loaf volume was from 490 to 835 mL (average 706 mL). Only 39.5% samples had loaf volume between 750 and 900 mL (13.2% samples had loaf volume from 800 to 850 mL). Loaf volume was

correlated positively with mixograph characteristics (tolerance, peak time and area) statistically significantly. Loaf volume was correlated with other baking properties (mixing time, loaf density, texture, slice area, cell number, elongation and bread rate) statistically significantly.

The top fourteen organic wheat composites from the two locations were rated from good to very good in baking properties without adding oxidants. They were NW03666, NE01481, KARL92, NE05496, PRONGHORN, NE07444, NE06469, NE04424, NE02558 , NW03681, NE07569, SD05118, NW07505 and NE05425 in increasing order. Their average flour protein and ash contents were 10.6% and 0.455%, respectively. They had strong dough strength. They needed longer mixing times (average 6.6 min) to get optimal dough when water absorption was 62.2% in average. They had good exterior and crumb grain. They had smooth and resilient texture. They had high loaf volume (average 784 mL). The remaining twenty-seven poorer quality lines were baked by adding 7.5 ppm oxidant. The baking quality of these samples was improved statistically significantly. Therefore, only OVERLAND was evaluated as having poor baking quality.

3. 2009 Organic Wheat in Four Locations

In 2009 Organic Wheat, twenty-five organic wheat varieties, which were composited from Lincoln, Mead, North Platte and Sidney four locations, were analyzed in wheat quality by Baystate and Heartland Mills.

The flour yield of milling was from 69.8% to 75.7% (average 72.6%). The milling properties were not correlated with wheat protein statistically significantly.

The flour protein at 14% mb was from 10.0% to 12.0% (average 11.1%) and most (64%) samples had protein between 11.0 to 12.0%. The flour ash at 14% mb was from 0.460% to 0.604% (average 0.521%) and most (64%) samples' ash was higher than normal value. The ash was correlative statistically significantly with farinograph stability, alveograph strength and loaf volume.

Most samples (85%) had weak dough strength. Dough strength was affected on baking performance statistically significantly. The water absorption at 14% mb was from 50.5% to 55.5% (average 52.9%), which was much lower than 60% normal water absorption. Water absorption was correlated positively with protein statistically significantly. Water absorption was affected on baking properties statistically significantly. The loaf volume was from 2350 to 3200 mL (average 2790 mL). The loaf volume was correlative with ash statistically significantly. Because most of ash contents was higher in four locations wheat composites, few samples (20%) had loaf volume was within normal range.

The top thirteen organic wheat varieties had acceptable bread quality. They were HATCHER, CAMELOT, NE03490, WAHOO, PRONGHORN, ARROWSMITH, KARL92, DARRELL, WESLEY, OVERLAND (note the genotype by environmental interaction as Overland is often a poorer quality line; see previous paragraph), SD05118, NW03681, and NE05425 in increasing order. Their average flour protein and ash contents were 11.2% and 0.531%, respectively. Their average loaf volume was 2700 mL. The remaining organic wheat varieties had poor bread quality.

In summary, the wheat from the two locations composites possessed superior baking quality, as compared with those from the four locations composites. The flour protein and ash from 4 Location was greater than from 2 Locations. The protein content of organic wheat was lower than that of conventional wheat, and the ash content of organic wheat was higher than that of conventional wheat. The baking quality of organic wheat was not as good as that of conventional wheat.

4. 2009 Organic Wheat from Sidney

In 2009 Organic Wheat from Sidney, thirty-seven organic wheat varieties were analyzed in wheat quality by the Nebraska wheat quality laboratory and the Kellogg Company.

In wheat characterization, the single kernel hardness index was from 42.2 to 68.0 (average 58.7). 81.1% of samples were classified as HARD, and the remaining samples were MIXED. The single kernel weight was from 30.9 to 39.6 (average 34.9). All samples' kernel weight was greater than or equal to 30. The single kernel diameter was from 2.3 to 2.8 (average 2.5). Only two samples had diameter 2.3 mm which was smaller than normal value. The difference of kernel hardness was not given statistically significant difference in milling

properties. The whole wheat protein content at 12% mb was from 12.9% to 16.1% (average 13.8%). 73.0% samples had wheat protein contents between 12.0% and 14.0%, 24.3% of samples had wheat protein contents between 14.0% and 16.0%, and 2.7% samples had wheat protein contents ≥16.0%. The whole wheat ash content at 12% mb was from 1.57% to 1.86% (average 1.70%). 16.2% of samples had ash contents between 1.40% and 1.60% were found, while 64.9% of samples had 1.60% to 1.80% ash, and 18.9% of samples had ≥1.80% ash. The falling number was from 331 to 438 sec (average 398 sec). 5.4% of samples had falling number values between 300 and 350 s, 37.8% of samples had 350 to 400 s, and 56.8% of samples had falling number values ≥400 s. The differences in wheat protein and ash contents as well as falling number were resulted in statistically significant differences in wheat viscosity. The final viscosity was from 173 to 295 cP (average 225 cP). Meanwhile, 51.3% samples had wheat final viscosity that was larger than or equal to 225 cP. 37.8% of samples had total dietary fiber contents smaller than 12.0%, while 48.6% of samples had 12.0 to 13.0% total dietary fiber, 10.8% of samples had 13.0 to 14.0% total dietary fiber, and 2.7% of samples had ≥14.0% total dietary fiber.

In flour characterization, the protein content of flour at 14% mb was from 11.3% to 14.7% (average 12.4%) . 32.4% of samples had flour protein contents between 11.0% and 12.0%, 40.5% of samples had flour protein contents between 12.0% and 13.0%, 21.6% of samples had flour protein contents between 13.0% and 14.0%, and 5.4% of samples had flour protein contents ≥14.0%. The difference in flour protein content was resulted in statistically significant difference in flour dough strength and viscosity. 37.8% of samples had weak dough strength, while 24.3% of samples had fair dough strength, 27.0% of samples had strong dough strength, and 10.8% of samples had very strong dough strength. Only 2.7% of samples had low peak viscosity, while 54.1% samples had medium peak viscosity, 40.5% samples had higher peak viscosity, and 2.7% samples had very high peak viscosity. 18.9% of samples had lower final viscosity, while 51.3% samples had medium final viscosity, 29.7% samples had higher final viscosity.

The peak viscosity of flour, which was larger than or equal to 2500 cP, was from NE06469, ALLIANCE, ALICE, NE99495, NE07410, NE01481, NW03666, NW03681, NW07505, NE06607, DARRELL, NE02558, NE05430, NE06545, DANBY and NE05496 variety in increasing order. The cold paste (final) viscosity of flour, which was larger than or equal to 3000 cP, was from KARL92, NE07410, NE06469, ALICE, NE99495, NE05548, NE02558, NW03666, DARRELL, NE05430, and NE06545 variety in increasing order.

There were 3 HARD red wheat samples (NE05496, NE07569 and NE07668) that had protein between 11% and 12%, mixograph peak time between 3 and 5 min, area between 120 and 160%TQ.min and final viscosity between 2800 and 3000 cP.

5. 2009 WQC

In 2009 WQC study, twenty-one varieties were analyzed in flour protein, rheological dough strength and bread production.

The flour protein content at 14% mb was from 10.1% to 13.7% (average 11.6%). Most samples had protein between 10.0% and 13.0 %. Flour protein was affected on dough strength statistically significantly.

In farinograph, the water absorption at 14% mb was in range from 55.2% to 64.4% (average 59.6%). 42.9% samples had water absorption between 60% and 65%. The development time was in range from 2.3 to 13.7 min (average 6.8 min). Most samples (80.9%) had development time in range from 4 to 10 min. Only one sample had stability that was less than 10 min. All samples have mixing tolerance index smaller than 40. Therefore, most samples had strong dough strength. Dough strength was affected on baking performance statistically significantly.

Twenty varieties had excellent baking properties. Their average flour protein content was 12.2%. They had good rheological dough strength. The dough water absorption and mixing time were in normal values. They had good exterior and crumb grain. They had smooth and resilient texture. They had high loaf volume (average 911 mL). Only one variety had OK bread rating, accompanied by lower protein, weak dough strength, lower water absorption, and fine loaf volume. Its bread quality was worse than control flour.

We presented our results in 2009 WQC Annual Conference in Hard Winter Wheat section. Our results were consistent with the results of the most collaborators' labs.

6. 2009 Turkish vs. US Great Plain Wheat

In 2009 Turkey vs. US GP Wheat, 90 varieties from Lincoln, Mead, and North Platte, respectively, were analyzed in milling, flour protein, and rheological dough strength.

The flour protein content at 14% mb was from 10.4% to 14.4% (average 12.3%), 11.0% to 15.3% (average 13.1%), and 9.0% to 13.3% (average 11.2%) for Lincoln, Mead and North Platte. There was statistically significant difference in protein content from difference locations. The protein from Mead was larger than from Lincoln, and from Lincoln was larger than North Platte. 76.7% samples from Lincoln, 44.4% samples from Mead, and 84.5% samples from North Platte had protein between 10.0% and 13.0%. Flour protein was affected on rheology dough strength (tolerance, peak time, peak value and area of mixograph). When $10.0\% \leq$ Protein $< 13.0\%$, the dough strength was strong. When Protein $< 10.0\%$ or Protein $\geq 13.0\%$, the dough strength was either weak or very strong.

The peak value of mixograph was from 42.12 to 61.45%TQ (average 52.26%TQ) in Lincoln, from 46.80 to 65.50%TQ (average 54.10%TQ) in Mead and from 35.11 to 54.49%TQ (average 46.71%TQ) in North Platte. There was statistically significant difference in peak value from difference locations. The peak value from Mead was larger than from Lincoln, and from Lincoln was larger than North Platte. The peak time of mixograph was from 1.46 to 6.26 min (average 3.08 min) in Lincoln, from 1.85 to 4.98 min (average 3.15 min) in Mead and from 1.90 to 6.22 min (average 3.56 min) in North Platte. There was statistically significant difference in peak time from difference locations. The peak time from North Platte was larger than from Lincoln and Mead. The area in 8 min of mixograph was from 65.45 to 215.72 %TQ.min (average 136.71 %TQ.min) in Lincoln, from 93.03 to 246.15 %TQ.min (average 156.10 %TQ.min) in Mead and from 57.43 to 181.63 % TQ.min (average 114.33 % TQ.min) in North Platte. There was statistically significant difference in mixograph area from difference locations. The area from Mead was larger than from Lincoln, and from Lincoln was larger than North Platte. Therefore, the rheological dough strength Mead was larger than from Lincoln, and from Lincoln was larger than North.

7. 2009 Tam107-R7 x Arlin

In 2009 Tam107-R7xArlin Wheat, 320 varieties from Lincoln, Mead, and North Platte, respectively, were analyzed in milling, flour protein, and rheological dough strength.

The flour yield was d in 53.8% to 78.4% (average 68.9%) from Lincoln, 61.1% to 84.3% (average 69.4%) from Mead, and 58.4% to 73.1% (average 67.0%) from North Platte. Most samples (80-90%) had yield of flour between 65.0% and 80% from Lincoln, Mead and North Platte. There was statistically significant difference in flour yield from these three locations. The flour yield from Mead was larger than from Lincoln, and from Lincoln was larger than North Platte

The flour protein content at 14% mb was from 9.37% to 15.21% (average 11.51%) from Lincoln. 90.9% samples had protein between 10.0% and 13.0%. 3.8% samples had protein that was smaller than 10.0% and the rest of samples had protein that was larger than or equal to 13.0% from Lincoln. The flour protein content at 14% mb was from 10.66% to 14.73% (average 12.54%) from Mead. 72.5% samples had protein between 10.0% and 13.0% and the rest of samples had protein that was larger than or equal to 13.0% from Mead. The flour protein content at 14% mb was from 9.20% to 14.00% (average 11.58%) from North Platte . 94.4% samples had protein between 10.0% and 13.0%. 0.9% samples had protein that was smaller than 10.0%, and the rest of samples had protein that was larger than or equal to 13.0% from North Platte. The protein content of flour was in Mead greater than in Lincoln and North Platte. Flour protein difference was resulted in statistically significant difference of dough strength. Flour protein was correlative with peak time negatively and peak value positively statistically significantly.

77.8% samples had strong dough strengthen; the rest of samples had very strong dough strength from Lincoln. 56.2% samples had strong dough strengthen; the rest of samples had very strong dough strength from

Mead. 88.1% samples had strong dough strengthen, 11.3% samples had very strong dough strength and 0.6% samples had weak dough strength from North Platte. Dough strength from Mead was greater than from Lincoln, which was greater than North Platte.

8. 2009 Triplicate

In 2009 Triplicate wheat, sixty-two wheat varieties composites were characterized in wheat quality. All samples were classified as HARD, except that two samples were SOFT and MIXED, respectively. Most (90.3%) samples had kernel diameter greater than or equal to 2.4 mm. Most (95.2%) samples have kernel weigh larger than or equal to 30 mg. The single kernel hardness was affected on milling properties statistically significantly. One SOFT kernel sample had only 67.0% flour yield. The rest of samples had flour yield in range from 70% to 80% with bran rate from 1.0 to 4.5. The milling properties were not correlated with wheat protein statistically significantly.

The flour protein content at 14% mb was from 9.8% to 12.8% (average 11.2%). Most (96.8%) samples had protein in range from 10% to 12% %. Flour ash content at 14% mb was from 0.336% to 0.492% (average 0.422%). Most (93.5%) samples had ash in range from 0.35% to 0.45%. Flour protein and ash were affected on dough strength statistically significantly. Flour protein, ash and dough strength were affected on baking performance statistically significantly.

Most (80.7%) samples had mixograph peak value between 44 to 56 %TQ. 51.6% samples were between 3 and 5 min. Most (90.4%) samples had mixograph area in 8 min between 120 and 200 %TQ x min. Most (71.0%) samples had tolerance between 3 and 7. Therefore, most samples had strong dough strength. Dough strength was affected on baking performance statistically significantly.

There was significant difference in baking performance of triplicate wheat samples. The water absorption of making dough at 14% mb was from 61.5% to 68.5% (average 63.7%). Water absorption was correlated positively with protein statistically significantly. Water absorption was not affected on baking properties statistically significantly because it was in normal range. The mixing time in making dough was from 2.5 to 8.2 min (average 4.2 min). Mixing time was correlated with mixograph characteristics (tolerance, peak time and area) statistically significantly. Mixing time was correlated with other baking properties (dough rate, loaf volume, loaf density, slice area, slice brightness, cell number, and bread rate) statistically significantly. The loaf volume was from 695 to 945 mL (average 838 mL). Most (88.7%) samples had loaf volume between 750 to 900 mL. Loaf volume was correlated with mixograph characteristics (tolerance, peak time and area) statistically significantly. Loaf volume was correlated with other baking properties (mixing time, dough rate, proof time, loaf density, slice area, slice brightness, cell number, and bread rate) as well as ash statistically significantly.

Most varieties (95%) had from fair to excellent bread quality with 11.20% protein and 0.415% ash in average. They had fair to good rheological dough strength. The dough water absorption and mixing time were in normal values. They had good exterior and crumb grain. They had smooth and resilient texture. They had high loaf volume (average 853 mL). The bread quality of most (54.8%) samples was better than or equal to that of control flour.

Only three variety composites had unacceptable bread quality with protein 11.38% and ash 0.462% in average accompanied by weak dough strength, shorter mixing time, and fine loaf volume (755 mL in average). They were NE09559, NE09637 and NW09618.

9. 2009 IRDR

In 2009 IRDR wheat, twenty wheat varieties composites were characterized in wheat quality. All samples were classified as HARD, except one sample was MIXED. All samples had kernel diameter greater than or equal to 2.4 mm. All samples have kernel weigh larger than or equal to 30 mg. The single kernel hardness was not affected on milling properties statistically significantly. All samples had flour yield in range from 70% to 80% with bran rate from 1.0 to 3.5. The milling properties were not correlated with wheat protein statistically significantly.

The flour protein content at 14% mb was from 9.3% to 10.9% (average 10.1%). All samples had protein in low end of the range 10% to 12%. Flour ash content at 14% mb was from 0.350% to 0.419% (average 0.387%). Most samples had ash in low end of the range 0.35% to 0.45%. Flour protein was affected on dough strength statistically significantly, but ash was not.

All samples had mixograph peak value in range from 44 to 52%TQ. All samples had mixograph peak time between 3 and 6 min. Most (65.0%) samples had mixograph area in 8 min in range from 120 to 200 %TQ x min. All samples had tolerance between 3 and 5. Therefore, most samples had strong dough strength. Dough strength was affected on baking performance statistically significantly.

There was significant difference in baking performance of IRDR wheat samples. The water absorption of making dough at 14% mb was from 61.0% to 63.5% (average 62.8%). Water absorptions were not correlated in other baking properties statistically significantly because they were in normal range. The mixing time in making dough was from 3.9 to 6.8 min (average 4.7 min). Most (90.0%) samples had mixing time from 4 to 6 min. Mixing time was correlative with mixograph peak time and peak value statistically significantly. Mixing time was correlated with other baking properties (loaf volume, loaf density, slice area, and bread rate) statistically significantly. The loaf volume was from 781 to 898 mL (average 842 mL). All samples had loaf volume in range from 750 to 900 mL (60.0% samples had loaf volume from 800 to 850 mL). Loaf volume was correlated with other baking properties (mixing time, dough rate, loaf volume, slice area, cell number, and bread rate) statistically significantly.

All samples had good baking performance and bread quality, though the protein and ash contents were lower than normal values. The bread quality of some samples (25%) was better than or equal to that of control flour.

10. 2009 Organic Wheat NIN

In 2009 Organic Wheat NIN, forty eight from Mead and forty seven from Sidney organic wheat varieties were analyzed in wheat quality.

Most samples (87.5%) from Mead and all samples from Sidney had test weight that was smaller than target value 60.0 lb/bu. The test weight from Mead was statistically larger than from Sidney.

From Mead, 24 samples were classified as HARD, one sample (NE08452) was SOFT and the rest of samples were MIXED. From Sidney, eleven samples were classified as HARD, two samples (NE08531 and NE08499) were SOFT, and the rest of samples were MIXED. Only two samples from Mead had kernel weight that was less than 30.0 mg. Only four samples from Mead had diameter 2.3 mm. Most samples (91.7%) from Sidney had weight that was larger than or equal to 30.0 mg. Most samples (81.3%) from Sidney had diameter that was larger than or equal to 2.4 mm. The kernel hardness from Mead was statistically larger than from Sidney. There was no statistically difference in kernel weight and diameter between Mead and Sidney locations.

Most samples (97.9%) were produced flour yield that was larger than or equal to 65.0% from Mead and Sidney. The milling properties were not correlative with SKCS and wheat protein statistically significantly. The flour yield was correlative with bran rate statistically significantly from Mead but not from Sidney. The flour yield from Mead was larger than from Sidney statistically significantly.

The protein content of whole wheat grain at 12% mb was in range from 10.1% to 15.5% (average 11.7%) from Mead and 11.9% to 15.5% (average 13.5%) from Sidney respectively. The protein content of flour at 14% mb was in range from 8.3% to 13.5% (average 9.8%) from Mead and 10.0% to 13.4% (average 11.8%) from Sidney respectively. From Mead, only 39.7% samples had flour protein between 10.00% and 12.0%, 58.3% samples had protein that was smaller than 10.0% and one samples had protein larger than 13.0%. From Sidney, most samples (95.7%) had flour protein between 10.0% and 13.0%, and the remaining samples had protein that was larger than or equal to 13.0%. The flour protein was correlative with mixograph characteristics, but it was not correlative with viscosity statistically significantly from both locations. The flour protein was correlative with ash from Mead, but not from Sidney. The protein from Sidney was larger than from Mead statistically significantly.

The ash content of flour at 14% mb was in range from 0.350% to 0.595% (average 0.491%) from Mead and 0.413% to 1.029% (average 0.566%) from Sidney respectively. Most samples (85.4% from Mead and

97.9% from Sidney) had ash that was larger than or equal to 0.45%. The flour ash was not correlative with mixograph characteristics and viscosity statistically significantly from both locations. The ash from Sidney was larger than from Mead statistically significantly.

Most samples from both Mead and Sidney had fair to strong dough strength. The mixograph peak time, peak value and tolerance from Mead was larger than from Sidney statistically significantly, but the mixograph area was no statistically significantly difference in between Mead and Sidney locations.

The peak and hot paste viscosities of all samples in both Mead and Sidney locations were smaller than 2500 cP for peak viscosity and 1500 cP for hot paste viscosity, respectively. Only one sample (NE07487) had final viscosity that was larger than or equal to 2800 cP from Mead, and the rest of samples from Mead and all samples from Sidney had final viscosity that was smaller than 2800 cP target value. The three viscosities were correlative with each other in addition correlative with mixograph area statistically significantly. The viscosity from Mead was larger than from Sidney statistically significantly.

11. 2009 Organic Wheat SVT

In 2009 Organic Wheat SVT, twenty seven from Haskell and Clay Center, and thirty six from Mead organic wheat varieties were analyzed in wheat quality. Most samples had test weight that was smaller than target value 60.0 lb/bu. The test weight from Clay Center and Mead was statistically larger than from Haskell.

All samples from Haskell and Mead, few (8 out of 27) samples from Clay Center had hardness that was smaller than 60. Most samples from these locations had weight that was larger than or equal to 30.0 mg. Most samples from these locations had diameter that was larger than or equal to 2.4 mm. The kernel hardness from Clay Center was statistically larger than from Mead and Haskell. The kernel diameter and weight from Mead and Haskell was statistically larger than from Clay Center.

All samples were produced flour yield that was larger than or equal to 65.0% from Haskell, Mead and Clay Center. The milling properties (flour yield and bran rate) were not correlative with SKCS and wheat protein statistically significantly. The flour yield was correlative with bran rate statistically significantly from Clay Center but not from Haskell and Mead. The flour yield from Haskell and Mead was larger than from Clay Center statistically significantly.

The protein content of whole wheat grain at 12% mb was in range from 9.7% to 12.1% (average 10.7%) from Haskell, 10.2% to 13.1% (average 11.4%) from Mead, and 10.9% to 13.0% (average 12.2%) from Clay Center respectively. The protein content of flour at 14% mb was in range from 7.5% to 10.1% (average 8.6%) from Haskell, 8.1% to 11.1% (average 9.4%) from Mead, and 9.0% to 11.5% (average 10.3%) from Clay Center. More than 90% samples from Haskell and Mead, one third samples from Clay Center had protein that was less than 10.0%. The flour protein was correlative with mixograph tolerance, peak value and area from Haskell, it was correlative with tolerance, peak time, peak value, area, peak viscosity from Mead, and it was correlative with, ash and peak value from Clay Center statistically significantly. In all protein ranges, the dough strength was fair or good and viscosity was lower. The protein from Clay Center was larger than from Mead from which was larger than from Haskell statistically significantly.

The ash content of flour at 14% mb was in range from 0.405% to 0.637% (average 0.503%) from Haskell, 0.448% to 0.590% (average 0.515%) from Mead, and 0.456% to 0.621% (average 0.536%) from Clay Center, respectively. 92.6% samples from Haskell, 97.2% samples from Mead and all samples from Clay Center had ash that was larger than or equal to 0.45%. The flour ash was correlative with mixograph characteristics and viscosity from Haskell, but it was correlative with viscosities from Mead, and it was correlative with protein, peak time, and final viscosity from Clay Center statistically significantly. The ash from Clay Center was larger than from Haskell and Mead statistically significantly.

All samples from Haskell and Mead had peak values were less than normal range. Half samples from Clay Center had peak values were larger or equal to normal ranges. The peak value from Clay Center was larger than from Mead from which was larger than from Haskell statistically significantly. All samples from these three locations had peak time that was longer than or equal to 3 min. Most samples had peak time that was larger than 5 min. The peak time from Haskell and Mead was larger than from Clay Center statistically significantly. Most samples from these three locations had mixography area that was larger than 120%TQ.min.

The area from Clay Center was larger than from Mead from which was larger than from Haskell statistically significantly. In summary, most samples had strong dough strength from these three locations. The dough strength from Clay Center and Mead was larger than from Haskell statistically significantly.

The peak , hot paste and cold paste (final) viscosities of all samples from these three locations were smaller than normal values (2500 cP, 1500 cP and 2800 cP for peak, hot paste and cold paste viscosity, respectively). The peak viscosity from Mead was larger than from Clay Center statistically significantly. There was no significant difference in peak viscosity between Mead and Haskell, and between Haskell and Clay Center. The hot and cold paste viscosities from Mead and Clay Center were larger than from Haskell statistically significantly.

12. 2009 Organic Wheat Triplicate

In 2009 Organic Wheat Triplicate, sixty from Mead organic wheat varieties were analyzed in wheat quality.

The test weight was in was from 54.8 to 61.3 lb/bu (average 58.8 lb/bu). About one third samples had test weight that was larger than or equal to value 60.0 lb/bu. The test weight was correlative with positively kernel diameter, flour yield and bran rate statistically significantly.

The single kernel hardness index was in range from 0.0 to 66.5 (average 50.0). Only three samples (NE09437, NE09482 and NE09470) had hardness that was larger than 60. Most samples (58.3%) were classified as MIXED, three samples (NE09477, NE09583, and NE09637) were SOFT, and the rest of samples were HARD. The single kernel weight was from 27.5 to 39.6 mg (average 32.8 mg). Only six samples had kernel weight that was less than 30.0 mg. The single kernel diameter was from 2.3 to 2.8 (average 2.5). Only four samples had diameter 2.3 mm. The kernel hardness was correlative with positively bran rate and negatively with kernel weight statistically significantly. The kernel diameter was positively correlative with weight statistically significantly.

The protein content of whole wheat grain at 12% mb was in range from 9.7% to 13.8% (average 11.5%). The protein content of flour at 14% mb was in range from 8.0% to 11.7% (average 9.6%). Most samples (95%) had protein that was less than 11.0%. The flour protein was correlative with mixograph characteristics (tolerance peak time, peak value and area), but it was not correlative with viscosity statistically significantly.

The ash content of flour at 14% mb was in range from 0.399% to 0.658% (average 0.519%). Most samples (88.3%) had ash that was larger than 0.45%. The flour ash was not correlative with mixograph characteristics, but it was correlative with final viscosity negatively statistically significantly.

Half (50%) samples had mixograph peak value between 44 and 56 %TQ, Most samples (80%) had mixograph peak time between 3 and 7 min, most samples (98.3%) had mixograph area between 80 to 200 %TQ.min. In summary, most samples (98.3%) had from fair to very strong dough.

The flour peak, hot paste and cold paste viscosity was from 1123 to 2757cP (average1715cP), 369 to 1807 cP (average 1196 cP), and 831 to 3090 cP (average 2248 cP) respectively from Mead respectively. Most samples had viscosity that was less than target value 2500 cP for peak viscosity, 1500 cP for hot paste viscosity, and 2800 cP for final viscosity. The three viscosities were correlative with each other statistically significantly.

13. 2009 NIN

In 2009 NIN wheat, fifty four wheat varieties composites were characterized in wheat quality. The single kernel hardness index was from 44.9 to 80.7 (average 66.0). NE08452, NE08476, NE08527 and NE08659 were MIXED, respectively, and the remaining samples were HARD. The kernel diameter was from 2.2 to 2.7 (average 2.4 mm). Most (64.8%) samples had kernel diameter greater than or equal to 2.4 mm. The single kernel weight was from 25.9 to 40.4 (average 32.3). Most (85.2%) samples have kernel weigh larger than or equal to 30 mg. The single kernel hardness was not affected on milling yield, but it was affected on bran rate statistically significantly. The kernel weight was correlated with diameter positively statistically significantly.

The flour yield was from 64.8% to 75.6% (average 73.2%). The flour yield was correlated with bran rate positively statistically significantly. The milling properties were not correlated with wheat protein statistically significantly.

The flour protein content at 14% mb was from 10.9% to 13.7% (average 12.2%). The protein of most (85.1%) samples was in range from 10% to 12%. Flour ash content at 14% mb was from 0.272% to 0.496% (average 0.390%). Most ash of flour was less than 0.45%. Flour protein was affected on dough strength statistically significantly. Flour protein was not correlated on mixograph tolerance and area statistically significantly. However, flour protein was correlated with peak value positively and peak time negatively statistically significantly. Flour protein was affected on mixing time, loaf density, cell number, and bread rate baking properties statistically significantly. Flour ash was not affected on dough strength and baking performance statistically significantly because the ash was in normal range.

Most (87.0%) samples had mixograph peak value in range from 44 to 56 %TQ. 57.4% samples had peak time between 3 and 5 min. Most (83.3%) samples had mixograph area in 8 min in range from 120 to 200 %TQ x min. Most (83.3%) samples had tolerance between 3 and 6. Therefore, most samples had strong dough strength. Dough strength was affected on baking performance statistically significantly.

There was significant difference in baking performance of NIN wheat samples. The water absorption of making dough at 14% mb was from 60.0 % to 63.5% (average 61.2%). Water absorptions were not affected on other baking properties statistically significantly due to they were in normal range. The mixing time in making dough was from 2.8 to 8.3 min (average 5.1 min). Mixing time was correlated with mixograph characteristics (tolerance, peak time and area) statistically significantly. Mixing time was correlated with other baking properties (dough rate, crumb texture, loaf volume, loaf density slice area, cell number, cell elongation and bread rate) statistically significantly. The loaf volume was from 743 to 943 mL (average 822 mL). Most (94.4%) samples had loaf volume in range from 750 to 900 mL. Loaf volume was correlated with mixograph characteristics (tolerance, peak value, peak time and area) statistically significantly. Loaf volume was correlated with other baking properties (mixing time, dough rate, proof time, crumb texture, loaf density, slice area, slice brightness, cell elongation, cell number, and bread rate) statistically significantly.

Most varieties (94.4%) had from fair to very good bread quality with 12.26% protein and 0.387% ash in average. They had fair to good rheological dough strength. The dough water absorption and mixing time were in normal values. They had good exterior and crumb grain. They had smooth and resilient texture. They had high loaf volume (average 828 mL). The bread quality of most (94.4%) samples was less than or equal to that of control flour.

Only three variety composites had unacceptable bread quality with protein 12.63% and ash 0.408% in average accompanied by weak dough strength, shorter mixing time, and fine loaf volume (763 mL in average). They were NE08555, NE08523 and OVERLAND.

14. 2009 Noodle Testing

The twenty-five hard white winter wheat grain samples in 2009 were analyzed for noodle quality characterizations in polypenol oxidase (PPO), dough color change by L, a and b values, noodle cooking lost and water uptake of noodle as well as noodle texture by using texture analyzer.

The flour protein content at 14% mb was from 9.8% to 12.8% (average 11.2%). Flour protein was correlated negatively with, noodle initial color, noodle hardness, cooking loss and noodle rate statistically significantly.

The noodle *L*, *a* and *b* at 0 hr was from 84.8 to 88.5 (average 86.9), from -2.31 to -0.62 (average -1.40), and 5.23 to 19.46 (average 15.1), respectively. The *L*, *a* and *b* were changed after 24 hr in room temperature. The difference was from -12.2 to -6.0 (average -10.1), -5.99 to 1.24 (average 0.02), and -0.69 to 9.85 (average 1.22), respectively. The color change (Δa) was affected negatively on noodle rate statistically significantly.

The PPO of flour was from 0.461 to 0.734(average 0.565). The PPO was not correlated with other characterization tested statistically significantly.

The water uptake and cooking loss was from 71.9% to 146.7% (average 109.3%) and 0.44% to 1.80% (average 0.80%), respectively.

The shearing texture hardness of noodle was from 112.2 to 205.0 g (average 155.8 g). The texture hardness was correlated negatively with protein and positively with water uptake and noodle rate statistically significantly.

The overall noodle rate was scored from 0.0 to 6.0 (average 4.9). The noodle rate was correlated negatively with protein and positively with hardness and Δa value statistically significantly.

Most (83.3%) samples had good noodle making quality. Four samples had poor to fair noodle quality. They were NW09617, NW09615, NW09618 and WESLEY in decreasing order.

15. Others

- Calibrated software for protein and moisture of wheat seed was purchased for Foss NIR 1241 grain analyzer. There was not statistically significant difference (5% significant level) between nitrogen content and NIR measurements in wheat protein content at 12% mb.
- Serviced egg shell strength and egg yolk membrane strength test from animal science.
- Helped the wheat micro-quality test of graduate students' research.
- Toured several groups in grain quality lab.
- Attended NC213 and WQC conferences.