

Project Number: 5442-43440-011-00D **Accession:** 0419732 **FY:** 2011

ModeCode: 5442-05-25 NORTHERN PLAINS AREA
FARGO, NORTH DAKOTA
RED RIVER VALLEY AGRICULTURAL RESEARCH CENTER
CEREAL CROPS RESEARCH

NPL Leader: ROBERT L FIREOVID **Prin Invs:** JAE-BOM OHM

Start Date: 06/03/2010 **Term Date:** 06/02/2015

National Programs: 306 N Quality and Utilization of Agricultural Products
301 C Plant Genetic Resources, Genomics and Genetic Improvement

Title: QUALITY OF HARD SPRING AND DURUM WHEAT

Period Covered **From:** 10 / 2010 **To:** 9 / 2011 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Development of improved wheat germplasm. Wheat producers, milling and baking industries, and overseas customers require high standards in the quality of wheat to meet their evolving needs. ARS researchers in Fargo, ND contributed wheat end-use quality data that helped lead to the development of improved wheat germplasm and subsequent release of new cultivars of spring and durum wheat bred for commercial production. They provided over 40 different tests related to the physical and biochemical quality traits of the wheat kernel and related milling performance, flour, semolina, dough, baking, and spaghetti processing on over 4000 samples of hard spring, and durum wheat lines that were submitted by public and private wheat breeders and cooperating scientists. As a result, new spring wheat cultivars were released in 2009/10 that provide farmers, industry, and consumers with high quality wheat.

306 1 A 2010

02 Quality of refrigerated dough made from hard red spring wheat. Products obtained from refrigerated doughs account for greater than \$1.7 billion per year in sales in the US, and they are one of the fastest growing segments of the ready-to-use, grain-based food industry. Refrigerated storage of bread dough products can result in undesirable dough syrupeing (water separation). ARS researchers in Fargo, ND, in collaboration with North Dakota State University, investigated the effects of wheat cultivar and growing environment on dough syrupeing during refrigerated storage in relation to xylanase activity (a plant cell wall or sugar degrading enzyme activity) in hard red spring wheat. They discovered that growing environment had a greater impact on enzyme activity and dough syrupeing than cultivar of wheat. Some cultivars were consistently lower in apparent enzyme activity and dough syrupeing across all growing environments. The results indicate that certain cultivars grown in relatively dry environments across the prime hard red spring wheat growing region can be used in refrigerated dough formulations. This information will help millers and wheat breeders segregate cultivars for refrigerated dough production.

306 1 A 2010

Project Number: 5442-43440-009-00D **Accession:** 0417937 **FY:** 2010

ModeCode: 5442-05-25 NORTHERN PLAINS AREA
FARGO, NORTH DAKOTA
RED RIVER VALLEY AGRICULTURAL RESEARCH CENTER
CEREAL CROPS RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** GARY A HARELAND

Start Date: 07/06/2009 **Term Date:** 06/02/2010

National Programs: 306 N Quality and Utilization of Agricultural Products
301 C Plant Genetic Resources, Genomics and Genetic Improvement

Title: ENHANCE HARD SPRING AND DURUM WHEAT QUALITY AND UTILIZATION

Period Covered **From:** 10 / 2009 **To:** 9 / 2010 **Final Report?** Yes
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Development of improved wheat germplasm. Wheat producers, milling and baking industries, and overseas customers require high standards in the quality of wheat to meet their evolving needs. The Hard Red Spring and Durum Wheat Quality Laboratory (WQL) in Fargo, ND contributed wheat end-use quality data that helped lead to the development of improved wheat germplasm and subsequent release of new cultivars of spring, winter, and durum wheat bred for commercial production. The WQL provided over 40 different tests related to the physical and biochemical quality traits of the wheat kernel and related milling performance, flour, semolina, dough, baking, and spaghetti processing on over 4000 samples of hard spring, hard winter, and durum wheat lines that were submitted by public and private wheat breeders and cooperating scientists. The impact lies in the release of 5 experimental lines of spring wheat, which included the cultivar Brick.

306 1 A 2000

02 Molecular weight distribution (MWD) of proteins in hard spring wheat: relationship to quality parameters and intra-sample uniformity. ARS scientists and staff at the Wheat Quality Lab in Fargo, ND found that certain protein fractions from wheat were associated with bread-making parameters. Specifically, sodium dodecyl sulfate (SDS) unextractable high molecular weight polymeric proteins were identified to have positive effects on percent vitreous kernel content and bread-making parameters, including mix time and bread loaf volume. Intra-sample uniformity in protein MWD and kernel characteristics were estimated from three kernel subsamples which were separated according to single kernel protein content within individual wheat samples by a single-kernel near-infrared sorter. Intra-sample uniformity in protein MWD did not differ greatly among wheat samples. The results of this research provide information on the functional effects of protein fractions on wheat kernel characteristics and breadmaking quality and their intra-sample uniformity. The information will assist segregation of wheat breeding lines that have consistent and improved breadmaking quality.

306 1 A 2000

306 1 B 2000

306 1 C 2000

03 Variation in kernel characteristics and protein molecular weight distribution of Langdon durum-wild emmer wheat chromosome substitution lines. *Triticum turgidum* L. var. *dicoccoides* (DIC) provides a useful source of genes to improve agronomic and quality characteristics of durum wheat. Research was conducted by ARS scientists in Fargo, ND to identify DIC chromosomes that carry useful genes for quality improvement. Langdon-T. *dicoccoides* substitution lines were evaluated for kernel characteristics and protein molecular weight distribution (MWD). Chromosome 2A from PI481521

Project Number: 5442-43440-009-00D

Accession: 0417937

FY: 2010

increased kernel weight which resulted in increased semolina yield. Chromosome 6B from PI478742 was found unique in that it led to an increase in sodium dodecyl sulfate (SDS) insoluble high molecular weight polymeric proteins, which contributed to increased dough mixing strength. This research provides wheat breeders with the knowledge for selecting certain durum-wild emmer wheat chromosome substitution lines that have a potential gene source to improve kernel and dough characteristics of durum wheat.

306 1 A 2000

306 1 B 2000

306 1 C 2000

- 04 Chemical components of flour mill streams and their relationship to dough rheology and breadmaking traits. The aim of this research was to identify chemical components that are important for evaluating bread-making quality of flour mill streams (FMS). Sulfur quantity was identified to be important for quality evaluation of FMS as it had greater correlations with dough rheology and breadmaking properties than nitrogen quantity. Sodium dodecyl sulfate (SDS) unextractable polymeric protein fractions were also identified to be important as they have significant associations with dough rheology and breadmaking traits in FMS. Free asparagine, which is a primary precursor responsible for formation of potentially carcinogenic acrylamide during baking, was found at high levels in the third break and third reduction FMS. Ratio of nitrogen to sulfur was significantly correlated with free asparagine concentration in FMS. Results from this research provide information for more precise blending of FMS in commercial flour mills in order to meet customer specifications for high quality flour.

306 1 A 2000

306 1 B 2000

306 1 C 2000

- 05 Comparison between potassium bromate and ozone as flour oxidants in breadmaking. ARS scientists at Fargo, ND, in cooperation with the durum wheat quality laboratory at NDSU, performed research to compare the efficacy of potassium bromate with that of flour ozone treatment for the improvement of breadmaking. Ozone gas treatment of flour increased sodium dodecyl sulfate (SDS) insoluble polymeric proteins which were known to improve dough rheological property. Optimum ozone treatment of flour also improved bread quality, which was similar to the effect of potassium bromate. Information obtained from this research will contribute to eliminating the use of carcinogenic potassium bromate in bread-making.

306 1 A 2000

306 1 B 2000

306 1 C 2000

Project Number: 5442-43440-008-00D **Accession:** 0408465 **FY:** 2009

ModeCode: 5442-05-25 NORTHERN PLAINS AREA
FARGO, NORTH DAKOTA
RED RIVER VALLEY AGRICULTURAL RESEARCH CENTER
CEREAL CROPS RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** GARY A HARELAND

Start Date: 09/10/2004 **Term Date:** 07/05/2009

National Programs: 306 N Quality and Utilization of Agricultural Products
301 C Plant Genetic Resources, Genomics and Genetic Improvement

Title: ENHANCE HARD SPRING AND DURUM WHEAT QUALITY AND UTILIZATION

Period Covered **From:** 10 / 2008 **To:** 9 / 2009 **Final Report?** Yes
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Development of improved wheat germplasm. Wheat producers, milling and baking industries, and overseas customers require high standards in the quality of wheat to meet their evolving needs. The Hard Red Spring and Durum Wheat Quality Laboratory (WQL) in Fargo, ND contributed wheat end-use quality data that helped lead to the development of improved wheat germplasm and subsequent release of new cultivars of spring, winter, and durum wheat bred for commercial production. The WQL provided over 40 different tests related to the physical and biochemical quality traits of the wheat kernel and related milling performance, flour, semolina, dough, baking, and spaghetti processing on over 4000 samples of hard spring, hard winter, and durum wheat lines that were submitted by public and private wheat breeders and cooperating scientists. The impact lies in the release of 7 experimental lines of spring wheat in 2008/2009, which included the cultivars RB07 and Clearfield.

306 1 A 2000

02 Relationships of polymeric proteins with dough and bread-making quality in a recombinant inbred population of hard red spring wheat. Variation in wheat (*Triticum aestivum* L.) polymeric proteins is known to be associated with quality traits. The composition of polymeric proteins and their associations with dough mixing strength and bread-making characteristics were investigated in 139 inbred hard spring wheat lines grown at three locations through cooperation with wheat breeders from the University of Minnesota. Sodium dodecyl sulfate unextractable high molecular weight polymeric proteins were identified to contribute to enhancing mixing and breadmaking properties. The results of this research provide information on functional effects of polymeric proteins on flour bread making characteristics, and the information will assist evaluation of wheat breeding lines for improved bread making quality.

306 1 A 2000

306 1 B 2000

306 1 C 2000

03 Rheological changes in refrigerated dough during storage in relation to proteins. Refrigerated dough is a flour-based, unbaked product that is stored between 4-7 °C. Refrigerated storage results in dough deterioration over time, thus reducing bread making quality. Changes in rheological properties and associated proteins of dough during refrigerated storage were investigated in cooperation with the Spring Wheat Quality Laboratory at North Dakota State University. Results indicated that wheat cultivars showed differences in dough deterioration due to the hydrolysis of polymeric proteins and gliadins during refrigerated storage. This research will result in the selection of wheat cultivars that yield dough with improved tolerance to refrigerated storage and an understanding of the likely cause and effect of dough deterioration during refrigeration.

Project Number: 5442-43440-008-00D

Accession: 0408465

FY: 2009

306	1	A	2000
306	1	B	2000
306	1	C	2000

- 04 Structural changes of arabinoxylans and their relationships with syruing during refrigerated storage of dough. Degradation of Arabinoxylans (AXs) has a negative effect on dough quality, specifically causing release of water from dough (dough syruing) during refrigerated storage. Differences in decrease of molecular weight and the ratio of arabinose to xylose of AXs were observed during extended refrigerated storage among dough prepared from different wheat cultivars. Specifically, water unextractable-AXs, which have high water holding capacity, were observed to become soluble in water due to the decrease of arabinose to xylose ratio during extended refrigerated storage, which led to the 'syruing' condition of the refrigerated dough. This research provides wheat breeders with the knowledge needed to select and release cultivars with improved refrigerated dough quality.

306	1	A	2000
306	1	B	2000
306	1	C	2000

- 05 The effect of spring wheat starch properties on flour tortilla quality. Starch properties affect the end use quality of products made from wheat flour. Flour from seven wheat cultivars with different starch composition was tested for starch properties to assess the impact on tortilla quality. Tortilla dough exhibited physical characteristics ranging from soft and dry to moist and sticky, while tortillas had unique handling and storage properties related to the starch composition. Results indicated that various low-amylose flour mixtures enhanced tortilla quality. This information provides wheat breeders with the knowledge needed for selecting cultivars with improved tortilla-making quality.

306	1	A	2000
306	1	B	2000
306	1	C	2000

Project Number: 5442-43440-008-00D

Accession: 0408465

FY: 2008

- 04 Wheat flour protein and color characteristics of noodle dough. Color of noodle dough is a very important attribute in Asian countries where a major portion of wheat is consumed for noodle production. This research was performed in cooperation with the Wheat Quality Laboratory at Oregon State University to investigate relationships of protein composition and noodle colors. High molecular weight glutenin subunit composition of wheat protein significantly affected all the measured noodle parameters, specifically for the noodle water absorption and redness of noodle dough. Protein molecular weight distribution was also found to affect noodle characteristics. Applying multivariate analyses to SE-HPLC data indicated that calibration models to predict fresh noodle dough redness and yellowness values could be derived. The results of this research will assist evaluation of noodle making quality of wheat breeding lines. This research aligns with NP 306 Component 1, Quality Characterization, Preservation, and Enhancement, Problem Area 1A: Definition and Basis for Quality, Problem Area 1B: Methods to Evaluate and Predict Quality, and Problem Area 1C: Factors and Processes That Affect Quality.
- 05 Quality characteristics and size exclusion HPLC of protein extracts from soft white winter wheat. A better understanding of the relationship between molecular weight distributions of unreduced grain proteins and end-use quality characteristics of soft white winter wheat, together with faster methods for evaluation, would facilitate development of varieties with better end-use quality. Research was conducted on these relationships in cooperation with the Wheat Quality Laboratory at Oregon State University and Western Wheat Quality Laboratory, USDA-ARS. Significant associations of molecular weight distributions of proteins were found with quality characteristics. Specifically, high molecular weight polymeric protein fractions were found to have detrimental effects on soft wheat quality. Prediction models were developed by the application of multivariate methods to the SE-HPLC data and they explained over 90 % of the variation in mixograph water absorption, and cookie diameter and thickness. The results indicate that protein SE-HPLC data can be employed in breeding programs and industry for the evaluation of soft wheat quality, including milling properties as well as mixing and baking characteristics. This research aligns with NP 306 Component 1., Quality Characterization, Preservation, and Enhancement, Problem Area 1A: Definition and Basis for Quality, Problem Area 1B: Methods to Evaluate and Predict Quality, and Problem Area 1C: Factors and Processes That Affect Quality.

