Project Number: 5348-43440-006-00D **Accession:** 0419735 **FY:** 2011

ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: ROBERT L FIREOVID **Prin Invs:** CRAIG F MORRIS

Start Date: 06/13/2010 **Term Date:** 06/12/2015

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: ENHANCE WHEAT QUALITY, FUNCTIONALITY AND MARKETABILITY IN THE WESTERN U.S.

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

Progress and Outcomes:

4. Accomplishments

01 Discovery of three new polyphenol oxidase (PPO) genes. PPO, causes graying and browning of wheat dough and leads to discoloration in the end products. This is considered to be undesirable by consumers, and thus considerable effort is being made to minimize PPO in wheat varieties. ARS scientists in Pullman, WA have identified three additional PPO genes in wheat that were not previously known to be produced in wheat kernels. The new genes actually appear to account for 72% of the PPO RNA levels in developing wheat kernels, making them major contributors to discoloration of wheat dough products. Identification of three new very important targets that must be addressed for improvement of noodle dough color stability.

306 1 A 2010

02 Development of soft kernel durum wheat. Hard kernel texture of durum wheat limits its utilization, thus an alternative product is necessary. ARS scientist in Pullman, Washington, in cooperation with scientists at Univ. of Tuscia, Viterbo, Italy, transferred the puroindolines and some unknown amount of chromatin from hexaploid wheat to durum wheat; stabilized the trait and developed back-cross derived lines showing soft kernel texture provided milling and flour properties consistent with soft wheats. As a result, soft durum grain can be milled using soft wheat milling equipment producing high yields of break flour with low starch damage levels.

306 1 A 2010

03 Atomic force microscopy and other techniques examine the difference between soft and hard wheat endosperm. No one has a thorough understanding on the structural levels of soft and hard wheat at the molecular level. An ARS scientist in Pullman, Washington, in cooperation with a scientist with the Dept. of Chemistry, Washington State Univ., Pullman, used state-of-the-art atomic force field emission scanning electron microscopy, Raman and X-ray photoelectron spectroscopies to examine the difference between hard and soft near-isogenic wheat grain endosperm structure. Polished endosperm and flour of near-isogenic lines were examined using the aforementioned techniques. Soft wheat endosperm was less continuous with less distinct small granule structures, but with a greater number of larger features. Results contribute to a basic understanding of how soft and hard wheat grains differ, and how these difference may affect milling and flour quality.

306 1 B 2010

04 Association of puroindoline b-2 genes with other wheat traits. The association between puroindoline b-2 variant genes (Pinb-B2v) and other wheat traits are unclear. An ARS scientist in Pullman, Washington, in cooperation with Henan Agricultural Univ. and Chinese Academy of Agriculture scientists determined the associations between

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puroindoline b-2 gene allele variants with other grain and agronomic wheat traits. Allelic variation in puroindoline b-2 variant genes was examined in relationship to grain traits, yield components and flag leaf size in bread wheat varieties of the Yellow and Huai river valleys of China. Within the soft wheat class, the Pinb-b2v3 allele was assiciated with harder grain than v2 allele. Results provide a number of testable hypotheses to see if these associations are cause and effect or simply indicate founder effects of wheat germplasm.

306 1 A 2010

05 Distribution of arabinoxylans in wheat grain flour mill streams. Distribution of various arabinoxylan fractions among wheat flour mill streams is unknown. ARS scientists in Pullman, Washington, in cooperation with a graduate student at Washington State Univ., Pullman, measured the total, water-unextractable and water-extractable arabinoxylans of 10 flour streams from each of 31 genetically pure varietal grain lots. Mill stream (the product resulting from the passage of grist through a mill roll pair and subsequent passage through appropriately dimensioned sieves) was a bigger source of variation for arabinoxylans than was wheat variety. Arabinoxylan content was well correlated with flour ash content and increased with flour extraction rate. Selecting specific flour streams will may be a more effective strategy in increasing or decreasing arabinoxylan content compared to selection of specific varieties.

306 1 A 2010

06 Oxidative cross-linking in wheat grain flour mill streams. Oxidative cross-linking forms gels that affect both batter viscostity and food product quality. The oxidative cross-linking potential of various flour mill streams (products resulting from the passage of grist through a mill roll pair and subsequent passage through appropriately dimensioned sieves) is not known. ARS scientists in Pullman, Washington, in cooperation with a graduate student at Washington State Univ., Pullman, measured the endogenous and enhanced oxidative cross-linking potential of 10 flour streams from each of 31 genetically pure varietal grain lots. Hard wheat flours tended to produce more viscous batters; first break and first second middlings flour streams exhibited the greatest potential for oxidative cross-linking. These results will help food manufacturers and flour millers produce products with more consistent processing properties.

306 1 A 2010

07 Maize oil content. Use of the puroindoline transgene in maize must be approved in order to be used by the food production system. An ARS scientist in Pullman, Washington in cooperation with scientists at Montana State University in Bozeman, determined that constitutive expression of the wheat puroindoline proteins caused increased oil content in the germ. Oil produced from maize (i.e. corn oil) will benefit the food industry as well as producers by increasing the oil yields.

306 1 D 2010

08 Kernel texture protein functionality. Proteins called puroindolines control kernel textures. An ARS scientist in Pullman, Washington in cooperation with scientists at Montana State University in Bozeman, Montana, used saturation mutagenesis to determine which regions of the puroindoline proteins are most important for its function in controlling kernel texture. Several portions of the protein were determined to be essential for its function, and many novel hardness mutants with varying degrees of functionality were produced. Some of these new alleles could potentially be more desired by end users through traits such as improved milling yield.

306 1 A 2010

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306 1 D 2010

09 Barley grain quality genes. Mutations in the Vrs1 gene cause barley seed heads to form six rows of kernels instead of the usual two. These changes in head row type have a major effect upon end-use quality. ARS scientists at Pullman, WA, in collaboration with scientists at Montana State University, found that different changes of the Vrs1 gene affected end-use quality in different ways. Specific mutations leading to superior end-use quality were identified in this study. The most advantageous alleles can now be preferentially used by barley breedoing programs.

306 1 A 2010

306 1 B 2010

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ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: ROBERT L FIREOVID **Prin Invs:** CRAIG F MORRIS

Start Date: 06/13/2010 **Term Date:** 06/12/2015

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: ENHANCE WHEAT QUALITY, FUNCTIONALITY AND MARKETABILITY IN THE WESTERN U.S.

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

Progress and Outcomes:

4. Accomplishments

Project Number: 5348-43440-005-00D **Accession:** 0418319 **FY:** 2010

ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** CRAIG F MORRIS

Start Date: 08/13/2009 **Term Date:** 06/13/2010

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

Title: ENHANCE WHEAT QUALITY AND UTILIZATION IN THE WESTERN U.S.

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

Progress and Outcomes:

4. Accomplishments

01 Maize milling yields. Extraction of starch during wet milling is a primary economic consideration. ARS scientists in Pullman, Washington in cooperation with scientists at Montana State University in Bozeman, Montana, ascertained the effect of wheat puroindoline proteins in the endosperm of maize. The presence of the puroindoline gene expression caused an improvement in wet milling yields. Use of the transgene in maize must be approved before it can be used in the food production system. Increased milling yields would translate into more efficient utilization by the food industry.

306 1 A 2000

02 The basis for kernel hardness in wheat. Genetic control of kernel texture is a primary consideration in milling and baking quality. ARS scientists in Pullman, Washington, in cooperation with a scientist with the Institute of Crop Science, National Key Facility for Crop Gene Resources and Genetic Improvement, National Wheat Improvement Center, CAAS mapped a new variant of the puroindoline genes responsible for kernel softness. The genes were mapped to the three group 7 chromosomes. These genes may have a secondary role in kernel softness in wheat, and therefore plant breeders could use them to genetically improve milling and baking quality for these industries and consumers.

306 1 A 2000

03 A novel grain protein gene in wheat. Protein content of wheat is important for nutrition and for gluten development, hence baking quality. ARS scientists in Pullman, Washington, in cooperation with University of California Davis and North Dakota State University scientists ascertained the effect of a novel grain protein gene in wheat. The gene improves nutrition and baking but often decreased grain and milling quality. Wheat breeders will need to consider background effects before using this gene since it can be deleterious; therefore its impact could be both positive and negative on wheat quality.

306 1 A 2000

04 The basis for kernel hardness in wheat. Kernel texture affects milling performance and flour quality; different puroindoline alleles confer different levels of kernel texture. ARS scientists in Pullman, Washington, in cooperation with scientists at the Institute of Crop Science, National Key Facility for Crop Gene Resources and Genetic Improvement, National Wheat Improvement Center, CAAS characterized an important hardness allele in wheat and developed a molecular marker for it. The Pina-D1b allele is very important for wheat breeding and improvement as it contributes to an especially hard texture. Wheat breeders can use the marker to detect the allele;

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thereby positively impacting wheat grain quality (milling and baking).

306 1 A 2000

05 Wheat starch lipids. Lipids play a direct role in flour quality and baking performance. ARS scientists in Pullman, Washington, in cooperation with scientists at Kansas State University and Montana State University characterized the polar lipids on the surface of isolated wheat starch. Starch surface lipids may affect baking properties and food quality. Starch from soft wheat was found to have a much greater abundance of polar lipids compared to starch from hard; the method of starch isolation was also found to affect lipid presence. The reason for differences in starch surface lipids is not full known, the results will guide future research strategies.

306 1 A 2000

06 Wheat lipids and grain hardness. Lipids play a direct role in flour quality and baking performance. ARS scientists in Pullman, Washington, in cooperation with scientists at Kansas State University and Montana State University characterized the polar lipids among near-isogenic hard and soft wheat. The basis for kernel texture is not fully known nor is the effect it has on flour polar lipids. Polar lipids from whole grain meal, flour and isolated starch were characterized from near-isogenic hard and soft wheat. Meals did not differ in polar lipids, flours differed only slightly but polar lipids isolated starch were dramatically lower in hard compared to soft wheat starch. These results add to our understanding of how kernel texture in wheat affects quality.

306 1 A 2000

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ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** CRAIG F MORRIS

Start Date: 09/21/2004 **Term Date:** 08/12/2009

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

Title: ENHANCE WHEAT QUALITY AND UTILIZATION IN THE WESTERN U.S.

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

Progress and Outcomes:

4. Accomplishments

01 Dietary fiber in wheat grain. Differences in dietary fiber levels in wheat grain are not well known. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators determined how dietary fiber levels vary among a collection of different varieties and grown in different locations. Different wheat varieties differed significantly due to genetics. The nutritional quality of wheat grain can be increased by genetically increasing the content of dietary fiber.

301 2 C 2006

306 1 A 2000

306 1 C 2000

02 Noodle dough discoloration in wheat and wheat relatives. An undesirable brown color appears in Asian noodles and certain other wheat products due to an enzyme known as “Polyphenol Oxidase (PPO)”. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators characterized the PPO genes in wheat and wheat relatives. Further knowledge of the origins of PPO and the levels of PPO that occur in various wheat relatives was gained, showing that high PPO activity is likely caused by only a small number of the many PPO genes that are found in wheat. Future research can now be more efficiently focused on a few candidate genes.

301 2 C 2006

306 1 A 2000

03 Genes controlling barley grain hardness. The hardness of cereal grains, including barley, has a tremendous impact upon their suitability for various end-uses. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators identified the genes controlling endosperm texture in barley. These genes were found to vary greatly among varieties from diverse locations. Using these new genes, further modification of barley endosperm texture may be possible, which is believed to be advantageous to improving barley for end uses such as improved feed quality.

301 2 C 2006

306 1 A 2000

04 Development of new wheat varieties using special genetic techniques. Development of new wheat varieties requires efficient combining of genes from each parent. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators applied special genetic techniques to track parental genes. We demonstrated that these techniques provide a more efficient means to combine favorable genes from each parent. Application of the techniques will improve and speed the development of new wheat varieties.

301 2 C 2006

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301 3 C 2006

306 1 A 2000

306 1 B 2000

05 Mineral content of wheat grain. Differences in the mineral content of wheat grain are not well known and affect milling and human health. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators determined how mineral content varies within a collection of different varieties grown in multiple locations. The mineral content of wheat grain was found to mostly be determined by where wheat is grown with smaller differences amongst varieties. The research indicates little ability to manipulate grain mineral content via breeding and genetics.

301 2 C 2006

306 1 A 2000

06 Effect of added proteins on noodle making. Certain genes control most of the variation in wheat grain texture, which in turn affects milling characteristics as well as end product quality. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators examined the color and texture characteristics of white salted noodles processed from flour made from a wheat variety containing additional levels of proteins. In general, the flours performed equally well. This shows that even high levels of certain proteins can be added to noodle doughs without detrimental effects on product quality.

306 1 A 2000

306 1 C 2000

07 Quality of wheat grain depends on kernel hardness. There are different genetic ways to make wheat kernels hard, but we don’t know which specific gene produce the best quality. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators studied a number of these different genes and how they affected Chinese noodle quality. Specific genes were shown to produce better flour milling performance and Chinese noodle quality. Plant breeders can incorporate the better genes into new wheat varieties to improve quality.

301 2 C 2006

306 1 A 2000

306 1 C 2000

08 Color of wheat foods. Certain genes in wheat produce enzymes that discolor wheat foods, but the variety of genes is not fully understood. Such color changes affect the perceived quality and the product. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators identified discoloration enzymes in wheat and some of its relatives. Knowledge of these genes will allow plant breeders to develop new wheat varieties that produce grain with reduced discoloration problems.

301 2 C 2006

306 1 A 2000

09 Baking quality of cookie flour. Defining the potential cookie baking quality of flour is crucial to both wheat variety development programs, and to the baking industry where flour must be evaluated so that process parameters can be adjusted to successfully and economically produce baked products. ARS researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with 12 international collaborators evaluated a cookie bake test method. The new method was found to be a substantial improvement over the method it replaced. This new method will assist wheat breeders, cereal chemists and others tasked with accurately evaluating the baking quality of cookie flours.

301 3 C 2006

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306 1 B 2000

10 More accurate assessment of flour quality. Occasionally, methods contain errors that have become entrenched over the years. Researchers at the Western Wheat Quality Lab in Pullman, Washington, in cooperation with collaborators identified an error in the “Solvent Retention Capacity (SRC)” method that is used extensively in both variety development work and in industry to define the potential utility of flour in baking. The Official method was corrected and communicated to users, and the implications of the correction were also evaluated. The corrected method will allow more accurate and reliable assessment of flour quality.

306 1 B 2000

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ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** CRAIG F MORRIS

Start Date: 09/21/2004 **Term Date:** 08/12/2009

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

Title: ENHANCE WHEAT QUALITY AND UTILIZATION IN THE WESTERN U.S.

Period Covered **From:** 10 / 2007 **To:** 9 / 2008 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Assessed the current status of the molecular genetic control of wheat grain texture. This rapidly expanding field of cereal chemistry and genetics has not been evaluated and summarized recently. Three reviews were written and published, by the ARS scientists at the Wheat Genetics, Quality Physiology, and Disease Research Unit in Pullman, WA, providing researchers a concise description of the current status of the molecular genetic control of wheat grain texture. This active area of research is important for better utilizing wheat grain and flour; a previous review (2002) has been cited 83 times indicating the importance of periodic summaries to researchers. NP306 Action Plan Component 1, Quality Characterization, Preservation, and Enhancement; Problem Area 1a, Definition for Basis of Quality and 1c, Factors and Processes that Affect Quality; and NP 301 Action Plan Component 3, Genetic Improvement of Crops; Problem Area 3c, Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

02 Collaborated on evaluating the end-use quality of near-isogenic lines carry leaf rust resistance. Leaf rust is a leading pathogen of wheat and new sources and strategies for gaining resistance are needed. The milling and baking quality of wheat near-isogenic lines carrying a resistance gene from wild wheat was evaluated, by the ARS scientists at the Wheat Genetics, Quality Physiology, and Disease Research Unit in Pullman, WA in collaboration with scientist at U.C. Davis. The segment of alien DNA that carries the resistance gene is also associated with negative and positive effects on end-use quality. NP306 Action Plan Component 1, Quality Characterization, Preservation, and Enhancement; Problem Area 1a, Definition for Basis of Quality and 1c, Factors and Processes that Affect Quality; and NP 301 Action Plan Component 3, Genetic Improvement of Crops; Problem Area 3b, Capitalizing on Untapped Genetic Diversity, and Problem Area 3c, Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

03 Compressive strength of wheat kernel endosperm. Variation in wheat kernel texture is not fully understood and is not easily measured by non-empirical techniques. Micro-bricks were prepared, by the ARS scientists at the Wheat Genetics, Quality Physiology, and Disease Research Unit in Pullman, WA, from individual wheat kernels of various varieties and subjected to compression failure testing. This research provides for the preparation and analysis of the compressive strength of wheat endosperm in universal “engineering” units and indicates that the Single Kernel Characterization System provides reasonably accurate assessment of kernel-to-kernel hardness variation. NP306 Action Plan Component 1, Quality Characterization, Preservation, and Enhancement; Problem Area 1b, Methods to Evaluate and Predict Quality, and 1c, Factors and Processes that Affect Quality; and NP 301 Action Plan Component 3, Genetic

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Improvement of Crops; Problem Area 3c, Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

04 Prevalence of puroindoline alleles in wheat from eastern Asia. Wheat grain hardness results from natural mutations in the puroindoline genes, but mutation frequency varies in different gene pools and regions; eastern Asia has not been well characterized. The puroindoline gene sequence and kernel texture of a large number of wheat varieties from eastern Asia were determined by the ARS scientists at the Wheat Genetics, Quality Physiology, and Disease Research Unit in Pullman, WA; a new hardness mutation in puroindoline b was discovered. Manipulation and selection of puroindoline alleles is an important part of modern breeding strategies aimed at improving end-use quality. NP306 Action Plan Component 1, Quality Characterization, Preservation, and Enhancement; Problem Area 1a, Definition for Basis of Quality and 1c, Factors and Processes that Affect Quality; and NP 301 Action Plan Component 3, Genetic Improvement of Crops; Problem Area 3b, Capitalizing on Untapped Genetic Diversity, and Problem Area 3c, Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

05 Collaboration on silencing puroindoine a using a puroindoline transgene. Kernel hardness, which is controlled by the action of puroindolines, is a key end-use quality trait in wheat, but the regulation of puroindolines is not completely understood. Collaborative research, by the ARS scientists at the Wheat Genetics, Quality Physiology, and Disease Research Unit in Pullman, WA, showed that over-expression of a puroindoline a transgene could suppress expression of the native puroindoline gene, which resulted in hard kernel texture. This research contributes to the overall understanding of how the puroindoline genes are regulated in wheat. NP306 Action Plan Component 1, Quality Characterization, Preservation, and Enhancement; Problem Area 1a, Definition for Basis of Quality and 1c, Factors and Processes that Affect Quality; and NP 301 Action Plan Component 3, Genetic Improvement of Crops; Problem Area 3c, Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

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ModeCode: 5348-05-00 PACIFIC WEST AREA
PULLMAN, WASHINGTON
WHEAT GENETICS, QUALITY PHYSIOLOGY AND DISEASE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** CRAIG F MORRIS

Start Date: 09/21/2004 **Term Date:** 08/12/2009

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

Title: ENHANCE WHEAT QUALITY AND UTILIZATION IN THE WESTERN U.S.

Period Covered **From:** 10 / 2006 **To:** 9 / 2007 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

Collaborated on characterizing the biochemistry and genetics of wheat kernel polyphenol oxidases (enzymes that make dark colored pigments in food). Polyphenol oxidase has been implicated as a major cause of darkening in Asian noodles and other wheat products. However, the number of PPO genes and their expression and substrate specificity are not fully known. PPO proteins of two sizes (60 and 62 kD) were identified. Some forms of PPO were inhibited by a very specific inhibitor (called “tropolone”) while others were not. Total PPO activity in mature kernels is thus a function of specific PPO isoforms present, their abundance, and activation levels. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted, in part, at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Characterized puroindoline a and b alleles in Chinese wheat land races. Puroindolines are proteins that control kernel hardness in wheat, a primary end-use quality trait. Puroindoline a and b genes were sequenced in a number of diploid relatives of wheat, and Chinese land race germplasm; a new allele in puroindoline b was discovered. These results extended the discovery of the genetic basis of cereal grain texture and further demonstrate that naturally-occurring puroindoline gene sequence variation causes wheat grain to be hard or soft. Understanding the relationship between these gene sequences and grain texture will facilitate the enhancement of wheat and other cereal quality.These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

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Determined the influence of cultivar and environment on arabinoxylans in soft wheat. Arabinoxylans are hydrophilic non-starch polysaccharides found in wheat grain as minor constituents; they can associate with large amounts of water and can form gels, thus influencing wheat quality. The water-soluble and water-insoluble arabinoxylans in soft wheat were measured and their variation assigned to genetic and environmental sources of variation. These results indicate that arabinoxylan content varies significantly among different wheat varieties and therefore can be selected as an important end-use quality trait. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Determined the influence of flour chlorination and formulation on the quality of pancakes. Soft wheat flour is commonly chlorinated in North America for the production of cakes and pancakes; however the elimination of chlorination is desirable. A standard pancake laboratory method was developed and used to assess the effect of chlorination as well as pancake formula ingredients on pancake quality. Chlorination affected all pancake quality attributes and no change in formula ingredients could completely substitute for its affect. The results indicate that a more in-depth understanding of the effects of chlorination must be gained before its effects can be replaced with alternatives. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Release of New Wheat Varities. In collaboration with others, released four new wheat varieties – Masami soft white winter wheat, Otis spring wheat, Louise soft white spring wheat, and Bauermeister hard red winter wheat. The development of new wheat varieties provides farmers opportunities to grow high-yielding, high quality varieties with resistance to pests, diseases, and abiotic stresses; processors and end-users are provided with high-quality raw material for plentiful wholesome foods. These wheat varieties were developed in collaboration with Washington State University. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted, in part, at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Measured “oxidative gelation” (the formation of gels through oxygen-cross linking of

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flour polymers) and its influence on soft wheat end-use quality. Viscosity is an important end-use attribute for some soft wheat flour formulations, like pancake batter. A method was developed to identify variation in viscosity due to oxidative gelation. Results indicate that oxidative gelation is an important contributor to batter viscosity and also contributes to the quality attributes of dough systems. Better control of oxidative gelation of flours will allow end-users better process control and higher quality, more consistent consumer products.These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Determined the allelic variation of polyphenol oxidase genes and developed functional markers for PPO genes and wheat. Polyphenol oxidase enzyme activity is highly related to the undesirable browning of wheat-based products, especially Asian noodles. In this study, complete genomic DNA sequences of two PPO genes and their allelic variants were characterized; additionally molecular markers were developed to identify high and low PPO activity genotypes. This research will assist in the improvement of wheat varieties with low PPO and therefore good end-product color attributes. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Collaborated on the pilot scale milling characteristics of transgenic iso-lines of hard wheat over-expressing puroindolines. Wheat grain texture is an important determinant of milling properties and end product use; puroindoline proteins play a primary role in determining wheat grain texture. This study examined the milling characteristics of transgenic iso-lines that express more puroindoline a, puroindolines b, or both than normal on a large scale pilot mill. Puroindoline expression influenced break flour yield, flour yield, starch damage, cookie diameter, and bread loaf volume. This study provided further insight as to how puroindolines influence wheat grain texture, milling and end-product quality. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted, in part, at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Discovered molecular evidence for a multi-gene family for polyphenol oxidase in wheat

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and it's wild relatives. Wheat polyphenols oxidase enzyme is the major cause of browning reactions that discolor Asian noodles and other wheat products. PPO genomic sequences from diploid, tetraploid, and hexaploid wheat species were characterized to gain a better understanding of the structure and organization of PPO genes; results clearly indicate evidence for gene duplication with the number of genes obtained for bread and durum wheat higher than the expected number (one per genome). Researchers and others involved in wheat improvement will use these results in developing strategies for developing wheat varieties with low PPO activity and better end-product quality. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Registered Waxy-Pen soft white spring waxy wheat variety. “Waxy” refers to starch with 0% amylose; as such, waxy wheat provides food and feed processors, and industrial users a new and novel agricultural raw material. Waxy-Pen is the first waxy wheat variety to be developed, released, and registered in the United States. From this new variety new uses, processes and consumer products are anticipated. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

Critically evaluated the SDS sedimentation test for wheat meals and protein quality. Gluten quality varies among wheat varieties and grain lots, and is an important consideration for processing and end-product quality; a simple means of assessing gluten quality is therefore needed. This study critically examined the SDS sedimentation test for wheat meals, and demonstrated that the SDS sedimentation test is highly robust and reproducible (SDS is a common detergent). Sample weight (if adjusted), a recording time of at least 10 minutes, an SDS stock concentration of at least 1% (final), grinder type and screen aperture were minor sources of variation in the test. These results will facilitate the next phase of research, with the ultimate aim of developing a quick, reliable and market-applicable industry test for gluten quality. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted, at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.

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Developed a device for the preparation of cereal endosperm “bricks” from single wheat kernels. Kernel hardness is a key quality trade of wheat, yet there is no means to objectively assess the hardness of individual wheat kernels. We designed, built, and tested a sanding device that prepared tiny brick-shaped specimens of endosperm from individual wheat kernels; a detailed description of the device and the preparation and testing of bricks was provided. This device and procedure is currently being used in the next phase of research which is studying the material properties of soft and hard wheat kernels. These results will assist researchers and cereal chemists in the improvement of wheat quality. This work was conducted at the Pullman, WA Western Wheat Quality Lab and addresses 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; and NP 301 Component 1. Plant and Microbial Genetic Resource Management, Problem Statement 1B: Assess the Systematic Relationships and Genetic Diversity of Crop Genetic Resources, Component 2. Crop Informatics, Genomics, and Genetic Analyses, Problem Statement 2B: Structural Comparison and Analysis of Crop Genomes, Component 3. Genetic Improvement of Crops, Problem Statement 3B: Capitalizing on Untapped Genetic Diversity, and Problem Statement 3C: Germplasm Enhancement/Release of Improved Genetic Resources and Varieties.