Progress Report – Padu Krishnan

Project title: Enhanced End-Use Wheat Quality of South Dakota Wheat
Project period: 2 years (July 1, 2014-June 30, 2015)
Project investigators: P. Krishnan, K. Glover, and M. Treml.

Research Summary:

Introduction
Progress was accomplished in several areas of wheat research including, routine wheat grain and flour quality evaluation of SD wheat, investigation of health attributes of SD wheat, new tools for prediction of bread loaf volume, food product innovation, ingredient functionality investigation and submissions of provisional patents for invention discovery. In addition, several peer reviewed manuscripts were published in 2015 in the area of wheat quality. Rapid analytical techniques for wheat evaluations were explored. End use of SD wheat varieties in Asian food products was tested. Effects of pre-treatments of wheat bran in the acceptability of 100% whole grain wheat products were assessed.

Description of Accomplishments
Basic research on wheat dough rheology and prediction of dough attributes: While food research is essentially applied research, basic research into the fundamentals of food properties of food materials (eg. wheat kernel, flour, dough, etc.) is needed to understand the nature of those materials. Such an understanding allows us to predict the behavior of dough to determine its extensibility, ability to trap leavening gasses, resilience to stresses of food processing conditions and ultimately to impact eating characteristics and qualities. Environmental and genetic influences during the growth of the wheat crop have far reaching implications for consumer acceptance and profitability for processors.

Our journal article titled "Dough strain hardening properties, extensibility parameters and end product quality of wheat flour " published in Cereal Chemistry in the May-June issue, has provided a prediction model for dough behavior under the influence of external stresses.

Collaboration with Wheat Marketing Institute: A research paper was presented on the quality traits of Asian products under the influence of enzyme and emulsifiers in processing. Knowledge of the acceptability of wheat for the export market is essential.

A manuscript submitted to the Journal of Cereal Chemistry titled *"Increasing the fiber content of wonton wraps I. Effects of phosphorylated cross linked resistant starch and specialty wheat proteins on dough rheological properties*" explores the efficacy of SD wheat flour and commercial noodle flours in Asian food products. This is a collaboration between WMC, SDSU and Nestle Company.

Effects of wheat bran quality on the texture and sensory quality of bread. While the bran represents only 14% by weight of the wheat kernel, it has enormous effects on the quality of flour and food products made using 100% whole grains. This study subjected milled wheat bran from 5 HRS varieties to supercritical carbon dioxide fluid extraction and selective aqueous-ethanol solvents and then reintroduced the treated bran into patent flour. The resultant flour was evaluated for dough characteristics (Farinograph) and bread making potential (dough traits). Selective removal of bran lipids offers benefits to health while improving the color of flour. Compounds that contribute to the pronounced flavor of whole wheat foods may also be affected. The study will evaluate wheat phytonutrients content in bran and wheat flour. SCF carbon dioxide extraction of bran yielded a brighter bran color that will be beneficial in whole grain food products.

Acquisition of quality measurement instrument for bread crumb structure: A C-Cell instrument that was acquired in 2014 with funding from the SDWC. Wheat Commission funds were leveraged with Minnesota Corn Growers Association funds to acquire the instrument. The C-Cell provides information of the internal structure of wheat-based baked food products that will be helpful in learning of the effects of grain fractions on gas cell formation and gas retention during fermentation. Crumb structure and texture qualities of bread are measured using a digitized image of the product. If loaf volume is indeed the holy grail of the baking industry, then factors that improve the crumb structure and gas retention capacity of the dough will have an immediate bearing increasing loaf volume. A manuscript titled *Effects of corn distillers grains on dough properties and quality traits of Chinese steamed bread* explores the effective use of C-Cell data to explain bread characteristics. Figure 3 and table 1 in the Appendix provide graphic details to explain the effects of bread ingredients on air cell size, cell numbers, cell wall thickness, brightness and cell distribution in a slice of bread.

Engagement with the food processing industry: We continue to collaborate with Schwan Food Scientists. Schwan Food Scientist Brenda Bauer completed her work under PI Krishnan in 2015. *The role of enzymes on quality of whole grain pizza dough and pizza crust* will be reported at the Institute of Food Technologists Conference in 2016.

Branding project employing SD wheat: This project was pursued by Food Science students in the New Food Product Development Class (Figure 2 in Appendix). A wheat cookie production unit was acquired for product development efforts. This machine has been modified to mimic industrial food production conditions.

Gluten and Gluten Fractions: The work of Plant Science graduate student Stacy Dreis explores the relationship of alpha gliadin gluten fractions to wheat nutrient composition and food functionality in 48 HRS wheat lines. Total wheat protein, vital gluten and milling yield are measured in connection with alpha gliadin measured by immune assays. Environmental and genetic effects are also being investigated.

Publications and Presentations on wheat research

1. J. Y. Kindelspire, K. D. Glover, M, Caffé-Treml, and P. G. Krishnan. 2015. *Relationships between dough strain hardening properties, extensibility parameters and end product quality of wheat flour.* Cereal Chemistry 92 (3): 293-301.

2. Golam Rasul, Karl D. Glover, Padmanaban G. Krishnan, Jixiang Wu, William A. Berzonsky & Amir M. H. Ibrahim. 2015. *Additive-dominance genetic model analyses for late-maturity alpha-amylase activity in a bread wheat factorial crossing population*. Genetica. Volume 143 (6):143.

3. Stacy Dreis, Jai Rohila, Padmanaban Krishnan and Karl Glover. *Quantifying alpha gliadin in common wheat (Triticum aestivum L.).* Poster presented at McFadden Symposium.

4. David Karki, Karl D. Glover, Krishna Bondalapati, Padmanaban G. Krishnan. *Utilization of Weather Data in Predicting Bread Loaf Volume by Neural Network Method.* Submitted to Cereal Chemistry (October 2015).

5. Xioana Li, Chunyang Wang and Padmanaban Krishnan. *Effects of corn distillers grains on dough properties and quality traits of Chinese steamed bread* Submitted to Cereal Chemistry in November, 2015.

6. Julie Kindelspire, Gary Hou, Kyungsoo Woo and Padmanaban Krishnan. *Increasing the fiber content of wonton wraps I. Effects of phosphorylated cross linked resistant starch and specialty wheat proteins on dough rheological properties. Submitted to Cereal Chemistry (November 2015).*

Projections for the future

We will continue to explore new methods and protocols that provide information about the quality of our raw materials used in food processing.

We will continue to engage ENSAT students in wheat research as this is an effective use of funds to yield publishable new data on our crops.

We will provide research and analytical support for the breeding program while engaging with the food industry to sustain mutually beneficial research.

We will continue to submit proposals to the Sanford-SDSU Research Initiative. A proposal titled "Food Innovation Platform for the Development of Healthy Foods from SD Agriculture" is planned for 2016.

We will continue with product innovation effort. Two Provisional Patents were filed in the area cereal grains at SDSU.

Appendix:

Fig 1. Wheat Bran Supercritical Fluid Extract showing lipid fraction. The composition of the bran affects the consumer appeal of whole grain bread.

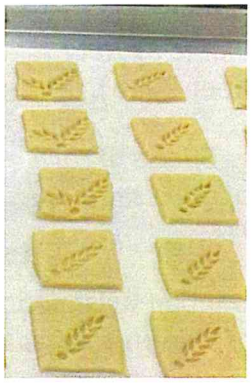

Fig 2. SD Wheat Commission logos imprinted on sugar cookie dough for use in Wheat Education Events (Wheat variety names could be emblazoned across the cookies as well (Hint! Hint!).

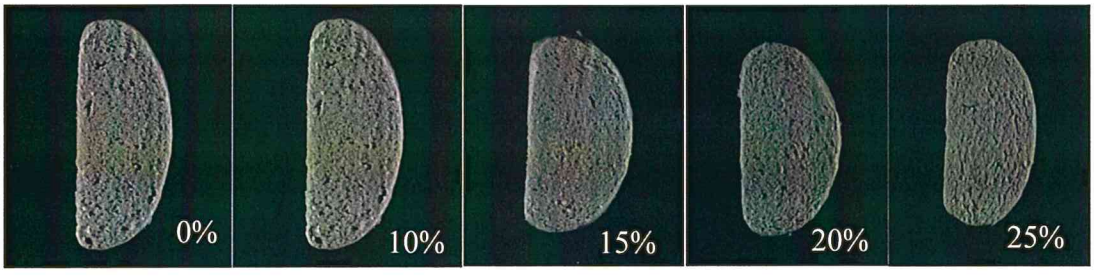

Fig 3. C-Cell images of steamed bread with different levels of DDG Fiber (from left to right, Control wheat 0%,10%,15%, 20% and 25% DDG).

Table 1. Image analysis of steamed bread with different percentages of DDG

Samples	0%DDG	10%DDG	15%DDG	20%DDG	25%DDG
Slice Area (mm^2)	4763.67±68.19a	3810.67±52.27b	3724.00±78.26bc	3642.00±137.01c	3403.33±66.08d
Wrapper Length (mm)	280.50±1.41a	247.93±7.31b	238.90±0.78c	230.90±3.74d	221.03±1.42e
Number of Cells	4144.33±204.18a	3347.00±323.11b	3388.00±237.31b	3231.33±91.27bc	2886.33±89.81c
Cell Diameter (mm)	1.69±0.05ab	1.71±0.08ab	1.56±0.13b	1.60±0.08b	1.84±0.13a
Wall Thickness (mm)	0.38±0.02b	0.40±0.02ab	0.39±0.01ab	0.40±0.00ab	0.42±0.01a
Slice Brightness	131.13±0.21a	96.47±4.10b	85.60±1.23c	81.23±0.32cd	79.27±3.60d

Mean ±standard deviation values in the same column that are followed by the same letters are not significantly different ($p>0.05$).