NC-213

(The U.S. Quality Grains Research Consortium)

2017 ANNUAL PROGRESS REPORTS

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MARKETING AND DELIVERY OF QUALITY GRAINS AND BIOPROCESS COPRODUCTS

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The Industry Advisory Committee

The NC-213 Industry Advisory Committee consists of at least five NC-213 stakeholder members recruited by and voted on by the NC-213 Executive Committee to serve a two-year term each. This committee serves in an advisory role to NC-213, its Executive Committee and its membership. In addition, the committee serves as a reviewer pool for The Andersons Grant Review Committee, acts as a liaison between NC-213 researchers and the industry, actively encourages existing industry stakeholders and recruits new industry stakeholders to participate in NC-213, and provides active feedback regarding research agenda and results. Current members are listed below:

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The **Quaker** Oats Company/PepsiCo ..... A. Bruce Roskens

Contents[1]

NC-213 Objective 1

To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.

NC-213 Objective 2

To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.

NC-213 Objective 3

To be a multi-institutional framework for the creation of measureable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security.

[1] Please note that some reports have more than one contributing institution and author. In the Contents, only the principal investigator, along with their institution, is listed. Please refer to the individual report for a complete list.

NC-213 (The U.S. Quality Grains Research Consortium)

Objective 1

To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.

Title

Characterizing and Evaluating Quality Attributes in Grain and Grain By-products through Near Infrared Spectroscopy (NIRS) Improved Calibration and Cost Models.

Objective 1. To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.

By

Hurburgh, C.R., Iowa State University
Rosentrater, K.A.

Outputs

Equipment from six near infrared spectroscopy (NIRS) manufacturers was calibrated for various grain and grain product analyses by the ISU Grain Quality Laboratory. The laboratory analyzed over 13,000 corn and soybean samples for 55 clients.

Dried distillers grains with several levels of solubles were modeled with various ambient temperature, consolidation pressure, and time conditions. Major factors predicting mass flow rates included the drying temperature, drying time, and cooling type.

Outcomes/Impacts

Calibration protocols were improved so that three NIRS platforms (instrument and calibration) were equivalence to within 0.02 percentage points of the single NIRS platform used by the USDA Federal Grain Inspection Service. The use of more than one machine without a loss in consistency of measurement would encourage technology development and lower testing costs for the grain market chain.

Enhanced knowledge on the mass flow of dried distillers grains with solubles may be beneficial to ethanol plant managers and handlers.

Publications

Licht, M., C.R. Hurburgh, M. Kots, P. Blake, and M. Hanna. 2017. Is there loss of corn dry matter in the field after maturity? 2017 Integrated Crop Management Conference Proceedings, 35-39.

Bhadra, R., K.A. Rosentrater, and K. Muthukumarappan. 2017. Modeling distillers dried grains with solubles (DDGS) mass flow rate as affected by drying and storage conditions. Cereal Chemistry, (4(2), 298-309.

Funding Source(s)

Iowa Extension 21 program
Industry contracts and service fees
United Soybean Board
USDA – GIPSA
USDA – ARS
Dakota Ethanol, LLC

Awarded Grants and Contracts

Equivalence of Near Infrared Transmission Platforms II, USDA-GIPSA.
Extension 21 Grants

Title

Multispectral Imaging Methodology to Measure Fungal Growth and aflatoxin in Maize.

By

Yao, Haibo, Geosystems Research Institute - Mississippi Agricultural & Forestry Experiment Station Mississippi State University

Output

Sorting of contaminated maize kernels is an approach to reduce aflatoxin levels in maize samples. The current research aims to evaluate an approach of repeated screening and sorting of maize samples to decrease the aflatoxin levels in contaminated grain with a multispectral fluorescence-based aflatoxin detection method. The multispectral fluorescence-based method uses two narrow bandwidth fluorescence bands for the detection. This method was developed based on a fluorescence shift phenomenon observed in the blue-green spectral region for maize kernels with a high aflatoxin content. A dual-camera imaging system was developed for rapid detection of contaminated corn. This multispectral system includes two scientific grade 14-bit Pixelfly cameras and two narrow-band filters. Corn samples were collected from field experiments and industrial sources.

Outcomes/Impacts

The focus is on the development of rapid, non-destructive technologies for fungal infection and aflatoxin detection in grains. Aflatoxin is a naturally occurring toxin, found in grain crops and products. It is regarded as one of the most important food safety problems in the world. Maize contaminated with toxigenic strains of A. flavus can result in great losses to the agricultural industry and pose threats to public health. The research effort aims at providing a rapid, non-destructive method for screening maize at elevators or grain collection points, identifying and diverting contaminated grain into alternative uses, thereby protecting the food supply and increasing producer profitability. Results from the current study enhanced the potential of using fluorescence multispectral imaging for the detection of fungal infected and aflatoxin contaminated maize.

Publications.

Xing, F., Yao, H., Liu, Y., Dai, X., Brown, R. L., Bhatnagar, D. (2017). Recent Developments and Applications of Hyperspectral Imaging for Rapid Detection of Mycotoxins and Mycotoxigenic Fungi in Food Products. Critical Reviews in Food Science and Nutrition. DOI: 10.1080/10408398.2017.1363709

Hruska, Z., Yao, H., Kincaid, R., Brown, R. L., Bhatnagar, D., Cleveland, T. E. (2017). Temporal effects on internal fluorescence emissions associated with aflatoxin contamination from corn kernel cross-sections inoculated with toxigenic and atoxigenic Aspergillus flavus. Frontiers in Microbiology. V8, 1718. DOI:10.3389/fmicb.2017.01718.

Xing, F., Yao, H., Hruska, Z., Zhu, F., Kincaid, R., Brown, R., Bhatnagar, D., & Liu, Y. 2017. Detecting peanuts inoculated with toxigenic and atoxienic Aspergillus flavus strains with fluorescence hyperspectral imagery. Proceedings of SPIE, "Sensing for Agriculture and Food Quality and Safety IX", 1021701.

Yao, H., Zhu, F., Xing, F., Hruska, Z., Liu, Y., Brown, R., Bhatnagar, D. 2017. NIR Spectroscopy Analysis of Aspergillus flavus-Inoculated Peanut Kernels. 18th International Conference on Near Infrared Spectroscopy. ICNIRS-1233. Copenhagen, Denmark. June 11 -15.

Funding Source(s)

USDA/Mississippi State University Cooperative Agreement NSF/STTR

Mississippi State University Agricultural and Forestry Experiment Station Special Research Initiative

Title

Improving Safety and Quality of Wheat Flour.

By

Rose D., University of Nebraska-Lincoln
Bianchini-Huebner A.
Hallen-Adams H.
Stratton J.

Outputs

The broad objectives of the NC-213 Multistate Project are to: 1) characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems; 2) develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain; and 3) be a multiinstitutional framework for the creation of measurable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security. Our group's contribution to this project was on objective 1. No contributions to objectives 2 and 3 were made during the reporting year. Two projects were completed under this objective.

In the first project, the variation in asparagine concentration was measured in Nebraska wheat. Acrylamide, a toxic compound, can be formed from asparagine during baking of wheat products. Three widely grown wheat cultivars ('Goodstreak', 'Camelot', 'Freeman') and seven experimental lines were grown at five locations in 2014. Due to the large environmental effect on asparagine concentration, the named cultivars were also evaluated at twelve locations in 2016. Asparagine concentration varied widely among samples (200-1100 mg/kg). In 2014, the highest concentration of asparagine was measured in samples grown at a location where delayed harvest resulted in excess solar radiation. In 2016, the highest asparagine concentration was measured in wheat grains grown in a location that experienced high disease pressure. In pairwise comparisons among all 17 locations sampled, asparagine was generally lower in Freeman compared with Goodstreak and Camelot. Asparagine concentration was positively correlated with kernel size and weight ($r=0.37$; $p=0.03$). In conclusion, the major differences in asparagine concentration were due to growing environment, although the cultivar Freeman may be a low asparagine accumulating genotype.

In the second project, steaming of wheat kernels prior to milling was assessed to determine the effects on storage stability of whole wheat flour and on microbial load of wheat flour. Lipase, lipoxygenase, polyphenol oxidase, and peroxidase activities were decreased by up to 81%, 63%, 22%, and 34%, respectively, as the time of steaming increased up to 90 s. Steaming had no effect on starch and gluten properties. Steaming for 90 s reduced the total plate count in wheat by log 7 CFU/g. Upon storage free fatty acids decreased with respect to time of steaming. Time of steaming did not affect lipid oxidation in flour; however, total carbonyls produced in dough made from stored flour were decreased with the increase in steaming duration. Thus, steaming wheat kernels prior to milling reduced lipase activity and consequently hydrolytic rancidity during storage without affecting starch and gluten fractions. This treatment also dramatically reduced the microbial load in flour. Steam treatment did not affect oxidative rancidity in flour during storage, but did reduce oxidation once the flour was made into a dough.

Outcomes/Impacts

This reporting year, our research on wheat microbial safety has resulted in current and potential impacts. Our group met with several milling companies that are testing our saline organic acid tempering and our steam-treatment processes on pilot scales in their facilities. We have previously shown that these treatments are effective in reducing microbial load in wheat flour. We expect that the implementation of these treatments in commercial production of wheat flour will reduce the risk of food borne illness outbreaks caused by consuming raw wheat flour. In our project on free asparagine in wheat flour we found that delayed harvest leads to higher asparagine accumulation in wheat kernels. In future years we will share this information with producers to reduce free asparagine in wheat and thus reduce the potential for acrylamide in wheat-based foods.

Publications

Sabillón L, Bianchini A, Stratton J, Rose DJ. 2017. Effect of saline organic acid solutions applied during wheat tempering on flour functionality. Cereal Chemistry 94:502-507.

Poudel R, Bhatta M, Regassa T, Rose DJ. 2017. Influence of foliar fungicide treatment on lipolytic enzyme activity of whole wheat. Cereal Chemistry 94:633-639

Navrotskyi S, Baenziger PS, Regassa T, Guttieri MJ, Rose DJ. Variation in asparagine concentration in Nebraska wheat. Cereal Chem. https://doi.org/10.1002/cche.10023

Title

Flaxseed and Food Safety.

By

Hall, C., North Dakota State University, Fargo

Outcomes/Impacts

Flaxseed is an oilseed that has documented health benefits. People consume flaxseed for a number of reasons, but improving cardiovascular health is one of the primary reasons. The anti-inflammatory, cholesterol-lowering and glycemic modulating activities are observed benefits of flaxseed consumption. The high levels of omega-3 fatty acid, dietary fiber, anti-carcinogenic lignans and proteins are thought to be the reason for the health benefits of flaxseed. Flaxseed is a low moisture food. Until recently, most low moisture foods were not considered a food safety concern. However, the recent outbreaks related to wheat flour have provided evidence that low moisture foods should be evaluated for safety. Considering that flaxseed is typically consumed raw, no kill step is involved prior to consumption; thereby, producing an elevated risk for foodborne illness. Microbial inactivation of raw commodities is one approach to minimizing potential foodborne illness. However, degradation of quality and of nutritional and health compounds can be negatively affected from any method used to inactivate microorganisms.

Flaxseed treated with vacuum steam pasteurization has been shown to be an effective means to inactivate microorganisms. However, no impact on health-promoting compounds or general shelf stability were previously reported. Vacuum steam pasteurization was completed on both whole flaxseed and milled flaxseed using conditions documented to inactivate microorganisms. The important omega-3 lipid was not affected by processing conditions in either whole or milled flaxseed.

Outputs

The vacuum steam-pasteurization system (SMC, Statisol 50, model no. NA 07) at the pilot plant facility of Napasol North America (Fargo, ND) was used to conduct the pasteurization. Flaxseed samples (whole and milled flaxseed) were subjected to pasteurization conditions of 75, 90 and 105 □C for 3 min, and at 90 □C for 9 min, except for the unpasteurized (non-processed control) samples. The samples were transferred to polypropylene-lined Kraft bags once the samples reached ambient temperature. Samples were removed from these Kraft bags at 0, 1, 2, 4, 6, 8, 12, 16, 20, 24, and 28 weeks for chemical shelf-life evaluation. The chemical (i.e. oil, lignan, moisture, fatty acids) contents and stability (peroxide values, free fatty acids, headspace volatiles) were completed on the flaxseed or oil obtained from the flaxseed.

Samples were removed from these Kraft bags at 0, 1, 2, 4, 6, 8, 12, 16, 20, 24, and 28 weeks for chemical shelf-life evaluation. The chemical (i.e. oil, lignan, moisture, fatty acids) contents and stability (peroxide values, free fatty acids, headspace volatiles) were completed on the flaxseed or oil obtained from the flaxseed.

The water activity and moisture contents in vacuum steam pasteurized flaxseed increased significantly due to processing. However, the water activity and moisture content decreased over the course of the 28-week storage to the point where neither of these values were significant among flaxseed samples, including the non-pasteurized flaxseed. The reduction in aw observed during storage may be explained by a decrease in humidity during storage conditions. The bag used for storage were not heat sealed and thus the moisture barrier was not sufficient to prevent the loss of moisture migration, especially during the winter months (low relative humidity in North Dakota). The oil content was not significantly affected by processing or storage. Changes in α-linolenic acid (omega-3 lipid) contents

did occur over the 28-week storage in milled flaxseed. However, no differences in α-linolenic acids was attributed to the processing condition since the α-linolenic acid contents in unpasteurized and pasteurized milled flaxseed were the same after processing. In whole flaxseed, no change in α-linolenic acid content was observed. Changes in other fatty acids did occur, resulting in a change in the ratio of monounsaturated to polyunsaturated (MUFA:PUFA). Only flaxseed pasteurized at 90 °C for 9 min had an overall mean MUFA:PUFA ratio that was significantly different from the other treatments. This observed difference was true in both whole and milled flaxseed. No clear trend was observed for the effect of processing on lignan content. In whole flaxseed, significant reduction in lignan occurred in flaxseed pasteurized at 90 C for 9 minutes compared to the non-pasteurized flaxseed and the other pasteurized flaxseed samples. In milled flaxseed no significant reduction in lignan content was observed between any of the samples, including unpasteurized milled flaxseed.

The process itself did not promote oxidative and hydrolytic degradation in flaxseed based on the observations that time zero (immediately after processing) pasteurized samples had peroxide values and free fatty acid contents that were not significantly different than the unpasteurized flaxseed. The shelf life stability of the processed flaxseed was supported by minimal changes in flaxseed processed at low temperatures. However, at week 28, peroxide values observed for samples pasteurized at 105 °C for 3 min (8.24 □ 0.68 meq/kg) were significantly ($p < 0.05$) greater than the values observed at the other conditions. Secondary oxidation markers did not change significantly during storage. Based on low peroxide values, the formation of secondary volatiles was minimal and therefore the non-significance like relates to low concentration of the volatiles. The free fatty acid contents of whole unpasteurized flaxseed were similar to values in pasteurized flaxseed, regardless of pasteurization temperatures. The free fatty acid values did increase significantly over the 28-week storage in the unpasteurized milled flaxseed. This suggests that pasteurization inactivated lipase, which is an enzyme known to promote free fatty acid formation in milled grains and seeds.

Only small reductions in omega-3 lipids were observed over a 28-week storage. The anticancer lignans also were not affected by the pasteurization process. The shelf-life was not affected by flaxseed processed at lower temperature; however, high processing temperature shortened shelf-life stability.

Vacuum steam-pasteurization can be used as an alternative method for the effective pasteurization of low moisture foods, such as whole flaxseed and milled flaxseed. The research provides flaxseed processors with an approach to mitigate potential foodborne hazards without negatively impacting flaxseed quality. The value of flaxseed production to flaxseed growers is over $70 million. An outbreak related to flaxseed would devastate the niche flaxseed market.

Title

Selecting Durum Genotypes for Whole-Wheat Pasta Quality.

By

Manthey, F. A., North Dakota State University, Fargo
Elias, E. M.
Deng, L.

Outputs

Available information regarding phenotypic traits that relate to desirable whole-wheat pasta is limited. This research was conducted to determine if genotypes that make excellent traditional semolina pasta would also make excellent whole wheat pasta. Thirty-six genotypes were grown in 19 environments in North Dakota. Traits commonly assessed for selecting genotypes for traditional/semolina pasta were evaluated along with a modified mixogram procedure designed to determine mixogram break-time for whole wheat flour.

Outcomes/Impacts

Genotypes varied in their suitability to make whole-wheat pasta. Genotypes identified as the best for whole-wheat pasta were not the top genotypes for traditional pasta. In fact,12 of the 36 genotypes tested produced good quality traditional pasta but made poor quality whole-wheat pasta. Cooked firmness was the only pasta quality factor that showed a relationship with any of the phenotypic traits evaluated. Grain protein content, mixogram break-time and gluten index did relate to cooked firmness of whole-wheat pasta. These results indicate that other traits need to be identified that can be used to help select genotypes for whole-wheat pasta.

Publications

Deng, L., Elias, E.M., and Manthey, F.A. 2017. Relationship between grain, semolina, and whole wheat flour properties and the physical and cooking qualities of whole wheat spaghetti. Cereal Chem. 94:801-804.

Deng, L., Elias, E.M., and Manthey, F.A. 2017. Influence of durum genotype on whole wheat and traditional spaghetti qualities. Cereal Chem. 94:857-865.

Awarded Grant(s) and Contract(s)

North Dakota Wheat Commission

Title

Baking quality of Hard Red Spring Wheat using various Bread-making Methods and Loaf Sizes based on a Scoring System.

By

Simsek, S., North Dakota State University, Fargo
Baasandorj, T.

Outputs

Bread-making is the ultimate test for Hard Red Spring wheat quality evaluation. Various bread-making methods, loaf size, and processing conditions are used depending on the objective of the bake test. For wheat breeding program, bread loaves are baked based on 25g and 100g flour using the straight-dough method. U.S. hard wheat breeding programs make early generation selections based on dough rheology test such as mixograph and 25g loaf bread-making, while 100g loaves are baked using the straight-dough method in later generation selection. In contrast, sponge and dough method is widely used in the baking industry. There have been relatively few comparison studies on bread-making methods, loaf sizes, and processing conditions. The objective of this research was to determine whether bread-making methods with different fermentation time and loaf size affect the overall ranking of HRS wheat cultivars in terms of baking quality evaluation. The secondary objective was to develop overall baking quality score to objectively rank these HRS cultivars. Therefore, an overall baking scoring system was developed to assess different baking methods for quality evaluation of these HRS cultivars.

Five bushels of six Hard Red Spring wheat cultivar composites (WA Glee, ND Elgin, MN Bolles, ND 817, SY Ingmar, and ND Glenn) were obtained from Pacific Northwest (PNW) export region, and another five bushels of 6 HRS wheat cultivar composites (SD Forefront, ND Elgin, MN Bolles, ND 817, SY Ingmar, and ND Glenn) were also obtained from Gulf/Great Lakes (G/GL) export region as part of the 2014 OVA. Additional five bushels of 6 HRS wheat cultivars of ND Dapps (2014), ND Elgin (2013), ND Faller (2014), SD Focus (2014), ND Glenn (2012), and ND Prosper (2014) from Casselton location were obtained from the North Dakota State Seed Department, thus making a total of 18 HRS wheat cultivars.

The wheat samples underwent kernel quality analysis using standard methods prior to milling. The wheat samples were tempered to 16% moisture for 18 hours before milling. The samples were milled into straight grade flour on a MIAG-Multomat laboratory mills (Miag, Braunschweig, Germany). Flour extraction was determined as the percentage of straight grade flour produces. The flour samples obtained from the mill were baked using the treatments listed in table 1.

Table 1. Bread Baking Procedures and Loaf Sizes Used for 18 HRS Flour Samples Obtained from MIAG Multomat Laboratory Mill

Baking Method	Fermentation Time	Loaf Sizes
Straight Dough	2 hour and 3 hour	25 g, 100 g, and 1 lb loaf
Sponge and Dough	4 hour	100g and 1 lb loaf

Bread was baked using AACC-I approved methods 10-09.01 and 10-11.01 for straight dough and sponge and dough, respectively. Bread was baked in “Shogren-type” pans. The bread was then evaluated on a scale of 1-10, with ten being the best and one being the worst, for crust color, crumb color, crumb grain and symmetry. AACC-I approved method 10-05.01 was used to determine loaf volume. The texture analysis of bread loaves was done one day after

baking. Breads were sliced crosswise using an electric bread slicer. A texture analyzer (Texture Technologies Corp., Scarsdale, NY) was used to determine the bread firmness according to AACC-I Approved Method 74-09.01.

The overall bread baking quality score for ranking these 18 HRS cultivars was assigned separately for 3 different loaf sizes: 25g, 100g, and 1 lb. The overall bread baking quality score further consisted of various baking quality tests in which weights were given to calculate individual quality score. Within each quality test, scores between 1 and 10 were assigned for a certain quality test to calculate the overall score, with ten being the best and one being the worst.

The experimental design Statistical analysis was performed using SAS (Version 9.3, SAS Institute; Cary, NC). An analysis of variance (ANOVA) was performed and least significant difference (LSD) with a 5% significance level was used to declare differences between treatments. The experimental design was two-factorial layout with bread-making methods and wheat cultivars as main factors. Bread-making methods and wheat cultivars interaction term was used as error term.

Outcomes/Impacts

Bread-making characteristics were shown to differ among all baking methods and fermentation times. Baking method had significant ($P<0.001$) effect on the oven spring. Sponge dough method had significantly ($P<0.05$) lower oven spring compared with straight dough method, and this was consistent across both 100g and pound loaves. The ANOVA showed that both wheat sample and baking method had significant ($P<0.001$) effect on the bread loaf volume; however, variation was due to the baking method. When comparing baking methods, although there was no significant ($P>0.05$) difference, the straight dough method produced smaller loaf compared to sponge and dough method for 100g loaf size. In contrast, sponge dough method produced significantly ($P<0.05$) higher bread loaves compared to the straight dough method for pound loaf size. These results indicated that the difference between the baking methods was more apparent for larger loaves than the smaller loaves such as 100g pup loaf. The ANOVA indicated that the baking method did not have significant ($P>0.05$) effect on crumb grain score, while wheat sample showing significant ($P<0.001$) effect on the crumb grain score. There was no significant ($P>0.05$) difference in the crumb grain score between straight dough and sponge and dough method. It was found that baking method had significant ($P<0.001$) effect on the crumb firmness. Sponge dough method resulted in more firm bread compared to the sponge and dough method. More firm bread was obtained for sponge and dough method and this was consistent for both 100g and pound loaves. Fine structure cell structure in sponge and dough method could indicate that bread was denser resulting in firmer crumb structure.

Bartlett's Chi-square test was used to test the homogeneity of the variance. Bartlett's test showed significant differences for baking parameters for different baking methods and processing conditions. Bartlett's test showed significant ($P<0.0001$) difference for the baking mix time. The CV is a relative measure of the variability that's present in the data set. It was observed that sponge and dough method had lower coefficient of variation (CV) for both 100g and 1pound loaves. The low CV values indicate that there was less variability in the mixing for sponge and dough method compared to the straight dough.

Various bread-making methods and processing conditions were evaluated based on the overall baking quality scoring system. The ANOVA indicated that both wheat sample and baking method had significant ($P<0.0001$) effects on the specific volume scores and bread loaf volume scores. However, much of the variation was due to bread-making method. Sponge and dough method received significantly ($P<0.05$) low specific volume scores and bread loaf volume scores for 100g loaf. In contrast, sponge and dough method had higher specific volume scores and bread loaf volume scores for pound loaf. Straight dough method would be suited for 100g loaf size, while sponge and dough is preferred method for 1 pound loaf size when evaluating bread-making quality of HRS wheat samples. In terms of final baking quality scores, straight dough method with 2 hour fermentation had the highest

overall baking quality score, which indicates that this processing condition is suited when baking 100g loaf breads. However, when baking breads at 1 pound loaves, it was observed that sponge and dough method received higher score over straight dough method with 2 different fermentation times. Although there were differences between baking methods and fermentation time

The overall baking quality scoring system was developed in order to assist in comparing and ranking HRS wheat objectively. In the baking quality evaluation of HRS wheat cultivars, the overall baking quality scores were developed to determine whether the ranking was affected by baking methods. When averaged across various baking methods and conditions, C-ND Elgin, C-SD Focus, C-ND Prosper, G-Forefront, and G-ND 817 cultivars were considered to have "fair" bread-making quality characteristics, while receiving overall quality scores less than 6. In contrast, cultivars PND 817, P-MN Bolles, G-MN Bolles, P-ND Glenn, and G-ND Glenn received overall baking quality scores of 6.5 or above hence these cultivars were considered to have "excellent" baking quality characteristics under different baking conditions. The results in the current research study indicate that although there are differences in the bread-making methods on the end-use quality evaluation, the ranking of HRS wheat flours is not affected by the baking methods and conditions. In other words, cultivars considered to have "fair" quality tend to have low bread-making quality, while "excellent" baking cultivars will have superior end-use quality regardless of the baking method and processing conditions.

Publications

Baasandorj, T. (2016). Hard red spring wheat quality evaluation with various roller mill types and breadmaking methods. PhD Dissertaion. North Dakota State University. Retrieved from https://ezproxy.lib.ndsu.nodak.edu/login?url=https://search.proquest.com/docview/1858816358?accountid=6766

Funding Source(s) and Amount(s)

North Dakota Wheat Commission. $30,000

Title

Adding Value to Cereal Grains Utilization.

By

Rayas-Duarte, Patricia, Oklahoma State University

Outputs

This project addresses the need to better understand the structures formed by biopolymers of wheat gluten proteins and their relation to how they perform in particular dough processing and yeast raised products. There is a gap in the knowledge of what specific components of the biopolymers formed structures that have a balance of viscoelastic properties described in terms of strength and extensibility in the field of cereal chemistry. We propose to analyze wheat kernels, dough and gluten samples with fundamental rheological tests to evaluate strength and extensibility and relate the structures formed to presently used quality indicators obtained with empirical methods. If the work is successful, i) an improvement of our understanding of the role of the different gluten proteins will be achieved and ii) this knowledge will be used to make suggestions for future selection of wheat cultivars with the desirable gluten protein expression designed to fulfill a combination of proteins for an end product performance (product specific) in mind.

This project also addresses the opportunity to improve the content of bioactive compounds naturally produced by cereal grains and the study of microorganisms in spontaneous fermentation of cereals that improve the nutritional quality of cereal grain based products. In the latter topic, we are specifically interested in studying the microbial ecology of spontaneous fermentation of cereals and screen for microbes with specific desirable enzyme activities that will improve the nutritional value of cereals. A success in these two areas (bioactive compounds and desirable enzymatic activity from microbial ecology of cereals) will provide added value to cereals by identifying opportunities to increase their value in the form of desirable bioactive compounds expressed in sufficient quantities to justify their extraction and yield and/or the consumption of the cereals more appealing. Success will also mean the identification of microbes with the enzymatic activity to reduce anti-nutritional factors from wheat and other cereal products.

Outcomes/Impacts

The long term objectives of this study are to understand the structures formed by different biopolymers of kernels, dough and gluten, their response to different deformation loads and the relationship to their protein composition, spatial conformation and the type of physical arrangement conducive to strength and extensibility of wheat kernels, gluten and dough. This study also aims to analyze selected bioactive components in blue, purple and red wheats and microbial enzymes from spontaneous fermentation of cereal grains, specifically of hard winter wheat genotypes, that will result increase nutritional value and interest in consuming whole grain products and/or extracts of these components.

Effects of high-molecular-weight glutenin subunits on viscoelasticity of wet gluten, and its relationships with mixing, extensibility, and breadmaking parameters, were investigated by creep recovery using the Kelvin-Voigt model on 19 hard red winter wheat flours. Gluten samples with Glu-A1 1 and 2* showed significant differences in retardation time (λ_2), whereas subunit 17+18 in Glu-B1 showed higher elastic moduli (G_0, G_1, and G_2) and viscosity coefficients (η_0, η_1, and η_2) compared with subunits 7+8 and 7+9. Wheats with Glu-D1 5+10 had higher values of G_0, G_1, G_2, η_0, η_1, and η_2 compared with Glu-D1 2+12. Gluten samples were on average 5.5, 3.1, and

1.6 times less stiff than dough when comparing G_0, G_1, and G_2, respectively; these differences suggest that the nongluten components have high influence in the instantaneous and first Kelvin-Voigt elements of the model, and they are manifested more quickly compared with gluten components. Higher explanation of variance of loaf volume was found in parameters η_2 and G_2 ($r = 0.57$ and 0.58, respectively, $P < 0.0001$) compared with η_1 and G_1 ($r = 0.45$ and 0.56, $P < 0.01$ and 0.0001, respectively). These findings indicate that large structures formed primarily by crosslinking and agglomeration of glutenins of long chain sizes (second Kelvin-Voigt element) had major effects on quality compared with short chain sizes (first element).

One post-doctoral associate and two graduate students completed their training in wheat and gluten properties using rheological evaluations.

Research articles have been published and results were also presented in conferences and annual reports written to be understand by the general public.

Initiate studies on the effects of sodium and potassium salts in the rheological properties of dough and gluten. Study the rheological nongluten systems used in cakes and other baked products.

Study physical and chemical properties of other cereal system starting with corn masa products.

Publications

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Title

Mycotoxin Risk Management and Outreach Programs in (the) Office of the Texas State Chemist

By

Herrman, T.J., Texas A&M AgriLife Research
Lee, K.M.
Li, W.

Outputs

The Aflatoxin Proficiency Testing and Control in Africa (APTECA) program sponsored by the Office of the Texas State Chemist hosted 4 high level breakfast meetings comprised of senior level Kenya government agency personnel from three ministries and representatives from several industry association. The high level breakfast meeting also included several members of the Kenya Parliament Agriculture Committee. As an outgrowth of these breakfast meetings, two members of Parliament visited Texas to learn about the co-regulation model used by the Office of the Texas State Chemist (OTSC) of Texas A&M AgriLife Research. A second outgrowth of the breakfast meetings was a one-week workshop in June 2017 at the Maanzoni Lodge in Machakos County Kenya to develop a regulatory roadmap highlighting overlapping authority among government agencies as well as regulatory gaps involving aflatoxin risk management. This exercise led to participants crafting a draft bill for aflatoxin risk management and outlining a national aflatoxin strategic plan.

APTECA analyzed 278 verification samples from 8 Kenya mills. There was a significant relationship ($P<0.01$) between commercial maize millers labs and the Texas A&M AgriLife Research ISO 17025 accredited laboratory located on the University of Nairobi Chiromo campus. APTECA hosted a global aflatoxin proficiency testing program comprised of 137 labs from 45 countries in 2017 in collaboration with the Food and Agriculture Organization (FAO). APTECA participated with the Kenya Agricultural Livestock Research Organization (KALRO) and Kenya Bureau of Standards (KEBS) in hosting aflatoxin testing and qualification workshop in conjunction with their Cereal and Pulses Grading Course. A total of 66 individuals attended and 17 qualified on the Vicam aflatest and 49 qualified using the Neogen Q+. APTECA expanded its outreach to Southern Africa by hosting two stakeholder meetings in Lilongwe and Blantyre, Malawi and one stakeholder meeting in Zimbabwe. As an outgrowth of the Malawi stakeholder meeting, two aflatoxin testing workshops were conducted, resulting in 41 analysts qualified to use different test kit platforms to measure aflatoxin content. Twenty establishments are pursuing the implementation of the APTECA quality systems protocol including development of a food safety plan, purchase and use of test kits to measure aflatoxin, and verification of aflatoxin testing results at the Lilongwe University of Agriculture and Natural Resources (LUNAR).

Outreach programs. The OTSC outreach program includes a distance learning educational programs and publishes the Journal of Regulatory Science. OTSC offers educational programs that focus on regulatory science, laboratory quality systems and Hazard Analysis and Critical Control Points (HACCP).

Outcomes/Impacts

In 2017, the OTSC outreach program includes regulatory, industry and laboratory personnel in 45 countries and helps facilitate management of food safety risk on a global level. Among the outcomes of the project include improved food safety for approximately 10 million Kenyans, development of a national strategic plan and draft bill to manage aflatoxin risk in Kenya, adoption of aflatoxin testing platforms in Malawi, and 104 new qualified analysts

to measure aflatoxin in Kenya and Malawi. A risk assessment was performed for Kenya to support a policy decision to raise the aflatoxin regulatory maximum level for classes of animal feed.

Publications

Tim Herrman and Harinder Makkar. 2016. Aflatoxin proficiency testing in labs. Feedipedia, Broadening Horizons. December #36

Funding Source(s)

Office of the Texas State Chemist
Food and Agriculture Organization

Title

Quantification of Beta-glucans, Lipid and Protein contents in Whole Oat Groats.

By

Armstrong, Paul R., CGAHR, USDA-ARS, Manhattan KS

Outputs

Single seed near-infrared spectroscopy was studied as a method to measure beta-glucan, protein and oil in oat seeds. A total of 1728 single intact groats of six different oat varieties were scanned by near infrared spectroscopy to develop non-destructive predictions of (1,3;1,4)-b-D-glucan (b-glucan), protein and oil content in groats. Prediction models for single kernels were developed using partial least squares regression. Regression parameters for cross validation models yielded correlation coefficients for b-glucan, protein and oil of 0.83, 0.72 and 0.92 respectively; root-mean-square error ranged from 0.25% to 0.60% for all compounds. Independent validation data yielded correlation coefficients ranging from 0.69 to 0.95; root-mean-square error of prediction values values were equal to or less than 0.52%, 0.62% and 0.27% for b-glucan, protein and oil, respectively.

Outcomes/Impacts

Whole oat has been described as an important healthy food for humans due to its beneficial nutritional components. The positive health benefits of consuming oats as a whole-grain food are attributed in part to b-glucan, which has outstanding functional and nutritional properties. Near infrared reflectance spectroscopy is a powerful, fast, accurate and non-destructive analytical tool that can be substituted for some traditional chemical analysis. The data indicated that non-destructive screening of b-glucan, protein and oil contents in single kernels of dehulled oat grains from their near infrared spectra could be successfully used in breeding programs.

Publications

Quantification of betaglucans, lipid and protein contents in whole oat groats (A.sativa. L) using Near Infrared Reflectance Spectroscopy 2017. Gracia Montilla-Bascon, Paul R Armstrong, Rongkui Han and Mark Sorrells. J. of Near Infrared Spectroscopy. 25(3) 172–179

NC-213 (The U.S. Quality Grains Research Consortium)

Objective 2

To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.

Title

Management of In-Bin Drying and Storage Systems for Grains to maintain Quality and Prevent of Mycotoxin Contamination.

By

Atungulu, G.G., University of Arkansas, Division of Agriculture

Outputs

-Securing grain (rice, corn and soybean) quality and safety during by drying, chilling aeration and storage;
-Mathematical modeling - simulations- and field- based studies to help optimize performance of grain drying, aeration and storage systems;
-Developing alternative/new techniques to improve grain drying efficiency, product quality and mycotoxin and insect pest control.

Outcome/Impacts

In collaboration with Arkansas grain producers and processors, our research continues to produce science-based knowledge to inform improved regional and national food security, chiefly in the rice, soybean and corn industries, on issues of determining best drying and storage practices that maintain quality and mitigate contamination with toxigenic fungi and their associated mycotoxins, many of which are carcinogenic to humans.

Study continues to document kinetics of grain quality deterioration and mycotoxin formation; lab- simulations, field experiments and computer modeling approaches are employed to provide refined constraints and define guidelines for optimal drying, aeration and storage strategies.

Developed novel one-pass drying and pest control strategies for rice: case studies of one-pass drying of rough rice with a 915 MHz industrial microwave and infrared heating techniques.

Optimizing selectivity of infrared wavelengths to inactivate mycotoxigenic fungi on corn.

Publications

Atungulu G. G. & Olatunde G. A., Sammy Sadaka. 2017. Impact of Rewetting and Drying of Rough Rice on Prediction of Moisture Content Profiles during On-Farm In-Bin Drying and Storage. Drying Technology. Published online: http://dx.doi.org/10.1080/07373937.2017.1345933.

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Title

Risk Assessment for the Food Safety Concerns of Mycotoxins in the Pacific Northwest under Climate Variability.

By

Ryu, D, University of Idaho

Outputs

For the objective 1, optimization and verification of methods for detecting and quantifying fungal population in soil, seasonal sampling has been performed twice using soil dilutions onto peptone-pentachloronitrobenzene agar (PPA). Colonies displaying unrestricted growth, indicative of Fusarium species, were easily recognized and transferred to homemade potato dextrose agar (PDA). The use of 24-well plates facilitated a highly efficient screening process of hundreds of isolates simultaneously to identify colonies capable of producing red-pigment. Red-pigmented colonies, which represent potential trichothecene producers, were transferred onto carnation leaf agar (CLA) and identified to species level using microscopic features such as macroconidia shape and phialide structure. F. culmorum, a potential deoxynivalenol (DON) producer and causal agent in Fusarium head blight (FHB), was shown to be cosmopolitan enough in soil samples to estimate soil population levels. F. graminearum, and F. pseudograminearum, other causal agents of FHB, were rarely detected and soil population levels for these plant pathogens were not determined. Further research will focus on F. culmorum as a model organism to assess the effect of climate on inoculum levels of plant pathogens capable of inducing FHB.

Considering the intrinsic variability of both the high degree of spatial aggregation of F. culmorum soil populations and soil dilution plating methods, enumerating soil populations of F. culmorum could still be reliably preformed. Using a square-root transform reduced variance caused by high soil populations in sampling quadrats these values for each field could be used to correlate soil population levels to local climatic variables within one year prior to sampling. Soil populations of F. culmorum were found to be significantly positively correlated to total monthly rainfall during the period of maximum precipitation from October through April. In addition, soil populations of F. culmorum were significantly negatively correlated with mean maximum monthly temperature. These results demonstrate the utility of methods used to detect and quantify fungal populations in soil and relate them to local climate factors.

The objective 2, development and validation of analytical method to detect mycotoxins using HPLC and LC-MS is in progress. Methods to assess the toxigenic potential of collected isolates is being developed and validated. Determination of mycotoxin concentration in both grains and extracts from fungal cultures is currently being assessed using an HPLC method with UV detection. The current limit of detection (LOD) and limit of quantification (LOQ) for DON using this method are currently 50 and 100 ng/mL in standard solutions injected directly into an Agilent 1260 infinity HPLC system. LOD and LOQ in sampled grains are currently being determined, as modifications to the extraction protocol can change those values for sampled grains. Approximately 400 F. culmorum isolates have already been transferred to yeast extract sucrose agar (YES) to determine toxigenic potential. A method using agar plug extracts to quantify the amount of DON produced has been developed. Some F. culmorum isolates are also likely to be nivalenol (NIV) producers, so the incorporation of NIV standards and the development of a multi-mycotoxin method using the same HPLC-UV parameters are in progress.

For the objective 3, determination of the mycotoxin concentrations and the presence of toxigenic fungi in soil and foods, the same collaborating wheat growers from which soil samples are collected have also agreed to the sampling of grains from their fields. Sampling of wheat heads and collection of grains will be performed during sampling in March and June 2017. Seasonal soil sampling has already been performed during June and September 2016, and

sampling is scheduled to take place in December 2016. Grain samples will be analyzed for fungal populations and mycotoxin concentration upon harvest, using plating methods for relevant fungi and HPLC-UV for mycotoxin concentrations. Given the high amount of Epicoccum nigrum detected when plating kernels from a field in Pullman, Washington prior to harvesting in August 2016, alternative options to determine the presence of toxigenic fungi using molecular techniques are being evaluated.

Outcomes/Impacts

The Pacific Northwest provides a sampling region with differing climate regimes relatively close together. By sampling from different agroecological classes simultaneously we can observe how populations of F. culmorum fluctuate and relate those changes to local climatic conditions. In the interest of climate change, understanding how an inoculum level of a plant pathogen changes due to climate conditions can hopefully prove useful in predicting how levels may change in the future. In addition, it is forecasted that areas which are currently under the annual cropping agroecological class may change to the transitional class in the future. Observing both simultaneously can give insight into how population levels might behave in the future under climate change. It is forecasted that climate change in the Pacific Northwest will manifest as warmer springs, summers, and winters along with wetter springs and drier summers. Understanding how population levels change over the seasons can help address whether climate change will bring Fusarium head blight into the Pacific Northwest. The survey has also collected approximately 400 F. culmorum isolates which will be utilized in future phylogenetic studies.

Title

Efficient Operating and Management Systems Addressing Food Safety, Feed and Grain Traceability and Grain Dust.

Objective 2: To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user-supply chain.

By

Mosher, G. A., Iowa State University
Maier, D.E.
Hurburgh, C.R.

Outputs

A spreadsheet model drawn from near infrared spectroscopy (NIRS) data was able to predict ethanol yields to within 0.02 galls per bushel, as validated by actual ethanol plant operations.

Grain dust explosions are a hazard to grain industry workers and the mitigation of these events requires attention to both quality and safety aspects. Training was conducted for workers in Indiana, Michigan, and Iowa on the prevention of grain dust explosions. The training emphasized engineering controls, properties of grain dust, and other worker-based mitigation strategies.

A workers' compensation claims database from a major agribusiness provider was used to characterize occupational injuries in the biofuels and grain handling industries. Workers' compensation provides valuable operational insight into the safety performance of biofuel and grain handling facilities, as many facilities are too small to be subjected to OSHA inspection.

A standards-based traceability protocol for the feed and grain supply chain was developed, identifying major traceability events and key data elements. Research needs to support a standards-based traceable feed and grain supply chain were identified.

Outcomes/Impacts

An Ames, Iowa based company has begun the development of supporting services and training for ethanol plant operators using models and data collected by the ISU Grain Quality Laboratory.

Approximately 200 grain elevator employees were trained on prevention of grain dust explosions. These grain workers and processors now have information on daily tasks, engineering controls, and preventive operations needed to keep grain dust explosions from occurring.

Information from workers’ compensation claims data provides a clearer picture of needed improvements in grain management and safety management in terms of worker safety, process safety and other continuous improvement efforts.

A review of the state-of-the-art in bulk materials traceability was completed.

Publications

Ramaswamy, S.K. and G.A. Mosher. 2017. Using workers' compensation claims data to characterize occupational injuries in the commercial grain elevator industry. Journal of Agricultural Safety and Health, 23(3), 203-217.

Sharma, R. and C.R. Hurburgh. 2017. Bulk product traceability – challenges and opportunities. Book chapter.

Funding Source(s)

Department of Labor, Occupational Safety and Health Administration
National Institute for Standards and Technology (NIST)
Extension 21 Grants

Grants and Contracts

Department of Labor, Occupational Safety and Health Administration
Extension 21 Grants
Industry contracts and service agreements

Title

Evaluation of Drying on the Volume Change of Corn.

By

Turner, A.P., University of Kentucky – Department of Biosystems and Agricultural Engineering
Montross, M.D.
McNeill, S.G.

Casada, M.E., USDA-ARS-CGAHR, Manhattan, KS

Petingco, M., Kansas State University -Department of Biological and Agricultural Engineering

Maghirang, R.G.

Thompson, S.A., University of Georgia - Department of Biological and Agricultural Engineering

Outputs

Moisture changes induced by in-bin drying and aeration are frequent occurrences during grain storage that could result in deviations from “typical” pack factors. The equations for compressibility that are used in conjunction with Janssen’s equation to predict packing do account for moisture content, but do not account for changes in moisture. Volume change related to moisture content changes from drying or aeration could directly impact inventory estimation.

Corn samples were mechanically harvested in the field and dried in a PVC cylinder with a 6” diameter to measure volume change during drying. The samples were placed in a controlled environment at 15.5C and 70% relative humidity for 72 hours. The airflow rate was high (approximately 110 cfm/bu) to insure the samples were dried before spoilage. Samples were initially level with the top of the 6” tall cylinder, and after drying the change in height was measured with digital calipers at multiple points across the surface. The initial and final moisture content was determined using the oven method.

The change in volume was linearly related to the moisture removal. Drying high moisture corn with an average moisture content of 33.9% to a final moisture content of 16.1% resulted in a volume change of 22.2%. The test weight of the sample increased from 52.7 to 55.6 lb/bu during drying. Corn at a typical harvest moisture content of 26.4% and an initial test weight of 54.3 lb/bu had a volume change of 17.4% and a final test weight of 59.1 lb/bu when dried. The change in volume due to vibration/aeration with no moisture change was found to be less than 2%.

Outcomes/Impacts

Existing packing models do not account for changes in moisture content due to moisture changes due to airflow. Moisture changes during aeration could have a significant impact on volume measurements that are directly related to inventory measurements.

Title

Evaluation of Pre-harvest and Harvest Losses during Corn Harvest.

By

Turner, A.P., University of Kentucky – Department of Biosystems and Agricultural Engineering
Montross, M.D.
McNeill, S.G.
Sama, M.P.
Dvorak, J.S.

Mark, T.B., University of Kentucky, Department of Agricultural Economics
Martin, B.

Outputs

Harvest losses need to be properly managed to reduce waste and maximize profits, and producers must balance potentially increasing losses with energy savings from allowing grain to field dry. Harvest losses are a combination of pre-harvest loss and machine loss. Pre-harvest losses occur due to dropped ears, pests feeding on the grain, or other 'invisible' losses. Machine losses occur at all stages of combing. Gathering losses are a combination of ears the corn head fails to pick up and kernels that are butt shelled. Threshing or cylinder losses occur when grain is not fully separated from the cob. Separation losses occur when the grain is not fully separated and is carried out the back of the combine with the MOG.

To measure machine losses, a normally operating combine was quickly stopped and allowed to clean out before backing up 5-10 m. Header kernel loss was evaluated by collecting kernels on the ground in front of the combine where the corn had been harvested but the combine had yet to pass. The process was repeated in an area behind the combine to evaluate total kernel loss. Partially shelled cobs were kept separate and counted as cylinder losses. The area for both of these measurements was 2.5 m2, across the full width of the corn head. Total ear loss was measured by collecting whole and partial ears in an area 30 m2 behind the combine. Pre-harvest losses were evaluated by collecting downed ears in a 30 m2 area directly in front of where the combine stopped for machine loss measurement. Yield was estimated in the same area by counting ears in a 10 m section of 3 rows. Every 10th ear was hand shelled, dried, and weighed to determine the average yield per ear. Additionally, yield was estimated from the mass of grain harvested by the combine and the row length. All collected material was oven dried before weighing, and calculations were adjusted back to a moisture of 15%.

Yield and harvest losses were measured for corn in a single field four times over the course of the 2017 harvest season. Measurements were taken to cover a wide range of grain moisture contents representing high moisture corn, the upper limit for drying, normal drying, and corn field dried to 15%. Measured yield and losses displayed little variation for moisture levels from 33.9% to 19.8%, with total losses less than 1.5%. Large amounts of wind damage occurred while allowing the grain to field dry to 15%. This resulted in a 19% reduction of observed yield, and harvest losses in excess of 12%. Losses were also measured for four additional combines across the state, and total losses were found to be between 1%-3% of total yield.

Outcomes/Impacts

Determining typical loss values gives producers a reference to evaluate their own losses. Changes in yield loss with time could be incorporated into models to determine harvest timing.

Title

Understanding, Preserving, and Capturing Economic Value within Changing Grain Marketing Landscapes

By

Anton Bekkerman and David Weaver, Montana State University

Outputs

Numerous research projects have been developed and either published, under review, or in progress that directly relate to the project's objectives. The publication, "Fallow replacement and alternative nitrogen management for reducing nitrate leaching in a semiarid region" considered the extent to which alternative fertilization management practices could maintain (or improve) existing wheat quality and yield, while simultaneously reducing the probability of nitrate leaching into ground water. The research used a combination of on-site experiments and market data to assess challenges and opportunities for altering production methods to increase economic and ecological sustainability in semi-arid regions, including Montana, North Dakota, Wyoming, and parts of South Dakota.

The report, "Influence of Shuttle-Loaders on Grain Markets in Kansas and Montana" represents a multi-institutional effort to use a lengthy data set about wheat market prices to determine the degree to which technological changes in the wheat supply chain impact the value that wheat producers realize due to those improvements. While the economic advantages for agribusinesses and cooperatives to invest in shuttle-loading facilities can be directly observed, the downstream implications for farmers have not been clearly identified. That is, the work asks, "Are cost savings passed by grain elevators passed along to farmers in the form of stronger basis bids?" and "Are there other benefits to farmers from these sizable investments?"

There were several presentations made to commodity clientele regarding identification of pre- and post-harvest pest species, losses these cause and best practices for safe storage and prevention of economic losses. These include training workshops for crop consultants and educational modules presented for State of Montana Commercial and Private applicator Certification Credits. Several publications focused on the genetics or expression of host plant resistance to insect pests of cereal grains.

Lastly, the numerous blog posts and recorded podcasts directly address applied, measurable issues related to wheat markets in a timely and relevant fashion. Many topics discussed issues about market valuation of wheat quality in the northern Great Plains, and the impacts of weather (drought) and associated pest influences on market availability and economic outcomes of decreased quality.

Outcomes/Impacts

The work that considered the differential impacts of fertilizer have timely and relevant implications for dryland grain producers. The insights from this research directly lead to measurable impacts for producers who wish to continue producing high-quality grains but increase the long-term viability and value of their operations through improved soil health. Producers can look to their specific situation and use the paper's findings to understand how to maximize production, quality, economic returns, and environmental sustainability in response to their choice of fertilization and cropping systems.

The research on grain handling technology and competition also provides important knowledge to both producers and agribusiness managers. One important example of how this work's findings can be used to assess management

decisions is an improved understanding about the interrelationship between investment and geographic market power. Second, the Kansas-to-Montana pass-through comparison can aid in selecting a more competitive site for a new or upgraded facility. Geographic competition between elevators and the proximity of farmers to a delivery location can significantly affect the proportion of cost-savings that a shuttle-loading facility may need to pass through. As such, these factors could be critical in improving the return on technological investment.

In 2017, the www.AgEconMT.com project and website, on which blog posts and podcasts are posted, received over 11,500 visitors. Many of these visitors are consumed information related to wheat quality and marketing issues. The project has also had a significant impact in social media, with over 124,500 individuals having seen blog posts and podcasts distributed via the Twitter platform, and 1,174 interactions with those tweets (including clicking on the link to read the article, replying and beginning a conversation about a blog post or podcast, and retweeting the topic).

Publications

Bekkerman, A. "Data-Driven Innovation: An Integrated Public-Private R&D Framework for the 21st Century." In proceedings, Grain Elevators and Processors Society Exchange, March 2017.

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Presentations (for State of Montana Certification credits)

Weaver, D. K. 2017. Identifying and managing insect pests of stored grain. Crop Pest Management School, Montana State University Extension, Bozeman, Montana. 63 attendees. January 5.

Weaver, D. K. 2017. Parasitic wasp – what's the attraction. Cenex Harvest States and Northwestern Ag Research Center Crop Production Update, Kalispell, Montana. 55 attendees. January 11.

Weaver, D. K. 2017. Safe practices in grain storage. Montana Ag Business Association / Montana Grain Elevator Association Annual Convention, Great Falls, Montana. 41 attendees. January 26.

Weaver, D. K. 2017. Wheat stem sawfly management. Lunchtime speaker remarks at Arthur H. Post Farm Field Day, Bozeman, Montana. 106 Attendees. July 17.

Title

Marketing and Delivery of Quality Grains and BioProcess Coproducts.

By

Brian Adam, Oklahoma State University, Department of Agricultural Economics

Outputs

Consumers are increasingly demanding high-quality, safe wholesome foods. At the same time, environmental and safety restrictions have reduced the availability of certain chemicals to control insects. As biological and chemical scientists and entomologists are developing alternative methods of insect control, there is a need for economic analysis and optimization to identify the most cost-effective of these alternatives so that increases in food costs can be minimized.

Also, the increasing complexity of our food system, with increasing demands by consumers for fresh foods with less processing yet increased safety, has increased the need for traceability systems in food supply chains. Development and implementation of such systems has the potential to increase food safety while also increasing efficiency and reducing costs of providing food. A multidisciplinary approach, including application of economic principles, is necessary to accomplish these goals. Both of these initiatives have the potential to increase wholesomeness and safety of our food supply, while maintaining its affordability.

Accomplishments:

To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.

To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.

To be a multi-institutional framework for the creation of measureable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security.

What was accomplished under these goals:

Insect Control in Food Processing and Storage Facilities. We continued to evaluate insect control approaches that could be used as alternatives or partial replacements for chemical treatments (IPM approaches), in addition to approaches that could make conventional approaches more efficient. This included measuring both the treatment costs as well as the costs of failing to control insects for each approach.

Food processing facilities face a high cost if they fail to control insects, but a relatively low probability of incurring those costs.

Outcomes/Impacts

In their operating context, a real options approach can provide a method for appropriately measuring the risks of insect infestation under alternative treatment approaches. We are attempting to apply this methodology to the decisions made by food processing facilities in order to improve timing of insect control measures to potentially reduce chemical use and cost and/or to improve effectiveness.

Traceability in the Food Supply Chain. We have continued to adapt the Proprietary Centralized Data Whole-Chain Traceability System (PCD-WCTS) developed as part of an earlier NIFA-funded project to other food products. We have begun collaborating with Ravi Jadeja (Animal Science, OSU), on food safety and traceability training for industry practitioners.
We have analyzed costs and benefits of implementing a whole-chain traceability system in the beef industry, including value- added opportunities through information sharing through the PCD-WCTS.

What opportunities for training and professional development has the project provided?
Four Ph.D. students are continuing dissertations under this project.

How have the results been disseminated to communities of interest?
Presentations were made at professional conferences and at training workshops for industry practitioners.

What do you plan to do during the next reporting period to accomplish the goals?
Entomologists on the project are collecting data that will enable us to more precisely estimate costs of each treatment option. They are also modifying insect growth models (and insects' responsiveness to treatment methods). Together those will allow our models to give more precise estimates of insect control costs from alternative treatment methods, and thus to give better recommendations. Thus, during this next reporting period we will continue to update our models with new data so that we can estimate costs more accurately and give more accurate recommendations. We are continuing to adapt the concept of real options to measure the economic and risk tradeoffs in insect control decisions in a food processing environment.

For the traceability project, we have completed a major funded project, and we have been awarded another funded project to adapt the developed technology for use with other food products as well as to interface with other traceability systems and marketing systems to make the technology more versatile and more widely used. This will enhance the food safety and value- added capabilities of the system.

Target Audience
Food processing and grain storage companies and managers, and other scientists conducting research on insect control in stored products and processing facilities. Food supply chain participants, government regulators, and others who want to increase efficiency of the food supply chain and the quality and safety of food.

Publications

Su, Lianfan, Brian D. Adam, Jayson Lusk, and Frank Arthur. 2017. “Anchoring, Information, and Fragility of Choice Experiments: An Application to Consumer Willingness to Pay for Rice with Improved Storage Management.” J. Agricultural & Resource Economics. 42(2):255–274.

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Ge, Candi, and Brian D. Adam. 2017. “Value-added Traceability: Using a Whole-Chain Traceability System to Transfer Information about Multiple Attributes along a Multi-Stage Beef Supply Chain.” Selected Paper presented by Candi Ge at the Agricultural and Applied Economics Association annual meetings, Chicago, IL, July 31-August 2.

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Adam, Brian D., Suling Duan, Li Niu, Frank Arthur, James Campbell, Tanja McKay, and Laura Starkus. 2017. “Economics of Insect Control in Rice Storage and Processing.” Presentations of Results of Grant-Funded Project for Rice Millers and Growers at Workshop in Rayne, LA and Jonesboro, AR. March 8-10.

Title

Determining Time, Aeration, and Loading Cycle Effects on Grain Packing.

By

Casada M.E. - USDA-ARS-CGAHR, Manhattan, KS

Thompson, S.A. - University of Georgia, Department of Biological and Agricultural Engineering

Bhadra, R. - Kansas Department of Health and Environment

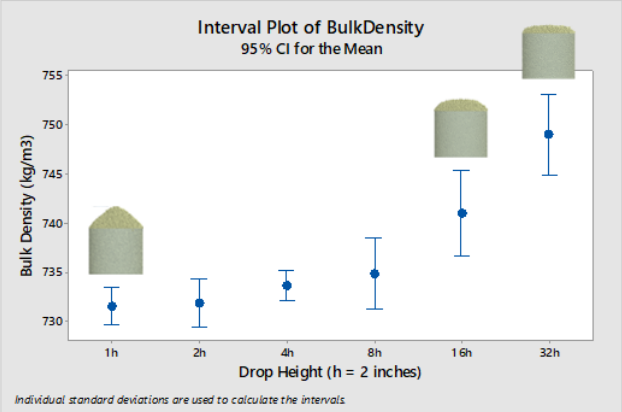
Maghirang, R.G. - Kansas State University, Department of Biological and Agricultural Engineering
Petingco, M.

McNeill, S.G. - University of Kentucky, Department of Biosystems and Agricultural Engineering
Montross, M.D.
Turner, A. P.

Outputs

The influence of kernel shape and size distribution on the compressibility and packing density of hard red winter wheat (HRW) were studied using a laboratory setup similar to that used in powder testing. Two dockage- and shrunken and broken- free hard red winter wheat samples were sieved using US Tyler sieves #6, #7, #8 and #10 and kernels retained in the sieves were used in the experiments. The HRW wheat sample had mean bulk density and average moisture content of 792.8 kg/m3 (61.5 lb/bu) and 11.8% wet basis, respectively. The kernel dimensional parameters (length, width, thickness) and bulk sample parameters (aerated bulk density, tapped bulk density, apparent density) were measured and additional derived parameters (equivalent spherical diameter, sphericity, flatness and elongation shape factors) were calculated for each size fraction and variety. Packing density and compressibility for each size fraction and of binary and ternary mixtures of the size fractions were determined for each variety. Packing density increased with larger kernel size while compressibility decreased. Sphericity and flatness shape factor had strong positive relationships with packing density and strong negative relationship with compressibility, while elongation shape factor showed the opposite effect on packing density and compressibility. The higher the percentage mass of the larger kernel fraction in a mixture, the higher was its packing density and the lower its compressibility. The two varieties did not significantly differ in packing density and compressibility. These results showed that kernel size distribution has significant effect on packing and compressibility of HRW wheat.

In a second study, laboratory tests and discrete element method (DEM) modeling were used to understand how the bulk density of wheat in storage bins correlates with the measured test weight (initial bulk density). HRW wheat sample used in this study came from the same lot used in the previous study. For these laboratory experiments, the standard test weight per bushel apparatus was used. There were some modifications to the standard FGIS procedure to facilitate varying filling heights (1h = 2 inches, 2h, 4h, 8h, 16h, 32h) and test cup diameters (1d = 4.5 in, 2d, and 4d). Results showed significant increase in bulk density (compared to measured test weight) as filling height is increased to eight times the original filling height (1h). Filling heights of 32 inches (16h) and 64 inches (32h) resulted in 1.2% and 2.4 % increase in bulk density, respectively (figure 1).



Discrete element method (DEM) modeling was used to simulate the particle dynamics and flow from a funnel to the test cup (figure 2a) and leveling the grain with a striker (figure 2b). DEM simulations of bulk density determination were conducted for filling heights of 2 inches, 32 inches and 64 inches. Single-sphere and seven-sphere (elliptical) wheat particle models were used. Material properties used were either based on measured or published values for wheat. Interaction properties were based on published values for DEM wheat modeling, but were refined based on simulations of angle of repose and funnel unloading time. Table 1 shows the measured and simulated bulk densities for the two different particle models at different filling heights. The seven-sphere models gave the least percent error range of -0.7% to 0.7% from the initial bulk density. Because bins come in larger diameters, laboratory tests will be conducted to determine if the measured bulk density is affected by the diameter. Previously, a corrugated steel bin (D = 6 ft, H = 18 ft) was filled sequentially at increasing height. The degree of packing was recorded for each height. This sequential loading will be simulated using DEM to study further how bulk density varies from the measured test weight in a larger storage structure.

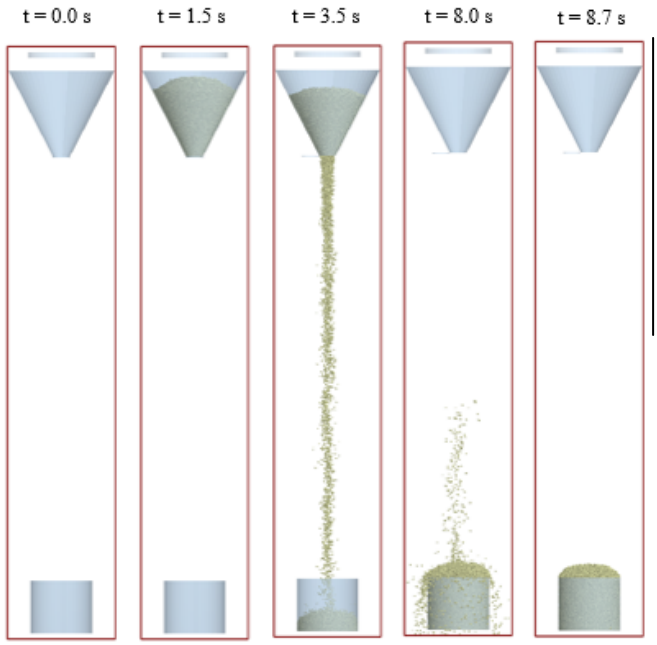


Figure 2a. DEM simulation of filling the test cup with HRW wheat at 16 h.

Table 1. Actual and S\simulated bulk densities using single-sphere and seven-sphere particle models at varying filling heights.

Drop height (h = 2in)	Measured Bulk Density (kg/m^3)	Simulated Bulk Density (kg/m^3)			
		Without Striking		With Striking	
		1 sph	7 sph	1 sph	7 sph
1h	792.8	789.1	798.7	780.8	790.5
16h	804.2	803.9	808.0	792.8	798.6
32h	809.9	815.6		801.8	

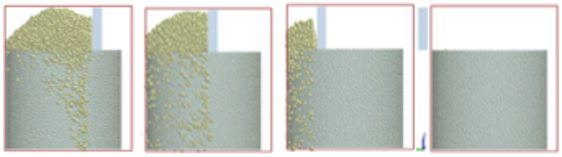


Figure 2b. DEM simulation of striking the test cup.

Outcomes/Impacts

New estimates of the effects of storage time, aeration effects, loading cycles, and secondary quality parameters on grain pack factors will produce more accurate predictions from WPACKING. Effects of time and aeration will be an important addition to improve its accuracy of prediction and grain volume calculations. The comprehensive WPACKING program is user–friendly software and will be an effective tool for crop insurance agencies, licensing agencies, and stored grain managers for accurate grain inventory information.

Publications

Bhadra, R., M.E. Casada, S.A. Thompson, J.M. Boac, R.G. Maghirang, M.D. Montross, , A.P. Turner, and S.G. McNeill. 2017. Technical note: Field-observed angles of repose for stored grain in the U.S. Applied Engineering in Agriculture 33(1): 131-137.

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Funding Source(s) and Amount(s)

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NC-213 (The U.S. Quality Grains Research Consortium)

Objective 3

To be a multi-institutional framework for the creation of measureable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security.

Title

Serving Industry and Educational Stakeholders by providing Practical and Timely Information on Preventive Controls in Grain and Feed.

Objective 3: To be a multi-institutional framework for the creation of measurable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security

By

Hurburgh, C.R., Iowa State University Grain Quality Initiative and Grain Quality Laboratory
Hardy, C.
Rippke, G.
Mosher, G.A.
Maier, D.E.

Outputs

The FSMA Preventive Controls for Animal Food Safety course was taught 10 times to 352 industry participants. Participant evaluations averaged 4.75 on a 5.0 point scale.

Characterization of the 2016 and 2017 were presented to agribusiness professionals.

An ongoing relationship with a major agribusiness insurance company has moved forward. One of the primary goals of this collaboration is to solidify the mindset for grain handlers that the quality of grain and the safety of their workers are closely linked.

The development of a feed technology academic minor for undergraduate students in bioprocess/food engineering, agricultural technology, animal science, food science, and agri business at Iowa State University has been offered with a courses offered in fall 2017 and spring 2018.

Outcomes/Impacts

Producers and the grain industry received advance forecasts of crop quality and storability conditions for 2017. Processors received advance estimates of product yields from both corn and soybeans. Collectively the training modules were downloaded 698 times in CY2016. The newsletter has 3000 regular subscribers and is downloaded an average of 30,000 times per month.

In partnership with the Midwest agribusiness insurance company, a webinar for insurance clients was presented in early 2017 to address linkages between grain quality and safety.

The updated version of the grain drying, handling, and storage handbook (MWPS-13) was released in spring 2017. The book has been used as a supplemental text for grain handling and processing courses at the undergraduate level for many years.

Publications

Maier, D., S. McNeill, and K. Hellevang. Grain Drying, Handling, and Storage Handbook. MWPS-13, Third Edition. Midwest Plan Service, Ames, IA.

Xiao, J. C. Hart, and S.H. Lence. 2017. USDA forecasts of crop ending stocks: How well have they performed? Applied Economics Perspectives and Policy, 39, 220-241.

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Funding Source(s)

The Andersons Research Grant Program
Iowa Extension 21 program
Industry contracts and service fees
NIH-FDA

Grants and Contracts

Extension 21 Grants
Industry contracts and service fees