
NC-213

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MANAGEMENT OF GRAIN QUALITY AND SECURITY IN WORLD MARKETES

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NC-213 Objective 1

Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds.

A Grain Facility System Analysis to Improve Adoption of Value-Enhanced Grain Handling and Marketing in the U.S. (The Andersons Research Grant Program – Team Competition - Joint Project between Kansas State University and Purdue University.) Kansas State University and Purdue University developed a common survey tool to gather data from 150 country elevators throughout seven U.S. Corn Belt states.	1
Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds. Iowa State has developed laboratory capability to calibrate a wide range of near infrared instruments and to collect very large spectral databases for these instruments. Calibrations for measuring subunit (amino acid, fatty acid, etc) factors of corn and soybeans will be extended. The local chemometrics and information technology necessary to optimize use of very large databases will be developed. Image analysis technology will be further refined for more precise applications in single seeds and low-concentration food safety/biotechnology factors.	4
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Evaluate physical, chemical and processing properties of sorghum and corn and develop improved food quality cultivars, improve aflatoxin tolerance and improve nutritional and processing quality of corn through breeding, and to define the attributes of wheat flours with excellent quality for flour tortillas..... 18

NC-213 Objective 2

Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets.

Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets. 24

Develop basic knowledge, science-based performance standards, and technologies that promote crop quality, food security, and food safety in grain markets. Iowa State has assisted a large country elevator in the creation of a certified quality management and product tracking system, based on the American Institute of Baking Quality Systems Evaluation System (QSE). The QSE system will be converted to the more management-based ISO 9000 format and applied to other grain and feed locations. At one location historic performance data sufficient to document the economic efficiency benefit of the quality management system will be compiled. A procedure and template for converting alternative or industry-specific quality management system formats to ISO 9000-2000 certifiable formats will be created. 26

Develop basic knowledge, science-based performance standards, and technologies that promote crop quality, food security, and food safety in grain markets. High value (pharmaceutical, industrial) grains will require extremely stringent isolation from staple commodities if they are to be grown in commodity-producing areas. Operations from planting to end-use will be quantitatively assessed for their potential to contribute either accidental or malicious mixing. Estimates will be pooled in 3 case-study traceability models, which will then be used to create a standard evaluation template. 28

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Survey microbial indicators for the HRS and durum wheat crop from the Northern Plains of the United States, to compare microbial indicators for the HRS and durum wheat crop from the Northern Plains region of the United States to quality attributes, weather patterns and other available production practice data, and to evaluate ozone treatments as a means to reduce microbial loads and degrade mycotoxins in post-harvest wheat. 37

Evaluate methods to treat *Fusarium* head blight (FHB) infected barley in order to prevent *Fusarium* growth and mycotoxin production during malting. 44

Development and Modeling of a Continuous-flow Dryeration Process. 46

Evaluate, under field conditions, the use of carbon dioxide detectors to monitor for bio-activity in stored corn prior to the time that spoilage would be detected by traditional methods. The hypothesis is that CO₂ monitors can efficiently detect grain in the early stages of spoilage. 48

Develop trapping and contour analysis of trap catch as a method for monitoring stored product insect pests in warehouses, processing plants, and retail stores, and locating foci of infestation. Observations of stored product insects in retail stores and experiments in a small shed have shown that the relationship of trap catch (n) to the distance of a trap from a source of insects (d) is well described by the exponential decay function $n = ae^{-bd}$. Our specific objective during 2004 was to investigate the physical/biological meanings of the parameters a and b 50

Develop and evaluate automatic grain aeration control strategies for maintaining grain quality and controlling insects during storage. 52

NC-213 Objective 3

Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain.

Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain. Operate quality analysis testing/instrument calibration services to support research and marketing activities. Achieve ISO 17025 certification with related statistical control of data management. 54

Identify methods of measuring shelled corn storability. When shelled corn subjected to conditions conducive to fungal growth, slower growth means greater storability. The specific objectives are: (1) to evaluate the use of a CO₂ Test Kit (Woods End Research, Mt. Vernon, Maine), for measuring CO₂ production (storability) of shelled corn; (2) to evaluate several rapid (< 15 min) tests that can be used together to provide a less precise but more rapid storability indication; and (3) to examine the correlations among the various tests used as storability indicators. 56

Conduct basic and applied research in the biochemistry and technology of grain sorghum to identify and evaluate the biochemical components that govern processing, functionality, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets. 59

Develop fast reliable methods for the identification of quality traits of wheat starches. 61

Evaluate kernel characteristics, milling properties, and dough and bread-, tortilla- and Asian alkaline noodle-making properties of hard winter wheat progenies. Determine protein and lipid contents, and composition and interaction among these components of cereal grains as they relate to storage, handling, and end-use properties. 63

Develop sensors, instrumentation, and procedures for objective grading, on-line measurement, and end-use property assessment of single kernels or bulk samples. 67

Investigate the role of the albumin and globulin proteins (water and salt soluble), phenolics and non-starch carbohydrates of wheat flour on quality and functionality. 70

Define the quality characteristics of barley for its uses in various food products and to explore an effective way to retard discoloration in barley-based food products. 72

Objective 1

Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds.

NC-213 Objective 1

Title

Grain Facility System Analysis to Improve Adoption of Value-Enhanced Grain Handling and Marketing in the U.S. (The Andersons Research Grant Program – Team Competition - Joint Project between Kansas State University and Purdue University)

Summary

Kansas State University and Purdue University developed a common survey tool to gather data from 150 country elevators throughout seven U.S. Corn Belt states. Most facilities have more than one receiving pit and multiple smaller storage structures, which make effective segregation of multiple grain streams feasible. Additionally, the system simulation approach is utilized to investigate how the efficiency and economics of the receiving and segregation operation at commercial grain elevators can be optimized. The system models were validated with the collected data, and used to explore “what if” grain segregation scenarios.

Project Objectives

1. Identify technical, social, economic, and institutional constraints that impede segregation of GM-based VE crops.
2. Create system analysis and management tools to assist in the adoption of VE grain handling and marketing strategies.

From

Kansas State University, Department of Grain Science and Industry
Purdue University, Department of Agricultural & Biological Engineering

By

Herrman, T.H.
Maier, D.E.

Results for 2004

Kansas State University and Purdue University developed a common survey tool in order to gather data from 150 country elevators throughout seven U.S. Corn Belt states. Information gathered from state grain and feed association directories allowed a random sample of elevators to be drawn based on overall licensed warehouse storage capacity. The purpose of this study was to investigate how well country elevators were equipped to handle the segregation of incoming multiple grain types. The results were previously reported on.

In 2004, Kansas State University ran a cluster analysis using several variables (receiving capacity, storage capacity, number of legs, and number of drives) on the data collected at the Western Corn Belt elevators. The cluster analysis entailed a hierarchical approach, where clustering began with each elevator comprising a single data point and then combined points, based on commonalities, until all observations were within one cluster. This resulted in three clusters of grain elevators. Two of the clusters were subdivided based on the number of drives, resulting in a total of 5 distinct elevator configurations. In terms of receiving system utilization, most of the elevators experienced the largest burden at 10% and 20%. The amount of grain received was more at 10% to 30% burden.

In 2004, Purdue University completed the development of five site specific grain elevator systems simulation models to assist in the adoption of value enhanced grain handling and marketing strategies. Data for the development of the systems models was gathered at five Eastern Corn Belt elevators located in Indiana and Illinois

during the 2002 and 2003 harvest seasons. Site specific grain elevator system simulation models were developed using EXTEND, a powerful modeling software. The system models were validated using a matched pair t-test ($\alpha=0.05$) with P-values ranging from 0.30 to 0.85. The practical application of these system models was demonstrated by evaluating 17 "What If" scenarios that involved making logistical modifications to and comparisons of the five elevators. For example, when two facilities exchanged scale probes for remote probes, the Average Service Time (AST) dropped by 4-6 minutes, a decrease of between 25 and 35%. The system models were also used to estimate the amount of contamination that occurs between channeled and non-channeled corn due to commingling at the elevator. The model predicted that the contamination of non-channeled corn never exceeded 0.6%. Furthermore, additional simulation experiments indicated that the amount of contamination at the elevator was directly related to the number of grain types delivered and receiving pits available. This simulation tool proved to be an effective method for evaluating the efficiency and performance of the grain elevators modeled.

Plans for 2005

Kansas State University and Purdue University are currently collaborating to complete the data analysis by state and region, and analyze the economics of country elevator operations for the segregated handling of value-enhanced grains and oilseeds.

Publications

McGill, J.M. and Maier, D.E. 2004. Using discrete event simulation to predict purity and contamination levels during identity-preserved handling of quality grains. Proceedings of the 2004 International Quality Grains Conference. Indianapolis, Indiana, July 19-22, 2004.

McGill, J.M. 2004. An infrastructure analysis of grain elevators and the development of system simulation models. Unpublished M.S. thesis, Purdue University, West Lafayette, Indiana.

Issues

Increased globalization of agricultural markets and the introduction of transgenic (GM) crops through biotechnology have created a need for further investigation of the U.S. grain handling infrastructure to segregate cereals and oilseeds in order to remain the world's least cost provider of safe and wholesome foods and feeds. This research addresses the study of grain unloading operations at country elevators using system simulation methodology. The differentiation of crops (Transgenic crops, Identity Preserved crops, etc.) increases the burden of elevators, which need to handle the same or greater amounts of grain, but with an increased number of crop types to be segregated. This fact poses a significant challenge for operators in terms of unloading, drying, and storage of different grains in facilities that were built to handle few commodities (corn, wheat and soybeans).

What Was Done

The goal of this project is a system simulation study of country elevators to improve the efficiency and the economics of grain handling. The study, rather than addressing the economic value of the operation with respect to IP or non-GM grains, has analyzed different simulated scenarios (product arrival, logistic of the system, management strategies, external drivers of change like market forces and regulations) in order to provide strategies to better manage the grain receiving operation.

Impacts

Creation of an object oriented grain handling system software package will now enable elevator operators to test the flexibility of their current facility or create their ideal grain handling facility with all its equipment in a simple click and drag type format. A system simulation and economic analysis tool will allow them to define the operating conditions at their elevator (e.g. truck size distribution, type of grain, delivery rate), estimate average delay time and queue length, and quantify the least cost segregation strategy. Additionally, this approach holds the future potential for a grain company (or merging companies) to link multiple individual elevator facility models together and

evaluate the optimization of combined system network resources.

Funding Sources

The Andersons Research Grant Program – Team Competition 2000-2002

Contacts

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University, Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@purdue.edu

Tim Herrman, Department of Grain Science & Industry, Kansas State University, Phone: 785-532-4082; Fax: 785-532-4017; e-mail: tjh@wheat.ksu.edu, URL: <http://www.GrainQuality.org>

NC-213 Objective 1

Project Objectives

Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds. Iowa State has developed laboratory capability to calibrate a wide range of near infrared instruments and to collect very large spectral databases for these instruments. Calibrations for measuring subunit (amino acid, fatty acid, etc) factors of corn and soybeans will be extended. The local chemometrics and information technology necessary to optimize use of very large databases will be developed. Image analysis technology will be further refined for more precise applications in single seeds and low-concentration food safety/biotechnology factors.

From

Iowa State University
Department of Agricultural and Biosystems Engineering

By

Hurburgh, C.R. Jr.

Results for 2004

Calibration models for determination of amino acid concentration in whole soybeans were developed using five NIR spectrometers and three regression methods. The study resulted in models characterized by various degree of accuracy most of which were usable for research purposes and sample screening. Unfortunately, no sufficient correlation could be established between spectral data and concentrations of such important amino acids as Cysteine and Tryptophan. The variation in NIR models' predictive ability was determined by how well a certain amino acid correlated to reference protein (Figure 1). Future research should attempt to break this correlation by introducing calibration samples with non-typical amino acid profiles.

Comparison of calibration methods demonstrated that (1) performance of Partial Least Squares and Least Squares – Support Vector Machines was significantly better than that of Artificial Neural Networks, and (2) choice of preferred modeling method was spectrometer-dependent. Comparison of instruments showed some advantage of FOSS Infratec 1241 Grain Analyzer and Perten DA 7200 over Bruins Omega G, Bruker/Cognis QTA, and Foss NIRSystems 6500.

Calibrations for linolenic acid in whole soybeans were developed for the Foss Infratec series of NIR units(Figure 2). The calibrations did not perform well in the field on new 2004 crop samples, however, and they are being updated to use the Neural Network algorithm.

Corn and soybean proximate analysis calibrations were developed for Bruins Omega (monochromator) and Perten DA7200 (diode array) units. These calibrations had accuracy equal to or better than the Official Infratec calibrations on the same samples. Post regression slope and bias (to units other than the calibration masters) will not work for diode array units; optical methods must be developed.

Plans for 2005

Complete the amino acid and fatty acid calibrations on up to five brands of NIRS. Develop a calibration transfer process for diode array units. Develop the theoretical basis for calibrations of different NIRS models that do not sacrifice collective accuracy relative to using one model only.

Publications

- Garraude, Y.G., C. R. Hurburgh, Jr., G.R. Rippke, and C. Yang. 2004. Measurement of antioxidant factors in rosemary with NIR. Kemin seminar series, Kemin Americas Co., Des Moines, IA. October 19, 2004.
- Hurburgh, C.R., Jr. 2004. NIR from laboratory to the field. 2nd International Conference on Embedded NIR. Centre Wallon de Recherches Agronomiques, Gembloux, Belgium. November 19, 2004. Invited presentation.
- Hurburgh, C. R. Jr. 2004. Advances in Spectroscopic Methods for High Throughput Crop Analytics. Pittcon 2004, Chicago IL. (abstract 24700-100). Invited.
- Hurburgh, C. R., Jr. 2004. Real-time model selection and other technical challenges for the general use of NIR. IDRC-2004, International Diffuse Reflectance Conference, Chambersburg, PA. Aug 19-23, 2004. Invited presentation.
- Kovalenko, I., G. Rippke, and C. R. Hurburgh, Jr. 2004. Near infrared spectroscopy determination of amino acid composition of soybeans. Pittcon 2004. Chicago, IL. (poster abstract 4100-3000)
- Kovalenko, I. V., G. Rippke, and C. R. Hurburgh, Jr. 2004. Measurement of Soybean Fatty Acids, Comparison of Linear and Non Linear Calibration Methods. IDRC-2004, International Diffuse Reflectance Conference, Chambersburg, PA. Aug 19-23, 2004. Poster.
- Roussel, S. A. and C. R. Hurburgh, Jr. 2004. Comparison of artificial neural network and partial least squares calibrations for Infratec analyzers. Abstract 129a. 2004 American Association of Cereal Chemists Annual Meeting, San Diego, CA. September 20, 2004.
- Yang, CiWen, C. R. Hurburgh, Jr., and E. Dierenfeld. 2004. A Spectral Wildlife Nutrition Database Using Visible and Near Infrared Spectroscopy. IDRC-2004, International Diffuse Reflectance Conference, Chambersburg, PA. Aug 19-23, 2004. Poster.

Issues

NIR technology can make many more measurements of biological materials than is presently done, but challenges of standardization and use of multiple models in trade must be overcome.

Impacts

We demonstrated several new applications for NIR, and determined that the very high-speed diode array technology could make large increases in measurement capabilities. The fatty acid application will be necessary to support marketing of modified soybeans that produce oil which will remove the need for trans-fat producing hydrogenation.

Figure 1. RPD values of the best NIR calibration models and linear protein regressions

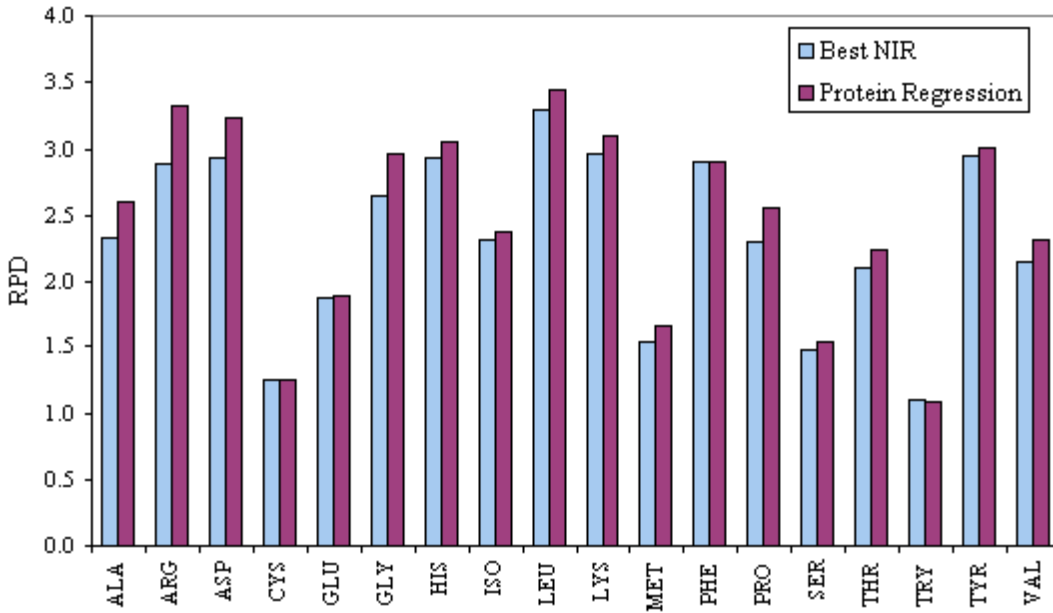
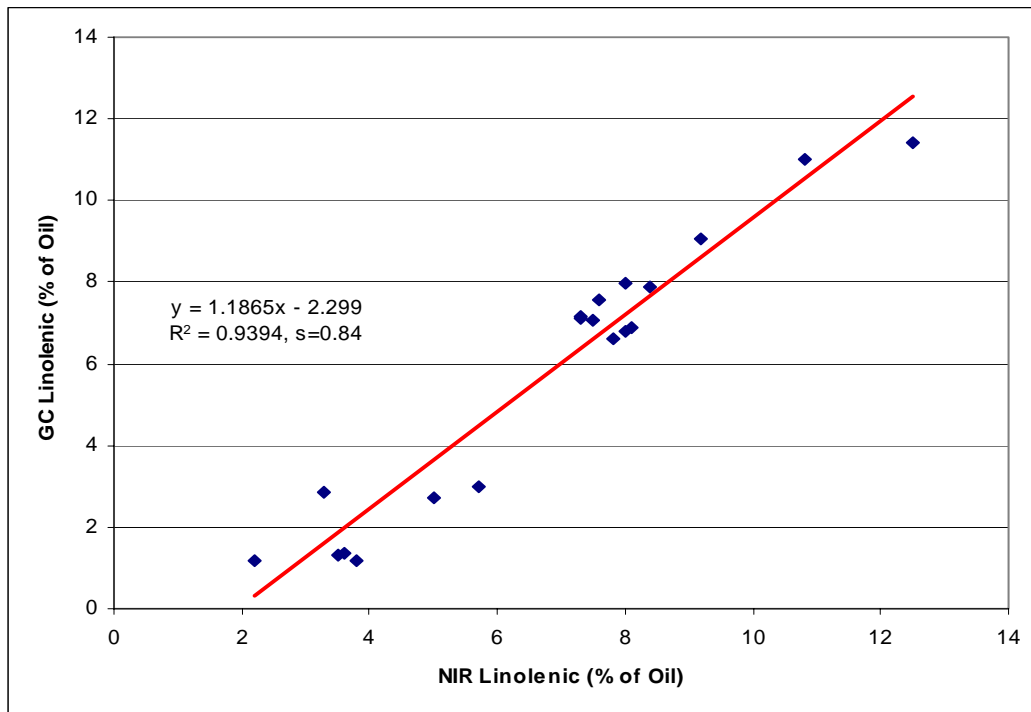


Figure 2. Soybean linolenic acid calibration for the Infracore



NC-213 Objective 1

Project Objectives

Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds. Iowa State has been surveying corn and soybean quality on an annual basis, targeted at end-use related factors. The on-line database of corn/soybean quality and yield information will be reorganized and expanded. Information gathering from annual crop quality surveys and variety trials will be improved.

From

Iowa State University
Department of Agricultural and Biosystems Engineering

By

Hurburgh, C.R. Jr.

Results for 2004

The 2004 U.S. soybean crop had slightly lower than average protein (35.2%) and slightly higher than average oil (18.7%) contents. The variability in protein and oil content was lower than 2003 and similar to the long-term average variability. Yields and total production were the highest on record due mainly to good growing conditions. There are continuing efforts on the part of many U.S. groups to improve soybean quality through education, price premiums and inspections. Low-linolenic soybean varieties are being grown and processed in the U.S. to address health concerns about trans-fatty acids. Linolenic acid and total oil content varied across environments, for the same variety. Growing conditions in 2004 increased linolenic acid levels 0.2-0.5 percentage points (of the oil) beyond what was expected from low linolenic varieties.

A three year database from a private variety testing service was assembled. This database contains yield and quality data from approximately 2500 soybean plots annually, across the corn belt and east coast growing regions. There was little correlation between quality (protein plus oil) and yield ($r < 0.3$). Six protein and oil pricing strategies, all in use by one or more users, rewarded very different combinations of oil and protein, which gives confusing signals to the genetics industry.

Plans for 2005

Continue the soybean survey and the modified fatty acid survey. Publish time series data from the survey and options for component pricing.

Publications

Brumm, T.J., and C. R. Hurburgh, Jr. 2004. Long-term study of US Soybean Quality: Protein, oil and amino acids. Proc. International Grain Quality Conference, Indianapolis, IN. July 19-21, 2004.

Brumm, T. J. , C. R. Hurburgh, Jr. and G.R. Rippke. 2004. Quality of the 2004 US Soybean Crop. American Soybean Association, St. Louis , MO. Invited presentations Seoul, Shanghai, Beijing, Tokyo, Taipei. November 2004.

Hurburgh, C. R., Jr. 2004. Quality of the 2004 Corn and Soybean Crop in NC Iowa. GEAPS Greater Iowa Chapter, September 14, 2004. Invited presentation.

Issues

Protein, oil, amino acids, and fatty acids are becoming increasingly important as marketing factors for soybeans. International customers have asked for a steady source of quality data on which to base decisions. Processors and genetics companies have asked for information and yield-quality tradeoffs, with their effects on net value of crops.

Impacts

Asian customers are clearly happy to have us do the survey and bring the results to them. Sales have been made because of this customer focus. Processors are gradually instituting component pricing systems.

NC-213 Objective 1

Project Objectives

A standardized set of criteria will be developed to assess the suitability of wheat, sorghum, and maize for particular end-uses.

From

Kansas State University

By

Herrman, T. J.
Tilley, K.
Maghirang, R

Results 2004

Maize kernel hardness and proximate constituents were evaluated by several methods. Proximate constituents and hardness-associated properties were significantly correlated, and their correlation coefficients were improved when moisture, protein, and oil contents were kept constant. Multivariate techniques were applied to create new sets of variables to characterize maize hardness. The principal component scores created by principal component analysis (PCA) were subjected to cluster analysis and discriminant analysis. A total of 248 maize samples were grouped into 7 and 10 subgroups by cluster analysis. The groups resulting from cluster analysis seem to have unique physical and chemical properties showing the different order in values of hardness measurements. The application of discriminant analysis to create a classification rule for hardness clusters revealed that new observations had an 87% correct classification into hardness clusters. The biochemical determinants of maize kernel hardness and their roles during extrusion processing were explored in an attempt to improve maize hybrid selection criteria for breeders, producers, and end-users. A representative hybrid from each cluster was selected for extrusion experiments. Maize hybrids representing each hardness cluster showed unique RP-HPLC chromatograms depending on endosperm texture. Maize kernel hardness significantly affected both the physical and textural properties of extrudates, including expansion ratio (ER), specific mechanical energy (SME), water absorption index (WAI), water solubility index (WSI), and oil absorption capacity (OAC). Extrudates from harder grits had lower protein solubility and greater protein aggregation after extrusion. Proteins in softer grit extrudates were more easily dissociated and degraded into smaller molecules as screw speed increased, which resulted in higher protein solubility and greater WAI, WSI, and OAC under similar extrusion processing conditions and starch properties.

A study was conducted to assess commingling in a country elevator in Manhattan, Kansas. The elevator, which has a capacity of 190 t/h, has 3 receiving pits and one leg. Soybeans were moved through one of the receiving pits followed by corn through the same flow path for each test without special cleaning in between these two operations. Samples were collected at specific time intervals during grain the corn transfer and analyzed for commingling. Commingling was calculated as percentage of soybeans mixed in corn. Commingling was greater than 1% only during the first 135 s (first 2 t received), except for the gravity-type pit configuration in which commingling remained in excess of 1% for the duration of the test (840 s or 7.3 t of grain). Measured mean cumulative commingling values at the end of operation were 1.25%, 0.30% and 0.23% for the combined effect of gravity-type pit and elevator leg, combined effect of leg and pit with drag conveyor, and effect of the leg, respectively. Computer simulations using SIMAN/ARENA predicted that a 10 t load through a pit with drag conveyor would result in a cumulative commingling of 0.28%, of which 0.27% would be from the effect of the leg.

Plans 2005

Complete the corroborative study involving other university and industry laboratories performing maize and sorghum quality evaluation.

Build a classification system for identifying maize and sorghum hybrids best suited for wet-milling, dry milling, and alkaline processing.

Prepare scientific manuscripts.

Impacts

Corn growers in KS, MO, NE, and IA can better identify corn hybrids best suited for dry milling and extrusion processing and have improved their profitability. Expansion of this research to include the eastern cornbelt and sorghum, and examining wet milling and alkaline processing in collaboration with colleagues from ARS and UNL will result in a similar benefits.

Publications

Lee, K.M., T.J. Herrman, J.E. Lingenfelter, and D. Jackson. 2004. Classification and prediction of hardness-associated properties using multivariate statistical analysis. *J. Cereal Sci.* In Press.

Tilley, M., R. E. Benjamin, P. Srivarin and K. A. Tilley. 2004. Nonenzymatic preparative-scale synthesis of dityrosine and 3-bromotyrosine. *Anal. Biochem.* 334:193-195.

Tilley, M. and K. Tilley. 2004. Modifying tyrosine crosslink formation in wheat dough by controlling innate enzymatic activity. *In: Proceedings of 12th ICC Cereal & Bread Congress.* Harrogate UK. 22- 26 May 2004

Presentations

Herrman, T.J., R. Bowden, M. Langemeier, and M. Schrock. 2004. Strategies to manage Karnal bunt and retain global markets. International Quality Grains Conference, Indianapolis, Indiana.

Ingels, M.E.A., M.E. Casada, R.G. Maghirang, and T.J. Herrman. 2004. Grain commingling at receiving in a country elevator. International Quality Grains Conference, Indianapolis, Indiana.

Tilley, M. and K. Tilley. Modifying tyrosine crosslink formation in wheat dough by controlling innate enzymatic activity. 12th ICC Cereal & Bread Congress. Harrogate UK. 22-264 May 2004

NC-213 Objective 1

Project Objectives

1. Determine temperature-time-mortality relationships for various life stages of Indianmeal moth.
2. Develop a thermal death kinetic model based on constant temperature data for various life stages of Indianmeal moth and red flour beetle.
3. Validate and implement the thermal death kinetic model by collecting independent data using various insect life stages during actual heat treatments of food-processing facilities.

From

Kansas State University
Department of Grain Science and Industry

By

Subramanyam, B.
Alavi, S.
Huang, F.

Results for 2004

The use of elevated temperatures (≥ 40 to 60°C) or heat treatments for managing insects in food-processing facilities is a viable alternative to space fumigation with methyl bromide. Quantitative data are lacking on the responses of life stages of the red flour beetle, *Tribolium castaneum* (Herbst), an important pest of food-processing facilities worldwide, to elevated temperatures used during heat treatments. We determined time-mortality relationships for eggs, young (neonate) larvae, old larvae, pupae, and adults of *T. castaneum*, exposed to constant temperatures of 42, 46, 50, 54, 58, and 60°C . Generally, mortality of each stage increased with an increase in temperature and exposure time. Young larvae were the most heat tolerant stage, especially at temperatures $\geq 50^{\circ}\text{C}$. Exposure for a minimum of 7.2 h at $\geq 50^{\circ}\text{C}$ was required to kill 99% of young larvae, whereas the other stages required less than 1.8 h. Heat treatments that control young larvae should control all other stages of *T. castaneum*, and young larvae should be used as test insects to evaluate efficacy against *T. castaneum* during an actual facility heat treatment.

A dynamic model was developed to predict survival of the most heat tolerant stage (young larvae) of *T. castaneum*, exposed to elevated temperatures between 42 and 60°C . The model is based on two nonlinear relationships: (1) logarithmic survival of young larvae as a function of time, and (2) logarithmic reduction in survival as a function of temperature. The model was validated with an independent data sets collected during actual facility heat treatments. The absolute deviation of the model with respect to the number of larvae surviving the heat treatment, and with respect to time for equal larval survival, were determined. The dynamic model appears to be useful for predicting survival of young larvae of *T. castaneum* during heat treatments of food processing facilities based on time-dependent temperature profile obtained at any given location.

The results provide the basis for successful use of elevated temperatures for management of *T. castaneum* life stages associated with food-processing facilities.

Plans for 2005

In 2005, additional data sets will be collected to validate survival of young larvae of *T. castaneum* at different heating rates. A thermal death kinetic model, based on methods developed for *T. castaneum*, will be developed and validated for the most heat tolerant stage of the Indianmeal moth, *Plodia interpunctella* (Hübner) in 2005.

NC-213 Objective 1

Project Objective

Examine milling properties, dough characteristics, protein functionality, and baking properties of soft white wheat varieties.

From

Michigan State University
Department of Food Science & Human Nutrition

By

Perry K.W. Ng

Results for 2004

We have continued to examine soft wheat varieties for milling and baking qualities. Biochemical studies on flour proteins were conducted. There was a wide range of protein quality among the examined flour samples. The use of transglutaminase (TG) to improve dough strength of weak gluten protein flour samples continued to be one of the foci of our investigations. We have shown that incorporation of TG would allow soft wheat flour to make satisfactory pan bread. Results revealed that TG has more beneficial effects on weaker protein flour than strong protein flour samples. Furthermore, TG increased the water holding capability of the flour samples. The functional and thermal properties of the cross-links formed among flour proteins via TG are being examined.

Plans for 2005

Our plans are to continue evaluating the intrinsic quality parameters of various soft wheat varieties relative to their respective milling and baking characteristics, to continue identifying possible biochemical markers for these characteristics, and to publish available data. In addition, functional and thermal properties of dough/flour samples treated with TG will be further examined.

Publications

Basman, A. Koxsel, H., and Ng, P.K.W. 2004. Utilization of transglutaminase to increase the level of barley and soy flour incorporation in wheat flour breads. 1st International Congress on Function Foods and Nutraceuticals. Antalya, Turkey.

Berghofer, E., Kreilmayer, I., Roggenhofer, M., and Ng, P.K.W. 2004. Production of bread, pasta and wafers from purple wheat. AACC Annual Meeting Program Book.

Gazza L., Nocente F., Ng P.K.W., and Pogna N.E. Genetic and biochemical analysis of bread wheat cultivars lacking puroindoline *a*. *Theo. App. Genet.* (in press).

Gazza, L., Nocente, F., Ng, P.K.W., and Pogna, N.E. 2004. Genetic and biochemical analyses of extra-soft common wheat cultivars. AACC Annual Meeting Program Book.

Ng, P.K.W., Ward, R., Tanhehco, E. MSU Wheat Quality Testing Program: Report on Milling and Baking Test Results for Selected Michigan-Grown Soft Wheats Harvested in 2003. January 2004. 37 pp.

Ross, A.S., Carter, B.P., Hou, G., Ng, P.K.W., and Ohm, J.B. 2004. Better exploitation of post-release end-use testing of US hard white wheats. AACC Annual Meeting Program Book.

Schoenlechner, R., Grausgruber, H., Berghofer, E., and Ng, P.K.W. 2004. Noodles produced from flour blends of wheat and various barley species. AACC Annual Meeting Program Book.

What Was Done

Samples were obtained from the Michigan State University Wheat Quality Testing Program, from various breeding programs in the country, and from commercial wheat flour samples. Experimental analyses were carried out either according to AACC official methods or following published procedures. Partial results were presented at the Michigan State Miller's Association Annual Meeting and at the AACC Annual Meeting, and published in refereed journals.

Impacts

This project will result in a better understanding of wheat flour quality in relation to end-use products. In addition, the use of TG will potentially allow (1) bakers to use weaker flour to produce satisfactory baked products, and (2) millers to provide more consistent flour quality to bakers in spite of environmental growing factors.

NC-213 Objective 1

Project Objectives

To determine the effect of preharvest production practices on end-use quality of wheat.

From

North Dakota State University

¹Department of Plant Sciences

²Department of Veterinary and Microbiological Sciences

By

Manthey^{1*}, F.A.

Wolf-Hall^{2*}, C.E.

Results for 2004

Results indicate that dry, vitreous kernels in spikes exposed to moisture will hydrate and expand in size. Hydrated kernels did not constrict to their original size during subsequent drying. The lack of constriction resulted in a nonvitreous appearance of the endosperm. Kernel bleaching increased with exposure to moisture. L-value (brightness) increased from 48.2 at time 0 to 52.9 at 24 h, when averaged over cultivars. Cultivars differed in their change in brightness after 24 h, which was greatest for 'Ben' and 'Belzer' and least for 'Munich' and 'Dilse'. Although Ben and Belzer had the greatest change in brightness, they also had the lowest initial brightness. Thus after treatment, Ben and Belzer were less bright than other genotypes. Vitreous kernel content decreased 18-45% for all cultivars after 3 h and 33-75% after 24 h. Loss of vitreousness was greatest for Belzer and 'Lebsock' and least for 'Maier'.

Plans for 2005

We plan to repeat the experiment using spikes collected from Prosper and Langdon, ND. We also plan to determine how much moisture is needed to affect kernel vitreousness and to determine the effect of grain moisture on lipid stability.

Publications

Manthey, F.A., Howatt, K.A., Wolf-Hall, C.E., and Dick, T.J. 2004. Harvesting Standing Wheat and Wheat That Has Been Cut and Windrowed: A Comparison of Grain Quality. Proc. International Quality Grain Conf. In press.

Singh, K., Manthey, F. A., and Elias, E.M. 2004. Effect of weathering on kernel quality of durum wheat. AACC Annual Program Book, p. 166. Abstract No. 412.

Issues

Traditionally, durum wheat grown in the northern Great Plains has been cut and windrowed to promote the desiccation of green vegetation and reduction of kernel moisture prior to harvest. Untimely rainfall and/or prolonged damp conditions can result in kernel bleaching, preharvest sprouting, and subsequent mold growth in spikes and grain in the windrows. Kernel bleaching is the discoloration of the seed coat. Bleached kernels are often designated as nonvitreous, which reduces the value of the grain. The genotypic variation in susceptibility to kernel bleaching is not known for durum cultivars typically grown in the Northern Plains of the United States.

What Was Done

Spikes from ten durum cultivars were cut from plants grown in field plots located near Casselton, ND. Spikes (25) were submerged in distilled water for 60 sec, gently shaken to remove excess water, placed in plastic bags and stored in the dark at room temperature for 0, 3, 6, 12, and 24 h. The spikes then were threshed, cleaned and air-dried. Kernel quality including brightness and vitreousness were determined.

Impacts

Durum cultivars seem to differ in their susceptibility to kernel bleaching and to loss of vitreousness due to absorption of moisture after maturity.

NC-213 Objective 1

Title

Grain Production System Modeling and Traceability

Project Objectives

The overall goal of this project is to develop a system simulation model to evaluate and quantify the practically achievable purity levels for the segregated handling and delivery of differentiated (GM vs. non-GM; identity preserved vs. commodity) grains and oilseeds from producer to end user. This will be accomplished by achieving the following objectives:

1. Documentation and analysis of segregation practices currently used on-farm and their effectiveness including estimation of the level of genetic contamination introduced during...
 - a. the production of corn and soybeans from the seed bag through planting and pollination,
 - b. during the harvesting of corn and soybeans from the combine through transport to on-farm handling systems or directly to handlers/processors, and
 - c. the post-harvest handling of corn and soybeans from receiving through drying and storage, and subsequent delivery to handlers/processors.
2. Modeling of the grain production, handling and delivery system to evaluate the impact of different practices on the ability to segregate and differentiate grains and oilseeds.
3. Investigation of currently available technologies to aid in the segregation and tracing of differentiated grains and oilseeds.
4. Formulation of realistic practices and recommendations to maximize the achievable levels of genetic purity in differentiated corn and soybeans from seed to end use.

Summary

This project focuses on developing a system simulation model to evaluate and quantify the practically achievable purity levels for the segregated handling and delivery of differentiated (GM vs. non-GM; identity preserved vs. commodity) grains and oilseeds from producer to end user.

From

Purdue University
Agricultural and Biological Engineering
Agricultural Economics
Agronomy

By

Maier, D.E.
Ess, D.R.
Fleck, N.
Alexander, C.
Nielsen, R.L.

Results for 2004

This project was initiated during the Spring 2004 by investigating currently available precision farming, communication and other technologies that could be used to aid in the segregation and tracing of differentiated grains and oilseeds from the seed bag to the planter, field, combine and into the post-harvest handling and delivery system. During 2004, efforts have focused on data collection with respect to genetic contamination during the crop production and harvesting processes, as well as documenting current segregation practices. The data were collected from a selected group of Indiana farmers, the selections being made on the basis of cleanout practices used and a desire to sample a wide variety of machine brands and models.

Plans for 2005

We will primarily focus on the completion of Objective 1, 2 and 3. The proposed system simulation model is envisioned to tie in with an existing commercial grain receiving network model.

Issues

Source verification (traceability, trace back, product tracking, identity preservation) is the ability to trace grains and oilseeds from their initial components (for example, seed) through the production and distribution system to an end user. Source verification is a process that requires documentation from start to finish, testing for specific quality traits or the absence of undesired attributes (e.g., certain genetic traits), special handling and logistics, external (third party) auditing, and formal certification. Given that a range of practices and equipment involved in grain production, harvesting and handling affect the quality and purity of grains and oilseeds, a systems approach is needed to manage quality assurance from production through delivery to end use.

What Was Done

We investigated currently available precision farming, communication and other technologies that could be used to aid in the segregation and tracing of differentiated grains and oilseeds from the seed bag to the planter, field, combine and into the post-harvest handling and delivery system. We also collected data to quantify genetic contamination during the crop production and harvesting processes.

Impacts

Source verification has been successfully applied to identity preserved products – those that are physically isolated throughout the market system. However, it also increasingly applies to documentation in bulk commodity markets. Grain markets have traditionally handled interchangeable average quality commodities. Biotechnology, food safety and bio-security concerns, and new consumer perceptions are converging to create a grain market need for source verification and the associated quality management and product purity certification systems. Source verification and assurance certification is already changing the mindset of the food supply chain. Food safety and bio-security concerns have resulted in more scrutiny of all food products and have greatly increased the willingness of food processors, manufacturers and retailers to implement ingredient tracking systems.

Contacts

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University; Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@purdue.edu, URL: <http://www.GrainQuality.org>

NC-213 Objective 1

Project Objectives

Evaluate physical, chemical and processing properties of sorghum and corn and develop improved food quality cultivars.

Improve aflatoxin tolerance and improve nutritional and processing quality of corn through breeding.

Define the attributes of wheat flours with excellent quality for flour tortillas.

From

Texas A&M University
Soil & Crop Sciences Department

By

Rooney, L.W.
Betran, J.
Waniska, R.D.
Jones, E.

Results for 2004

Two advanced wheat lines are in process of formal release to producers. More than two thousand wheat samples were analyzed prior to planting to enable selection for quality attributes. Single kernel hardness was used as the first preliminary screen followed by protein and mixograph properties.

Sorghum anti-oxidants are effective in preserving the shelf life of ground beef patties. A patent disclosure was made describing the use of finely ground bran from special sorghums to preserve meat patties without adversely affecting the color or flavor. In addition, VITABRED a composite mix for bread machines with natural dark color, high levels of soluble and insoluble dietary fiber and an excellent flavor was developed. Addition of ground flax increases omega 3 fatty acids and anti-oxidants.

Work continued to characterize the tannins in sorghums with different genetics that affect the color and location of tannins. The analysis indicates that there are no condensed tannins in sorghums without a pigmented testa and that different types of tannins exist when the B1-B2S genes differ. New types of sorghums with different levels and types of tannins were discovered.

Gluten free breads containing sorghum flour, cassava, xanthan and corn starch had good loaf volume and crumb structure compared to commercial mixes. Inulin improved loaf volume and produced high fiber gluten free breads when blended with sorghum flour and ground flax seed.

White, tan plant sorghum hybrids continue to be identity preserved and marketed in Japan where a large number of snacks, baked and related products are produced. The PI participated in workshops on white food sorghums in South Africa, Mali, and Central America and in a snack food processing short course at TAMU. Additional extrusion experiments confirm that cracked or coarsely ground whole grain white sorghum makes excellent snacks when a short barrel friction extruder is used. The bland flavor of the white sorghum gives a unique character to mild flavors. The whole grain potential is significant because of its nutritional importance.

Sorghum tannins are misunderstood around the world and negatively affect its marketing. HPLC analysis of the tannins clarifies that types of sorghum without a pigmented testa do not have condensed tannins. There are small amounts of materials that give positive tests for phenols in all cereals but they are not tannins. The PI participated in workshops to clarify that most sorghums do not have tannins. In addition, those with tannins are consumed by

animals but the feed efficiency is significantly reduced depending upon the animals and methods of processing and feeding the grain.

Sorghum Mold Prevention. Sorghums that retain higher levels of antifungal proteins (chitinase and sormatin) in their caryopses from physiological maturity to combine harvest have improved grain mold resistance. It is clear that antifungal proteins prevent mold damage in some cultivars but they are ineffective in other cultivars. Thus, a combination of factors affect mold resistance in sorghum including kernel hardness, presence of unknown inhibitors to molds in some grains, plant characteristics and other factors.

Corn Tortillas. Use of soy flour, guar gum, CMC and maltogenic amylases significantly improved texture of corn tortillas stored at room temperature and refrigeration. Soy flour addition improved the nutritional and anti-staling properties of corn tortillas. The best soy products in terms of functionality are those with low heat treatments but they still reduce the flavor of the tortillas.

Tortillas with significantly improved texture can be made by proper combinations of enzymes and hydrocolloids.

Several blue and red corns have excellent processing properties. There were differences in cooking time, pericarp removal and other properties. The new corn lines may produce deep red alkaline cooked products. Quality protein maize (QPM) inbreds released by the corn improvement program have good alkaline processing properties and higher lysine and tryptophan content. There are differences in cooking times and pericarp removal among the QPM hybrids.

Aflatoxin Resistance: Our goal is to identify and develop corn inbreds with factors that reduce the risk of aflatoxin and have good agronomic performance in hybrids. We have used three locations in South Central Texas and inoculation with *Aspergillus flavus* (isolate NRRL3357) using the nonwounding silk channel or colonized corn kernels on the soil surface. At harvest, infected ears were husked, rated for kernel integrity and visible fungi colonization, shelled, ground with a mill, and evaluated for aflatoxin. Quantification of aflatoxin was conducted with monoclonal antibody affinity columns and fluorescence determination (Vicam Aflatest™).

These experimental screening techniques and inoculations have facilitated the display of genetic differences and increased heritability in aflatoxin evaluations. The response of inbreds to aflatoxin accumulation varies, depending upon the environment and the genetic background. Therefore, their evaluation in several hybrid combinations and multiple environments under inoculation has been necessary to identify the most consistent resistant germplasm.

Low aflatoxin accumulation was associated with good husk coverage, flinty endosperm texture, good kernel integrity, high grain yield, and late maturities. Selection for these associated traits having high heritabilities and strong correlation with low aflatoxin, in addition to low aflatoxin accumulation in inbreds and hybrids, has helped in reducing the risk of aflatoxin contamination. The less susceptible white inbreds in hybrids across evaluations in Texas have been CML176, and TX experimental lines derived from crosses among CML269, Tx110, CML78, and CML270. The less susceptible yellow inbreds have been TX experimental lines derived from crosses among CML288, Tx772, CML161, and NC300, and several lines from Tx69Q and LAMA breeding populations. Most of these lines have shown good agronomic performance and less aflatoxin than commercial hybrids in southern areas in testcrosses with testers LH195 and LH210, which are representative of heterotic groups commonly used in the U.S. The combined evaluations for aflatoxin and agronomic performance has facilitated the selection for adaptation, yield potential, stability, and reduced aflatoxin risk. Ultimately, we aim to incorporate aflatoxin resistant factors into elite genetic backgrounds suitable to produce commercial hybrids.

Flour Tortillas. In collaboration with the US Grain Marketing Lab in Manhattan, KS, a small-scale baking procedure to evaluate wheat cultivars for tortilla quality was devised and correlated with a pilot-scale hot-press tortilla procedure. The small scale test is being applied to wheat cultivar evaluation.

Flours with good bread baking properties usually do not produce good tortillas. Some combination of protein quality and content characterizes the properties of wheat flours that produce excellent tortillas. Tortilla flour specifications are still not understood. The utilization of selected protein isolates significantly improved the performance of flours that produce tortillas with short shelf stabilities and large diameters. The combination of protein isolates gives these weaker flours the ability to produce tortillas with optimum attributes. Multigrain low carb tortillas were produced

using different ingredients including sorghum and oat brans and various resistant starches.

Plans for 2005

Objective 2

Analyze the levels of tannins in sorghum and other common cereals to compare the levels of phenols and tannins using different tannin analysis and HPLC separation of the tannins.

Evaluate the levels of proanthocyanidins and other antioxidants in special sorghum cultivars with different genetics. Determine what happens to proanthocyanidins during friction type extrusion.

Evaluate factors affecting processing quality of corn and sorghum.

Continue efforts to develop aflatoxin resistant corn hybrids.

Determine factors affecting the staling of flour and corn tortillas. Evaluate wheat flours and other ingredients for tortilla quality.

Publications

Books

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Book Chapters

Rooney, L.W., Waniska, R.D., McDonough, C.M. and Serna-Saldivar, S.O. 2004. Tortillas. Encyclopedia of Grain Science. Colin Wrigley, Harold Corke and Chuck Walker, eds. Elsevier: Oxford, UK, Vol. 3, pp. 290-298.

Rooney, L.W. and Awika, J.M. 2004. Specialty sorghums for healthful foods. In: Specialty Grains for Food and Feed. Peter Wood and E. Abdelaal (eds.), AACC, St. Paul, MN, pp. 283-312.

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Issues

Sorghum quality for food is alleged to be inferior and sorghum is used only as livestock feed in the Western Hemisphere. Improved sorghum food quality must be developed to capture food and ingredient markets.

Corn quality for alkaline cooking and tortilla staling. Fresh corn tortillas have excellent taste and texture but many consumers have never tasted a fresh tortilla. Methods to maintain texture and taste during storage are needed.

What Was Done

New sorghum hybrids with significantly improved food characteristics were developed by incorporation of genetic material from the world collection. We devised methods to evaluate sorghum milling and food properties that were used to select food types of sorghum. Marketing of food sorghums is currently expanding.

Combinations of soy flour, guar gum, CMC and amylases were optimized to produce tortillas with optimum shelf stability. Other additives from soy were evaluated and some products had improved functionality in corn and flour tortillas.

Impacts

The PI has presented information on food products from white sorghum in workshops in South Africa, Mali, Central America and the USA. The new sorghums are especially important as a new grain for use in gluten free and ethnic foods. A source of good quality sorghum is available for use in food and feed products which has allowed production on new products.

The high levels of tannins in special sorghums have led to effective use of special sorghum bran fractions as preservatives for ground beef patties. Natural brown or black breads are also made from selected sorghums with high levels of antioxidants.

The understanding of what happens during tortilla staling has led to improved flavor and texture of tortillas which could significantly increase their consumption since they are low in fat and contain significant levels of calcium and fiber. A combination of maltogenic amylases, hydrocolloids and soy flour give tortillas longer shelf life in terms of rollability.

Usefulness of Findings

- The potential to produce aflatoxin resistant corn hybrids exists. More work is required to determine if this is

practical.

- Corn with improved nutritional quality and processing properties has been released.
- Snacks from U.S. identity preserved food sorghums are being sold in Japan.
- Food sorghums have excellent extrusion properties and produce bland, light-colored extrudates equivalent to rice.
- Whole sorghum can be extruded to produce excellent products for special dietary (celiacs) and ethnic needs.
- Special sorghums can be used to produce health foods containing high levels of antioxidants and insoluble fiber with a dark brown natural color.
- Wheat flour quality attributes for tortillas is significantly different from that of bread flour. Methods to evaluate the quality of wheat specifically for tortillas are available and are being used in breeding programs.

Objective 2

Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets.

NC-213 Objective 2

Project Objectives

Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets.

From

Illinois Agricultural Experiment Station
Agricultural and Biological Engineering Department
Urbana, IL

By

Paulsen, M.R.
Nimaiyar, S.
Rathore, S.
Newgard, E.

Results for 2004

In 2004, research continued on using near-infrared spectroscopy to measure extractable starch in corn. During the 1997 to 2004 crop years, over 3000 samples of corn were scanned on the Foss Infratec 1229 near-infrared transmittance (NIT) unit. Extractable starch was predicted using the Infratec 1229 and 1241 NIT spectrophotometers with a standard error of prediction (SEP) of 1.31, R^2 of 0.84 and a RPD of 2.4. The extractable starch calibration has been licensed to Foss North America and a new calibration will be available in January 2005.

Calibrations using Fourier Transform Near Infrared (FT-NIR) spectroscopy were developed in order to measure 16 amino acids and five fatty acids in soybean seeds. Fourier-transform near-infrared instruments have the advantage of providing better wavelength reproduction, resolution and greater light throughput than dispersive NIR instruments. FT-NIR spectroscopy is less expensive and more rapid than current analytical techniques and allows more extensive germplasm screening for the efficient selection of desired traits in the development of new varieties. Soybeans were obtained from four crop years 1999 through 2002 from the USDA/ARS National Germplasm Lab at the University of Illinois, Urbana-Champaign. Samples were scanned on a Perkin Elmer Spectrum One FT-NIR spectrophotometer. The instrument measured absorbance between 4000 per cm to 12000 per cm, with 8 per cm resolution. A total of 16 scans were averaged for each sample. Prior to building the calibration models using TQ Analyst v6 software, one-third of the samples were removed and placed in a validation set. Partial least squares were used to develop calibration and validation models. Calibrations for fifteen amino acids: aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, and arginine were developed. The FT-NIR calibration models obtained r values ranging from 0.45 to 0.91, RMSEP values from 0.08 to 0.32% db, and RPD values from 1.0 to 2.6.

Validation models for five fatty acids showed a wide range of r values (0.49 to 0.87), RMSEP (0.39 to 3.46% of total oil) and RPD (1.0 to 1.9). The results indicate that the FT-NIR calibration and validation models developed for ground soybean seeds are suitable for the determination of oleic, linoleic and linolenic acid content. The application of FT-NIR to the determination of palmitic acid and stearic acid needs refinement.

Plans for 2005

Plans for 2005 are to investigate sources of error relative to an extractable starch calibration and to develop methodology for measuring fermentation products with near infrared spectroscopy.

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- Paulsen, M.R., R.K. Stewart, and S.L. Hofing. 2004. Seven years of value-enhanced corn quality traits: What have we learned? Proceedings of the International Quality Grains Conference. Indianapolis, IN. July 19-22, 2004.
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- Singh, M., M.R. Paulsen, L.Tian, and H. Yao. 2004. Site-specific study of corn protein, oil, and extractable starch variability using NIT spectroscopy. Applied Engineering in Agriculture Joseph, MI 49085.

Issues

Ability to quickly measure extractable starch in corn and fatty acids and amino acids in soybeans.

What Was Done

Extractable starch yield was measured using NIT spectroscopy. Soybean fatty acids and amino acids were measured using FT-NIR spectroscopy.

Impacts

For corn used for wet milling, extractable starch is a highly important indicator of value. By selecting corn varieties with high extractable starch combined with low to moderate heat drying methods, higher extractable starch corn can be obtained with an estimated increase in value of 4-6 cents per bushel per percentage point of extractable starch.

Contacts

Marvin R. Paulsen, 360-B Agricultural Engineering Sciences Bldg., 1304 W. Pennsylvania Ave. ,Urbana, IL 61801; 217-333-7926; fax: 217-244-0323, e-mail: mpaulsen@uiuc.edu

NC-213 Objective 2

Project Objectives

Develop basic knowledge, science-based performance standards, and technologies that promote crop quality, food security, and food safety in grain markets. Iowa State has assisted a large country elevator in the creation of a certified quality management and product tracking system, based on the American Institute of Baking Quality Systems Evaluation System (QSE). The QSE system will be converted to the more management-based ISO 9000 format and applied to other grain and feed locations. At one location historic performance data sufficient to document the economic efficiency benefit of the quality management system will be compiled. A procedure and template for converting alternative or industry-specific quality management system formats to ISO 9000-2000 certifiable formats will be created.

From

Iowa State University
Department of Agricultural and Biosystems Engineering

By

Hurburgh, C.R. Jr.

Results for 2004

Quality Management Systems (QMS) have great potential to expand markets and improve efficiency of food production systems. While ISO 9000 is the most clearly recognizable QMS, industry specific systems have been used as effectively as a transition and educational process in the introduction of statistically based process controls. The largest producer owned grain handling firm in Iowa, Farmers Cooperative Elevator Company, Farnhamville, Iowa has taken the national lead in application of QMS for agricultural marketing.

Dr. Hurburgh remained the technical advisor to the company as 7 more of the company's 35 grain elevators became AIB Quality Systems Evaluation certified. The Odebolt elevator and the central grain marketing department became ISO 9000 certified on July 7, 2004, with KEMA Registrars of Netherlands as the registrar. The ISO certification added the dimension of upper management review of performance data generated in the statistical controls. The initial estimate of \$2 profit per \$1 invested in the QMS has remained, and a major study of performance benchmarks has begun. A spreadsheet-based perpetual inventory system has enabled the company to capture higher value by meeting customer specifications more closely with less material to be marketed as lower quality.

Two other large cooperatives have now started the QMS process with the recognition that this has the potential to transform how agribusiness operates. The materials, templates and statistical measures created by Iowa State are becoming recognized through the grain industry as the state of the art in this area. Traceability has emerged as a major concern in all food markets; one of the QMS statistics in the FC system is an index of traceability, to measure how precisely grain from the farm can be tracked to individual food lots sold by second and third stage processors.

Plans for 2005

Develop benchmarking metrics for the grain industry quality system. Create a draft ISO guideline for the grain industry. Quantify the benefits of quality systems in grain elevators. Document the present level of the traceability index in FC facilities and test run software intended to make significant improvements in bulk grain tracking.

Publications

Hurburgh, C.R., Jr. 2004. An ISO-based system for quality management and traceability in the US grain handling industry. Proc. International Grain Quality Conference, Indianapolis, IN. July 19-21, 2004. Invited presentation.

Hurburgh, C. R., Jr. 2004. Certification, Traceability and Security in the Grain Handling Industry. Educational Seminar, Grain Elevator and Processing Society, Ames, IA. January 21, 2004.

Hurburgh, C. R., Jr. 2004. Certification and Traceability in US Grain Markets. Sustainable Agriculture Colloquium, Ames, IA. February 4, 2004.

Hurburgh, C. R., Jr. 2004. Quality Management Systems for Elevators. NC 213 Multistate Annual Technical Meeting, Minneapolis, MN. February 25, 2004.

Hurburgh, C.R., Jr. 2004. Impact and operational response to traceability in US commodity markets. Abstract 69. 2004 American Association of Cereal Chemists Annual Meeting, San Diego, CA. September 20, 2004. Invited presentation.

Hurburgh, C.R., Jr. 2004. Certification, and Product Traceability in the Grain Handling Industry. Purdue University International Training Seminar, Purdue University, W. Lafayette, IN. December 15, 2004. Invited Presentation.

Issues

Consumers and food retailers are demanding steps to verify that security and health risks are protected and that the food can be tracked to its source in the event of problems. Affluent consumers are willing to pay for such assurances, and the United States has an opportunity to convert what was thought to be a problem (differentiation) into a competitive advantage.

Impacts

The US grain industry is adapting to food safety, biosecurity, consumer right to know and other market pressures by instituting systems that will not only meet the needs but improve efficiency as well.

NC-213 Objective 2

Project Objectives

Develop basic knowledge, science-based performance standards, and technologies that promote crop quality, food security, and food safety in grain markets. High value (pharmaceutical, industrial) grains will require extremely stringent isolation from staple commodities if they are to be grown in commodity-producing areas. Operations from planting to end-use will be quantitatively assessed for their potential to contribute either accidental or malicious mixing. Estimates will be pooled in 3 case-study traceability models, which will then be used to create a standard evaluation template.

From

Iowa State University
Department of Agricultural and Biosystems Engineering

By

Hurburgh, C.R. Jr.
Iowa Grain Quality Initiative Group

Results for 2004

A conceptual and flowchart analysis of grain isolation/traceability was initiated, along with an inventory of current providers of quality management system/traceability services. The first case study, nonGMO consumer traits (low linolenic soybeans) was started, with data collected from two producer groups. There will be two other case studies. Two doctoral students are working on the project.

Plans for 2005

Complete review of traceability literature/providers and draft white paper to include operations flowcharts and potential policy issues. Analyze low linolenic soybean data provided by producers. Create first version of economic/operational analysis spreadsheet. Plan Market Choices and non-food, non-feed case studies.

Publications

Hurburgh, C. R., Jr. 2004. Certification and source verification in the bulk corn market. Proceedings of the Corn Utilization Conference, June 7, 2004. National Corn Growers Association, St. Louis, MO. Invited presentation.

Hurburgh, C.R., Jr. 2004. Impact and operational response to traceability in US commodity markets. Abstract 69. 2004 American Association of Cereal Chemists Annual Meeting, San Diego, CA. September 20, 2004. Invited presentation.

Jarboe, D., R. Ginder, and C.R. Hurburgh, Jr. 2004. Corn stewardship for biotechnology corn. Proc. Int'l Grain Quality Conference, Indianapolis, IN. July 19-21, 2004.

Jensen, J.H. and P. Kassel. 2004. Growing and marketing low linolenic soybeans – a value added opportunity. Proc. 16th Integrated Crop Management Conference, Iowa State University Extension, Ames, Iowa. December 2, 2004.

Issues

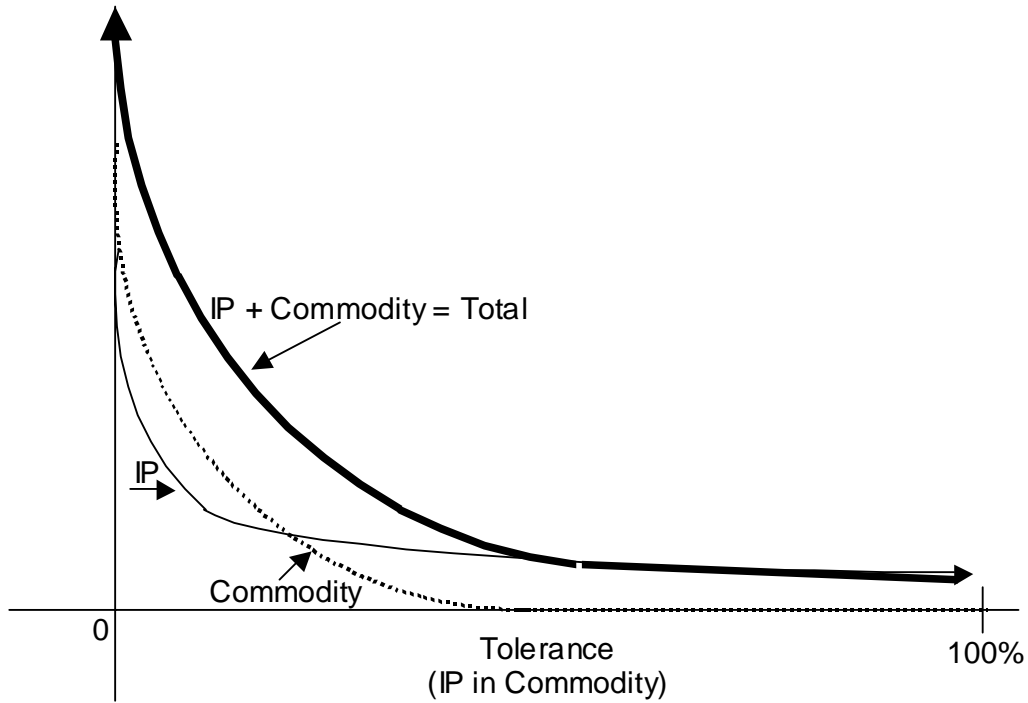
World markets and economic conditions in affluent nations are driving US grain markets toward differentiation

based both on traits of value and avoidance to consumers. The US has an opportunity to regain competitive edge that has been lost in commodity production.

Impacts

This project has already led to the organization of an ISO work item proposal for Ag Quality Systems standards. The information gained from the producers of low linolenic soybeans is being used to create benchmarking metrics against which benefits of quality management systems with their associated traceability can be measured. ISU scientists have been invited to participate in similar studies/policy formulations in the EU.

Figure 1. Conceptual analysis of costs and efforts for segregating bulk commodities



NC-213 Objective 2

Project Objectives

Assess the constraints and profitability of implementing a certifiable quality management system for identity-preserved (IP) marketing of trait specific grains.

From

Kansas State University

By

Herrman, T.J.
Tilley, K.
Maghirang, R.

Results 2004

Maize kernel hardness and proximate constituents were evaluated by several methods. Proximate constituents and hardness-associated properties were significantly correlated, and their correlation coefficients were improved when moisture, protein, and oil contents were kept constant. Multivariate techniques were applied to create new sets of variables to characterize maize hardness. The principal component scores created by principal component analysis (PCA) were subjected to cluster analysis and discriminant analysis. A total of 248 maize samples were grouped into 7 and 10 subgroups by cluster analysis. The groups resulting from cluster analysis seem to have unique physical and chemical properties showing the different order in values of hardness measurements. The application of discriminant analysis to create a classification rule for hardness clusters revealed that new observations had an 87% correct classification into hardness clusters. The biochemical determinants of maize kernel hardness and their roles during extrusion processing were explored in an attempt to improve maize hybrid selection criteria for breeders, producers, and end-users. A representative hybrid from each cluster was selected for extrusion experiments. Maize hybrids representing each hardness cluster showed unique RP-HPLC chromatograms depending on endosperm texture. Maize kernel hardness significantly affected both the physical and textural properties of extrudates, including expansion ratio (ER), specific mechanical energy (SME), water absorption index (WAI), water solubility index (WSI), and oil absorption capacity (OAC). Extrudates from harder grits had lower protein solubility and greater protein aggregation after extrusion. Proteins in softer grit extrudates were more easily dissociated and degraded into smaller molecules as screw speed increased, which resulted in higher protein solubility and greater WAI, WSI, and OAC under similar extrusion processing conditions and starch properties.

A study was conducted to assess commingling in a country elevator in Manhattan, Kansas. The elevator, which has a capacity of 190 t/h, has 3 receiving pits and one leg. Soybeans were moved through one of the receiving pits followed by corn through the same flow path for each test without special cleaning in between these two operations. Samples were collected at specific time intervals during grain the corn transfer and analyzed for commingling. Commingling was calculated as percentage of soybeans mixed in corn. Commingling was greater than 1% only during the first 135 s (first 2 t received), except for the gravity-type pit configuration in which commingling remained in excess of 1% for the duration of the test (840 s or 7.3 t of grain). Measured mean cumulative commingling values at the end of operation were 1.25%, 0.30% and 0.23% for the combined effect of gravity-type pit and elevator leg, combined effect of leg and pit with drag conveyor, and effect of the leg, respectively. Computer simulations using SIMAN/ARENA predicted that a 10 t load through a pit with drag conveyor would result in a cumulative commingling of 0.28%, of which 0.27% would be from the effect of the leg.

Plans 2005

Complete the corroborative study involving other university and industry laboratories performing maize and sorghum quality evaluation.

Build a classification system for identifying maize and sorghum hybrids best suited for wet-milling, dry milling, and alkaline processing.

Prepare scientific manuscripts.

Impacts

Corn growers in KS, MO, NE, and IA can better identify corn hybrids best suited for dry milling and extrusion processing and have improved their profitability. Expansion of this research to include the eastern cornbelt and sorghum, and examining wet milling and alkaline processing in collaboration with colleagues from ARS and UNL will result in a similar benefits.

Publications

Lee, K.M., T.J. Herrman, J.E. Lingenfelter, and D. Jackson. 2004. Classification and prediction of hardness-associated properties using multivariate statistical analysis. *J. Cereal Sci.* In Press.

Tilley, M., R. E. Benjamin, P. Srivarin and K. A. Tilley. 2004. Nonenzymatic preparative-scale synthesis of dityrosine and 3-bromotyrosine. *Anal. Biochem.* 334:193-195.

Tilley, M. and K. Tilley. 2004. Modifying tyrosine crosslink formation in wheat dough by controlling innate enzymatic activity. *In: Proceedings of 12th ICC Cereal & Bread Congress.* Harrogate UK. 22- 26 May 2004

Presentations

Herrman, T.J., R. Bowden, M. Langemeier, and M. Schrock. 2004. Strategies to manage Karnal bunt and retain global markets. International Quality Grains Conference, Indianapolis, Indiana.

Ingels, M.E.A., M.E. Casada, R.G. Maghirang, and T.J. Herrman. 2004. Grain commingling at receiving in a country elevator. International Quality Grains Conference, Indianapolis, Indiana.

Tilley, M. and K. Tilley. Modifying tyrosine crosslink formation in wheat dough by controlling innate enzymatic activity. 12th ICC Cereal & Bread Congress. Harrogate UK. 22-264 May 2004

NC-213 Objective 2

Project Objectives

The primary objectives of our work in 2004 were to study the effects of low temperatures on mortality of Indian meal moth (*Plodia interpunctella*), to model temperatures inside grain bins under various management schemes, and to use this information to develop stored grain management recommendations that will reduce problems with Indian meal moth (IMM).

From

University of Minnesota
Biosystems and Agricultural Engineering Department
Entomology Department

By

Morey, R.V., University of Minnesota Biosystems and Agricultural Engineering Department
Wilcke, W.F., University of Minnesota Biosystems and Agricultural Engineering Department
Kaliyan, N., University of Minnesota Biosystems and Agricultural Engineering Department
Carrillo, M., University of Minnesota Entomology Department

Results for 2004

Accomplishments and results for 2004 include:

- Collected data on mortality for laboratory cultures of fifth-instar *P. interpunctella* exposed to -10°C for different periods of time. Laboratory larvae reached 100% mortality after 12 h exposure while cold-acclimated larvae reached 100% mortality after 312 hours.
- Conducted a field experiment starting in fall 2003 through winter 2004 to determine the mortality of cold acclimated fifth-instar *P. interpunctella* under field conditions (in grain bins). Larvae were placed in cages and sampled every 15 days. Temperatures ranged from 0 to -10°C. Mortality increased throughout the test with 100% mortality reached after about 60 days.
- Completed and submitted a manuscript describing supercooling point (SCP) variability to *Journal of Stored Products*. The manuscript is currently in press.
- Completed a computer model to simulate temperatures of the grain bin headspace and grain within one meter of the top surface both for conditions of natural ventilation of the headspace as well as aeration of the grain bulk. Used the model to evaluate headspace and grain temperatures under natural ventilation. Results showed that for galvanized steel bin surfaces, increasing openings in the headspace to increase natural ventilation reduced headspace-air and grain temperatures. For white colored bin surfaces, minimizing natural ventilation reduced headspace-air and grain temperatures. Submitted a paper for publication of this work.
- Developed a cumulative lethality index (CLI) model to estimate mortality of *P. interpunctella* larvae under changing temperature conditions. A CLI greater than 1 corresponds to 100% mortality.
- Used simulation studies to develop practical weather-based management for controlling cold-acclimated, diapausing *P. interpunctella* larvae. Simulations included use of winter ambient air for twelve locations: Minneapolis-St. Paul, MN; Des Moines, IA; Grand Island, NE; Kansas City, MO; St. Louis, MO; Indianapolis, IN; Columbus OH; Lexington, KY; Wichita, KS; Oklahoma City, OK; Chattanooga, TN; and Little Rock, AR. A CLI corresponding to 100% mortality at 0.4 m depth during the period of December through February was used as the criteria for success. For storage with no aeration during the three winter months, a CLI sufficient to create 100%

mortality was not reached at the 0.4 m depth for any of the locations, including Minneapolis-St. Paul, MN. However, when an aeration strategy based on running the fan when the temperature at 0.4 m was less than the headspace temperature was used, CLI values sufficient to obtain 100% mortality were easily reached at 9 out of 12 locations. Even the three southern-most locations reached the 100% mortality criteria at the 0.4 m depth in an average year.

Plans for 2005

In 2005, we plan to complete the 2004-2005 field tests, analyze data from those experiments and publish the results. We will also refine the CLI model and complete publication of the headspace ventilation and weather-based simulation modeling work.

Publications

Carrillo, M.A., Kaliyan, N., Cannon, C.A., Morey, R.V., and Wilcke, W.F. 2004. A simple method to adjust cooling rates for supercooling point determination. *CryoLetters* (25) 155-160.

Carillo, M.A. and C.A. Cannon. 2005. Supercooling point variability in the Indian meal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae). *Journal of Stored Products Research*. In Press.

Kaliyan, N., Morey, R.V., W.F. Wilcke, M.A. Carrillo, and C.A. Cannon. 2004. Evaluating low temperatures to control Indian meal moth in stored grain. ASAE/CSAE Meeting Paper No. 046135. ASAE St. Joseph, MI 49085.

Issues

Alternatives to chemical insecticides are needed for managing stored grain insects. Insects have become resistant to some traditional stored grain chemical insecticides and there is growing concern about the impact of insecticides on the environment and on human health. It is well known that insect activity slows as temperature decreases. Most insects become dormant below certain critical temperatures and many insects die if held at a low enough temperature for a long enough time. In the northern parts of the U.S. grain growing areas, it should be possible to manage stored grain insect populations by using aeration with outdoor air to control temperatures inside bins of stored grain at levels that limit insect activity and possibly even kill insects. More information is needed on the specific time-temperature relationships needed to kill insects and on the typical number of hours available at various outdoor temperatures in order to develop recommendations that can be used to limit stored grain insect populations and reduce the need for chemical insecticides.

What Was Done

We collected data on mortality for laboratory cultures of fifth-instar *P. interpunctella* exposed to -10°C for different periods of time.

We conducted a field experiment starting in fall 2003 through winter 2004 to determine the mortality of cold acclimated fifth-instar *P. interpunctella* under field conditions (in grain bins).

We developed a computer model to simulate the temperature of headspace and grain in the upper 1.0-m depth. This model can be used for any geographical location. The model requires readily available inputs such as bin and grain properties, and local weather information such as air temperature, solar radiation, and wind speed. The model outputs the temperatures of headspace and grain layers to a depth of 1.0-m from the top surface for mechanically ventilated and unventilated headspace conditions.

We developed a cumulative lethality index (CLI) model to estimate mortality of *P. interpunctella* larvae under changing temperature conditions.

We used simulation studies to develop practical weather-based management for controlling cold-acclimated,

diapausing *P. interpunctella* larvae. Simulations included use of winter ambient air for twelve locations.

We conducted a field experiment starting in fall 2003 through winter 2004 to determine the mortality of cold acclimated fifth-instar *P. interpunctella* under field conditions (in grain bins).

Impact

It is expected that this research will lead to recommendations for storage bin equipment and for stored grain management that can be used to limit insect populations without the use of chemical insecticides. Reduced use of chemical insecticides should reduce grain storage costs and reduce potential harmful environmental and human health impacts from chemical insecticides.

Overall Results

Our objectives are to measure supercooling points and lower lethal temperatures for Indian meal moth, analyze weather records, and use computer models so that we can develop new stored grain management recommendations that take advantage of low outdoor temperatures as an alternative to chemical insecticides in managing stored grain insects. We have developed a technique for measuring supercooling points of insects, we have measured supercooling points for Indian meal moths, we collected data on mortality for laboratory cultures of fifth-instar *P. interpunctella* exposed to -10°C for different periods of time, we determined mortality under field conditions, we have analyzed 35 years of upper Midwest weather data, we have developed computer models for predicting temperatures inside grain storage bins, and we have developed some grain storage management strategies that should allow use of cold temperatures rather than chemical insecticides to manage insect populations.

NC-213 Objective 2

Project Objective

Determine the fate of mycotoxins in grains and processed grain-based foods and to search for and screen food grade lactic acid bacteria and other biological agents for antifungal activity that may be useful in preventing mold invasion, and growth in grains, and possible degradation of mycotoxins.

From

University of Nebraska
Department of Food Science & Technology

By

Lloyd B. Bullerman

Results for 2004

This work is funded in part by an Anderson Research Grant Award. This report covers the first year of work on this grant. The specific goal of this work is to assess the reduction in toxicity of fumonisin during extrusion cooking of contaminated corn grits using chemical, biochemical and bioassay methods. The work this year has concentrated on producing the contaminated corn grits for the extrusion process. This was done by growing two fumonisin producing strains of *Fusarium proliferatum* on flaking corn grits. The moisture content of the grits was adjusted to 35-40% and then the grits were sterilized by autoclaving. After autoclaving and cooling the grits were inoculated with the two strains and incubated at ambient temperature (20-25C). It was determined that the target level of fumonisin that needed to be achieved was approximately 50 mg/Kg (50 ppm). This work is in progress and currently is concentrated on achieving the desired concentration in a small batch of 25 Kg or about one bushel. Once the desired concentration in this small quantity is reached, the entire quantity will be used to inoculate 30 to 35 bushels (800-900 Kg). Once the larger batch reaches a fumonisin concentration of 50 ppm, the contaminated grits will be used for extrusion studies. Presently, problems in reaching the desired concentration of fumonisin have been encountered and are being addressed.

Plans for 2005

In 2005 the contaminated grits will be extruded at extruder barrel temperatures of 150 to 200 C and screw speeds of 50 to 150 rpm, with and without glucose added to the grits. Extruded corn grits will be analyzed for loss of fumonisin by high performance liquid chromatography (HPLC) and enzyme-linked immunosorbent assay (ELISA). Extruded corn grits will also be analyzed to determine the identity of any degradation products of fumonisin using liquid chromatography and mass spectrometry (LC-MS). And finally, the extruded corn grits will be tested to determine the loss of fumonisin toxicity using an *in vivo* rat bioassay, by feeding the extruded contaminated corn grits to rats. This will prove if any apparent loss of fumonisin, as measured by the HPLC and ELISA tests, is real and can be confirmed by the rat feeding trial.

Issues

The main issue is to prove whether or not the toxicity of fumonisin is destroyed or reduced by extrusion processing using a rat feeding trial/bioassay.

A secondary issue is to solve a technical problem to be able to produce corn flaking grits containing 50 ppm fumonisin.

What Was Done

Corn flaking grits were inoculated with two fumonisin producing strains of *Fusarium proliferatum* in attempts to produce grits containing 50 ppm of fumonisin for extrusion studies. Work is in progress to increase the fumonisin concentrations from 30 to 50 ppm.

Impacts

The impact of this work, if it is successful, will be to generate conclusive evidence of reduction in toxicity of fumonisin in corn by extrusion processing using a sensitive rat bioassay. This will help to improve the safety of extruded corn-based foods for human food and for animal pet foods.

Usefulness of Findings

The findings will be useful to both regulatory agencies and the food industry, and ultimately the general public who consumes corn based food products, to show that extrusion processes help reduce the fumonisin contamination of corn products.

NC-213 Objective 2

Project Objectives

1. To survey microbial indicators for the HRS and durum wheat crop from the Northern Plains of the United States.
2. To compare microbial indicators for the HRS and durum wheat crop from the Northern Plains region of the United States to quality attributes, weather patterns and other available production practice data.
3. To evaluate ozone treatments as a means to reduce microbial loads and degrade mycotoxins in post-harvest wheat.

From

North Dakota State University

¹Department of Veterinary and Microbiological Sciences

²Department of Plant Sciences

By

Wolf-Hall^{1*}, C.E.

Manthey^{2*}, F.A.

Chakraborty^{2*}, M.

Results for 2004

The 2003 hard red spring (HRS) and durum wheat harvest of the Northern Plains was surveyed for quality, microbial loads and mycotoxins. Figure 1 indicates the districts sampled for the durum harvest, and Figure 2 indicates the districts sampled for the HRS harvest. This report is a preliminary summary of this database, but is not a comprehensive report of all data or data analyses.

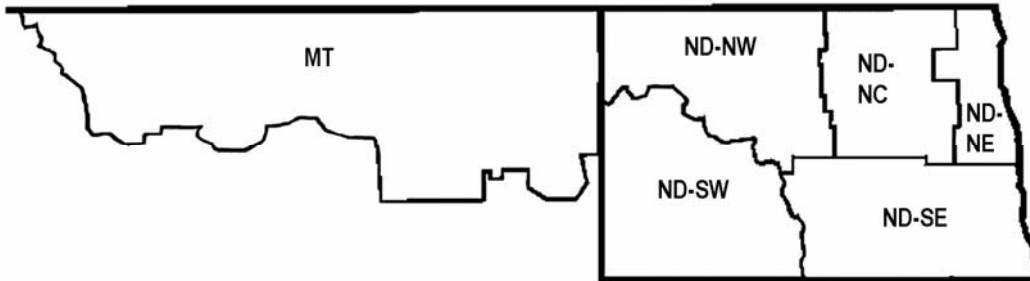


Figure 1. Durum wheat producing districts in the Northern Plains region of the USA.

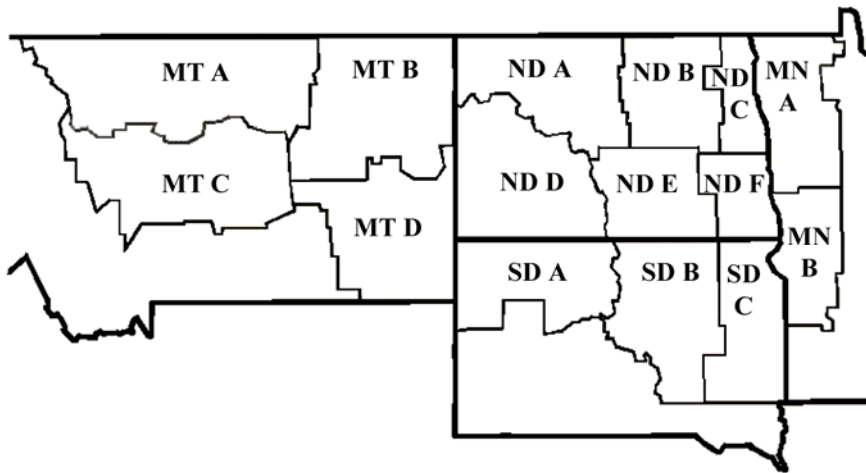


Figure 2. Hard red spring wheat producing districts in the Northern Plains region of the USA.

Table 1 lists the microbial tests done for this survey. If plate counts were below quantification limits, estimated counts were done.

Table 1. Microbial tests, abbreviations, methods, and limits.

<u>Test</u>	<u>Abbreviation</u>	<u>Method</u>	<u>Detection or Quantification Limit</u>
Aerobic plate count	APC	3M Petrifilm ^a	250 colony forming units (CFU)/gram
Mold and yeast count	MYC	3M Petrifilm	150 CFU/gram
Internal mold infection	IMI	Wolf-Hall & Bullerman ^b	1 infected kernel in 100 kernels (1%)
Internal <i>Fusarium</i> Infection	IFI	Wolf-Hall & Bullerman	1 infected kernel in 100 kernels (1%)
Coliform	Coli	3M Petrifilm	150 CFU/gram
<i>Escherichia coli</i>	<i>E. coli</i>	3M Petrifilm	150 CFU/gram
<i>Staphylococcus aureus</i>	<i>S. aureus</i>	3M Petrifilm	150 CFU/gram
Mesophilic spore formers	Meso	Compendium ^c	1 spore per gram
<i>Bacillus cereus</i>	<i>B. c.</i>	Compendium	3 most probable number (MPN)/g
<i>Salmonella</i> spp.	<i>Salmonella</i>	Neogen Reveal ^d	1 cell/g (±)
<i>Listeria monocytogenes</i>	<i>Listeria</i>	Neogen Reveal	1 cell/g (±)
Deoxynivalenol	DON	GC/MS ^e	0.5 µg/g
15-acetyldeoxynivalenol	15-ADON	GC/MS	0.5 µg/g
Nivalenol	NIV	GC/MS	0.5 µg/g

^ahttp://solutions.3m.com/wps/portal/_s.155/92879/_s.155/92845

^bWolf-Hall, C.E. and L.B. Bullerman. 1998. Characterization of *Fusarium graminearum* strains from corn and wheat by deoxynivalenol production and RAPD. *J. Food Mycol.* 1:171-180.

^cCompendium of Methods for the Microbiological Examination of Foods, 4th Edition.

^d<http://www.neogen.com/foodbornebacteria.htm>

^eTacke, B.K. and H.H. Casper. 1996. Determination of deoxynivalenol in wheat, barley, and malt by column cleanup and gas chromatography with electron capture detection. *J. Assoc. Offic. Anal. Chem.* 79:472-475.

Table 2 summarizes the microbial data from the durum harvest by district. No *E. coli*, *Staphylococcus aureus*, *Salmonella* or *Listeria* were found in the durum samples.

Table 2. Ranges, means and standard deviations for microbial analyses of **durum** wheat samples from the **2003 crop**, categorized by district.

Test ^{ab}	MT N=36			ND- NW N=70			ND- NC N=45			ND- NE N=33			ND- SW N=33			ND- SE N=15			Region N=232		
	R^c	M^d	S^e	R	M	Std	R	M	S	R	M	S	R	M	S	R	M	S	R	M	S
APC	3.0- 6.4	4.3	0.8	3.0- 6.0	5.0	0.7	3.7- 6.4	5.2	0.7	4.7- 6.9	5.9	0.5	3.0- 6.1	4.3	0.9	3.7- 7.0	5.5	0.8	3.0- 7.0	5.0	0.9
MYC	2.3- 4.7	3.4	0.7	3.1- 5.1	4.0	0.5	3.2- 5.1	4.3	0.5	3.1- 4.9	4.3	0.4	2.2- 4.6	3.6	0.7	3.2- 5.0	4.2	0.6	2.2- 5.1	4.0	0.6
IMI	1-95	54	30	43- 100	81	13	45- 100	87	13	84- 100	99	3	4-98	44	28	43- 100	87	17	1-100	76	26
IFI	0-86	24	21	3-95	38	21	8-93	48	24	15- 100	83	19	1-58	17	16	9- 100	60	25	0-100	43	29
Coli	0-2.3	0.8	1.5	0-1.0	-	0.1	0-1.4	0.1	0.7	0-0	0	0	0-1.5	0.2	0.8	0-0	0	0	0-2.3	0.2	1.1
Meso	1.2- 3.2	2.5	2.5	1.2- 3.2	2.6	2.6	1.3- 3.6	2.5	2.8	1-3.5	2.4	2.7	1.4- 3.4	2.7	2.8	1.7- 2.9	2.4	2.4	1-3.6	2.5	2.7
<i>B. c.</i>	0-43	3.2	7.6	0-0	0	0	0-0	0	0	0- 1,100	37	191	0- 240	13.8	41.4	0-0	0	0	0- 1,100	5.9	64.6
DON	0-0.7	0.0	0.1	0-1.6	0.1	0.2	0-2.5	0.3	0.5	0-8.3	2.5	1.9	0-0	0	0	0-4.2	0.7	1.4	0-8.3	0.5	1.2

^a microbial counts for APC, MYC, Coli, and Meso in log₁₀ CFU/g; IMI and IFI in %; *B. c.* in MPN/g; and DON in µg/g.

^b0 = none detected

^cR = range

^dM = mean

^eS = standard deviation

Table 3 summarizes the data from the HRS harvest by state. No *Staphylococcus aureus*, *Salmonella* or *Listeria* were found in the HRS samples.

Table 3. Ranges, means and standard deviations for microbial analyses of HRS wheat samples from the 2003 crop, categorized by state.

Test ^{ab}	Minnesota N=51			Montana N=84			North Dakota N=168			South Dakota N=43			Region N=346		
	R^c	M^d	S^e	R	M	S	R	M	S	R	M	S	R	M	S
APC	3.8-5.8	5.1	0.5	1.6-7.5	3.5	1.0	2.3-6.3	4.8	1.0	2.3-6.2	4.1	1.0	1.6-7.5	4.4	1.1
MYC	2.0-4.5	3.8	0.6	1.0-6.8	2.8	1.0	1.9-5.5	3.9	0.6	2.6-4.8	3.8	0.5	1.0-6.8	3.6	0.8
IMI	79-100	97	4	0-96	34	28	20-100	87	18	32-100	87	20	0-100	76	31
IFI	14-98	64	20	0-73	7.0	11	0-95	39	27	0-90	38	28	0-98	35	29
Coli	0-1.8	0.4	1.0	0-2.0	0.8	1.2	0-2.4	0.7	1.4	0-1	0.1	0.5	0-2.4	0.6	1.3
<i>E. coli</i>	0-0	0	0	0-1	-1.0	0.04	0-1.0	-0.1	-0.1	0-0	0	0	0-1.0	-1	-0.1
Meso	0.6-3.6	2.4	2.8	0.6-7.4	4.5	5.5	0.3-4.0	2.6	3.0	0.8-3.4	2.4	2.6	0.3-6.4	3.9	5.2
<i>B. c.</i>	0-0	0	0	0-240	10.7	39.6	0-93	7.5	14.6	0-0	0	0	0-0	0	0
DON	0-1.8	0.4	0.5	0-1.0	0.1	0.2	0-7.1	0.5	0.9	0-0.9	0.1	0.2	0-7.1	0.3	0.7

^a microbial counts for APC, MYC, Coli, *E. coli*, and Meso in log10 CFU/g; IMI and IFI in %; *B. c.* in MPN/g; and DON in µg/g.

^b0 = none detected

^cR = range

^dM = mean

^eS = standard deviation

Nivalenol and 15-ADON were not detected in the durum or HRS samples. For *Salmonella* and *Listeria*, only one sample each from composite district samples for HRS wheat gave an initial positive result from the Reveal[®] tests. However, after confirmatory testing the *Salmonella* was determined to be negative and the *Listeria* species isolated was *L. welshimeri* (non-pathogenic) and not *L. monocytogenes*. No *Staphylococcus aureus* was found in either HRS or durum wheat.

Table 4 summarizes correlation coefficients which showed statistically significant relationships between microbial indicators and grading and nongrading factors for durum wheat.

Table 4. Statistically significant (P = 0.001) correlation coefficients for data from the 2003 durum and HRS wheat harvests.

Durum	DON	Test Weight ^a	Damage^a	Grade ^a	Kernel Weight^b
APC	0.41	-0.37	0.34		0.51
MYC		-0.39			0.45
IMI	0.34	0.63	0.25		0.65
IFI	0.52	0.50	0.35		0.58
DON			0.69		0.31
HRS					
APC	0.31	0.39	0.34	-0.24	0.46
MYC		0.47	0.21	-0.36	0.40
IMI	0.25	0.65	0.26	-0.51	0.59
IFI	0.25	0.40	0.20	-0.29	0.45
DON			0.59		

^aGrading factor

^bNongrading factor

This database provides useful information for evaluating microbial quality and safety aspects of the HRS and durum wheat crops from the Northern Plains region. Data analysis is ongoing and will be combined with data from the 2004 harvest and the data available from the 2001-2002 harvests along with other data such as weather pattern data for predictive modeling.

Initial experiments using gaseous ozone on whole grain have indicated that ozone may reduce microbial loads, but requires fairly large dosages (>1,000 ppm) to penetrate the seed. We are in the process of developing a bench-scale experimental design to evaluate effective dosages and exposure times for whole grain. A similar design will be used to evaluate the effectiveness of treatments for different processing fractions, which would have smaller particle sizes.

Plans for 2005

We will complete the survey of the 2004 harvest. We will continue the data analysis from the survey studies. We will continue the ozone experiments.

Publications

Manthey, F.A., C.E. Wolf-Hall, S. Yalla, C. Vijayakumar, D. Carlson. 2004. Microbial Loads, Mycotoxins and Quality of Wheat from the 2001 Harvest of the Northern Plains Region, USA. *J. of Food Protection*. 67(4):772-780.

Issues

Monitoring of overall and specific microbial loads in hard red spring and durum wheat would be prudent to establish microbial specifications, as an indicator of potential problems that may develop as production and processing practices change, and as a surveillance mechanism for bio-security. Comparing microbiological indicators to other quality attributes and finished product quality will also help in determining science-based specifications for HRS and durum wheat.

What Was Done

The 2003 hard red spring and durum wheat harvest of the Northern Plains region was surveyed for quality, microbial loads and mycotoxins. Experiments evaluating ozone in whole grain were initiated.

Impacts

This project will contribute to the process of determining appropriate microbial specification levels for wheat destined for food processing and an understanding of how these microflora may relate to wheat quality and end use. The survey database generated will be available for those interested in wheat quality and safety. The evaluation of ozone as a means to lower microbial loads and mycotoxin content may lead to a method that will add value and safety to portions of the wheat crop.

NC-213 Objective 2

Project Objectives

To evaluate methods to treat *Fusarium* head blight (FHB) infected barley in order to prevent *Fusarium* growth and mycotoxin production during malting.

From

North Dakota State University

¹Department of Veterinary and Microbiological Sciences

²Department of Plant Sciences

By

Wolf-Hall^{1*}, C.E.

Schwarz², P.B.

Results for 2004

Utilization of *Fusarium* infected barley for malting may lead to mycotoxin production and decreased malt quality. Methods for treatment of *Fusarium* infected barley may prevent these safety and quality defects and allow use of otherwise good quality barley. Gaseous ozone and hydrogen peroxide were evaluated for effectiveness in reducing *Fusarium* survival (FS) while maintaining germinative energy (GE) in barley. Gaseous ozone treatments (GOT) included concentrations of 11 and 26 mg/g for 0, 15, 30, and 60 minutes. Hydrogen peroxide (HP) treatments included 0, 5, 10, and 15% concentrations with exposure times of 0, 5, 10, 15, 20, and 30 minutes. For GOT, in naturally *Fusarium*-infected barley, a statistically significant ($P < 0.05$) decrease (24-36%) of FS occurred within 15 minutes of exposure at either concentration. GE was significantly ($P < 0.05$) affected by 30 minutes at both concentrations in naturally *Fusarium* infected barley, but not in sound barley. GOT did not cause any significant ($P > 0.05$) effect on GE in sound barley at either concentration over the full 30 minute exposure time. For HP, FS was significantly decreased (50-98%) within 5 minutes of exposure. With the exception of two treatments (10% and 15% HP agitated for 20 minutes) GE was not statistically significantly different from the control in naturally *Fusarium* infected barley. In sound barley, HP had no significant ($P > 0.05$) effect on GE. The results suggest that GOT and HP may have potential for treatment of *Fusarium* infected malting barley.

Plans for 2004

Continue screening treatment methods, including physical, chemical and biological methods for effects on FI and GE. Effective treatments will be further studied for effects on malting quality and mycotoxigenesis of surviving *Fusarium*. Effects will also be determined for these treatments on overall microbial loads in malt. The most effective treatments will be evaluated for economic feasibility.

Publications

Boddeda, A. and C.E. Wolf-Hall. 2004. RAPD analysis of *Fusarium graminearum* isolates from electron beam irradiated barley. Poster abstract from the 2nd International Symposium on Fusarium Head Blight Incorporating the 8th European Fusarium Seminar. Orlando, Florida, December 11-15.

Kottapalli, B., C.E. Wolf-Hall, and P.B. Schwarz. Evaluation of Gaseous Ozone and Hydrogen Peroxide Treatments for Reducing *Fusarium* Survival in Malting Barley. J. Food Protection. Submitted.

Kottapalli, B., C.E. Wolf-Hall, and P. Schwarz. 2004. Effect of electron-beam radiation on the safety and quality of *Fusarium* infected malting barley. Abstract from presentation at the 2004 Institute of Food Technologists national meeting in Las Vegas, Nevada, July 12-16.

Kottapalli, B., C.E. Wolf-Hall, and P. Schwarz. 2004. Mathematical models for predicting the effect of electron-beam radiation on the safety and quality of *Fusarium* infected malting barley. Poster abstract from the 2004 World Brewing Congress Conference in San Diego, California. July 25-28.

Kottapalli, B., C.E. Wolf-Hall, and M.B. Rao. 2004. Mathematical models for hot water, electron beam radiation, and hydrogen peroxide treatments on the survival of *Fusarium* spp. and germinative energy in malting barley. Poster abstract from the International Association for Food Protection annual meeting. Phoenix, Arizona, August 8-11.

Kottapalli, B., C.E. Wolf-Hall, and P.B. Schwarz. 2004. Evaluation of ozone and hydrogen peroxide treatments for preventing post-harvest *Fusarium* infection in malting barley. Poster poster abstract from the 2nd International Symposium on Fusarium Head Blight *Incorporating the 8th European Fusarium Seminar*. Orlando, Florida, December 11-15.

Issues

Barley with mild FHB may lead to the production of mycotoxins during malting. Maltsters have strict limits for malt quality that ultimately have severely affected barley production in the USA. Treatment of FHB infected barley may prevent mold growth and further mycotoxin production during malting allowing utilization of otherwise good quality barley. Another issue for food-grade malt producers is high microbial loads in finished malt. The treatments we find effective for control of *Fusarium* during malting may also be effective in reducing levels of other undesirable microbial flora.

What Was Done

Ozone and hydrogen peroxide were evaluated for treating FHB infected malting barley.

Impacts

The results suggest that ozone and hydrogen peroxide may be applicable for treating mildly FHB infected barley. This research could ultimately lead to processing practices that allow increased utilization of US barley for malting.

NC-213 Objective 2

Title

Development and Modeling of a Continuous-flow Dryeration Process

Summary

This project is part of an effort to provide for the implementation of the dryeration process at on-farm and commercial grain facilities where high grain quality is to be obtained at high throughput capacities. We set up a small prototype continuous-flow dryeration (CFD) system and collected data for a range of operating conditions. We also conducted single kernel moisture content and stress crack analysis tests while corn steeped in the tempering bin. We are now working on a computer simulation model to optimize the CFD process and finalize a commercial design.

Project Objectives

This project is part of an effort to provide for the implementation of the continuous dryeration process at on-farm and commercial grain facilities where high grain quality is to be obtained at high throughput capacities. The specific objectives are:

1. Collect performance data on a small prototype continuous-flow dryeration (CFD) unit during the 2003 and 2004 crop drying seasons, and develop system improvement recommendations for a large prototype CFD unit to be built for the 2005 crop drying season. (Year 1)
2. Develop a computer simulation model of the counterflow continuous-flow dryeration process, and use the model to optimize the CFD process. (Years 1-2)
3. Collect performance data on a large prototype CFD unit during the 2005 crop drying season, and finalize specifications for a commercial CFD unit. (Year 2)

From

Purdue University
Agricultural and Biological Engineering

By

Maier, D.E.
Heber, A.J.

Results for 2004

In preparation for the 2003 crop drying season, a small prototype continuous-flow dryeration (CFD) system was set up and instrumented for data collection at the pilot facility of the Post-Harvest Education & Research Center in West Lafayette, Indiana. Six field tests were run during the 2003 crop drying season and two additional tests during the 2004 crop drying season. The data was extensively analyzed, and our two main assumptions were confirmed:

1. The tempering results indicated that the tempering process reduced single kernel moisture variability and reduced stress crack severity. Longer tempering times reduced the variability, but even the shortest (4hr) tempering time improved corn quality significantly.

-
2. The cooler data indicated that higher airflow rates reduced the amount of moisture that could be removed from the kernels. The specific data obtained will be used to validate the proposed simulation model.

Plans for 2005

We will primarily focus on the completion of the computer simulation model for the counterflow continuous-flow dryer process, and apply the model to optimize the CFD process in order to finalize the design for the large prototype CFD unit (Objective 2). During the 2005 crop drying season, we will collect performance data on the large prototype CFD unit, and subsequently finalize specifications for a commercial CFD (Objective 3).

Publications

Heber, A.J. and D.E. Maier. 2004. Effect of Tempering Shelled Corn on Single Kernel Moisture Content and Stress Cracks. Proceedings of the 2004 International Quality Grains Conference. Indianapolis, Indiana, July 19-22, 2004.

Issues

As the need for greater grain handling capacity increases with the demand for higher quality grains at reduced energy costs, a better method for effectively drying grain while retaining quality is vital to the success of the grain handling industry. As part of the drying process, tempering and counter-flow cooling can be utilized to reduce corn kernel stresses and single kernel moisture variability while reducing overall energy costs associated with drying.

What Was Done

We set up a small prototype continuous-flow dryer (CFD) system and collected data for a range of operating conditions. We also conducted single kernel moisture content and stress crack analysis tests while corn steeped in the tempering bin.

Impacts

This project has evolved from discussions the PI has had over the past 10 years with numerous producers, who in the past used the dryer process but since have upgraded the capacity of their systems and outgrew their tempering bins. Most would like to utilize dryer but realize that only the implementation of a continuous-flow process would allow for that.

Funding Sources

The Andersons Research Grant Program 2004-2005 and private industry.

Contacts

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University; Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@purdue.edu, URL: <http://www.GrainQuality.org>

NC-213 Objective 2

Title

Monitoring stored grain quality

Summary

This project is investigating the utilization of carbon dioxide detectors to monitor for the spoilage of stored corn prior to the time that spoilage would be detected by traditional methods. An automatically controlled water drip apparatus was built and used to simulate the development of a hot spot in stored grain. In-lab and pilot bin experiments as well as tests in large commercial storage structures have been conducted and indicate the effectiveness of CO₂ detection.

Project Objectives

The goal of this project is to evaluate, under field conditions, the use of carbon dioxide detectors to monitor for bio-activity in stored corn prior to the time that spoilage would be detected by traditional methods. Our hypothesis is that CO₂ monitors can efficiently detect grain in the early stages of spoilage. The specific project objective are:

- (1) To determine the parameters for monitoring changes in CO₂ concentrations within a grain bin.
- (2) To determine the relationship between a fungal biomass growing in a grain bin and the early detection of CO₂.
- (3) To determine the impact of fungal feeding insect infestations on detection of CO₂ from spoiling grain.
- (4) To determine scale-up parameters through modeling in order to implement the CO₂ monitoring technology in commercial-sized storage structures.

From

Purdue University
Agricultural and Biological Engineering
Botany and Plant Pathology
Entomology

By

Maier, D.E.
Ileleji, K.E.
Bhat, C.
Hulasare, R.
Woloshuk, C.P.
Mason, L.J.

Results for 2004

The first objective of this research project was completed in 2000, and has been previously reported on. The in-lab experiments of the second objective were completed in 2001, and were previously reported on. The pilot bin trials of the second objective were completed in 2002, and were previously reported on. The impact of fungal feeding insect infestations on detection of CO₂ was monitored as part of on-going stored grain insect pilot bin studies during the summer of 2003, and were previously reported on. The feasibility of CO₂ detection was further explored by

intermittently monitoring the exhaust air of several 500,000 bushel steel tanks at one commercial elevator between January and June 2003. These tests were continued in 2004. We installed one wall mounted CO₂ sensor in a fixed location in the headspace of a storage tank filled with about 400,000 bushel dried corn (average 15.5% moisture content). Hourly automatic monitoring of the CO₂ readings indicated that throughout the winter and spring, the CO₂ concentration recorded by our sensor hovered around 400 ppm which was essentially equivalent to the ambient CO₂ level. By mid-May, an initial peak of about 700 ppm was observed that was followed by larger and increasing peaks of 800 to 1500 ppm in late May and early June confirming the steady rise in the observed CO₂ levels recorded in the headspace that indicated spoilage in the grain mass. We also developed a preliminary mathematical model for the generation and movement of low CO₂ levels due to biological activity (fungi, insects) in a stored grain mass using a Computational Fluid Dynamics package called Fluent.

Plans for 2005

The fourth objective of this research project will be completed in 2005. We will focus on the completion of the CO₂ movement model. It will be validated using data collected from the in-lab and pilot bin experiments as well as the field test of CO₂ detection undertaken for objectives 2 and 3 of the project. Additionally, with funding from a USDA-SBIR grant we will cooperate with two companies and the USGMPRC to set up a wireless CO₂ monitoring network on several large storage tanks and outdoor storage piles.

Publications

Bhat, C.G., D.E. Maier, and K.E. Ileleji. 2004. Early Detection of Spoilage in Stored Grain. Proceedings of the 2004 International Quality Grains Conference. Indianapolis, Indiana, July 19-22, 2004.

Issues

In the United States close to 20 billion bushels of grain are stored every year. Insects and fungi create numerous quality problems in these stored grains that cause millions of dollars in losses. It is essential for the grain storage industry to have effective pest management programs to protect against economic loss due to contamination from insects, fungi and mycotoxins. A major contributor to the spoilage of grain is the growth of various fungal species, including several that produce mycotoxins. Although quality of harvested grains can never be improved with storage time, the rate of deterioration can be slowed with an integrated systems approach that combines engineering, biological and economic principles.

What Was Done

Monitoring the condition of thousands of bushels of grain is a difficult task with only the technology of temperature sensors. Our research has presented evidence that CO₂ monitoring technology can be effectively used in stored grain management.

Impacts

The impact of this research will help solve grain storage problems by applying an available technology that can detect spoilage before it gets out-of-hand. If spoilage is detected early by an increase in CO₂ concentration, the problem can be corrected by simple management practices such as applying aeration to cool and dry the grain mass.

Funding Sources

Anderson Research Grant Program 1999-2001, 2002-2003 and private industry

Contacts

Dirk Maier, Department of Agricultural and Biological Engineering, Purdue University; Phone: 765-494-1175; Fax: 765-496-1356; e-mail: maier@purdue.edu, URL: <http://www.GrainQuality.org>

NC-213 Objective 2

Project Objectives

To develop trapping and contour analysis of trap catch as a method for monitoring stored product insect pests in warehouses, processing plants, and retail stores, and locating foci of infestation. Observations of stored product insects in retail stores and experiments in a small shed have shown that the relationship of trap catch (n) to the distance of a trap from a source of insects (d) is well described by the exponential decay function $n = ae^{-bd}$. Our specific objective during 2004 was to investigate the physical/biological meanings of the parameters a and b .

From

USDA, Center for Medical, Agricultural and Veterinary Entomology
Agricultural Research Service
Gainesville, FL

By

Arbogast, R. T.*
Chini, S. R.

Results for 2004

The parameter a should predict trap catch at a source of dispersing insects (when $d = 0$, $n = a$), and thus a should increase in proportion to the number of insects released. Experiments to test this hypothesis (using the cigarette beetle, *Lasioderma serricornis*) were inconclusive, because the estimates of a had very large standard errors caused by a strong bias in direction of dispersal. Thus, traps in one direction from a point of release usually captured far more beetles than traps at nearly the same distance, but in other directions. The direction of bias tended to be consistent among replicates and experiments. The reason for this must be understood before we can proceed to examine the meanings of the parameters. We found that pitfall traps with only mineral oil and no pheromone or food attractant captured a large number of beetles, although significantly fewer than baited traps. This opens the possibility that non-baited traps can be used to study the paths followed by dispersing beetles without the possibility that the paths will be altered by attraction to bait. Preliminary tests in which live cigarette beetles were added to the mineral oil in half the traps at each of three distances from a point of release showed that traps with beetles captured significantly more beetles than those with only mineral oil. This suggests that non-baited traps may become attractive as trapped beetles accumulate in them. These tests also showed that the number of beetles captured tended to decrease with distance from the point of release, but again there was a strong bias in trap catch toward one or two trap locations.

Plans for 2005

We will seek an explanation for the consistently high numbers of cigarette beetles captured at a few trap locations, from replicate to replicate and experiment to experiments.

Publications

Arbogast, R. T., and S. R. Chini. 2004. Abundance of *Plodia interpunctella* (Hübner) and *Cadra cautella* (Walker) infesting maize stored on South Carolina farms: seasonal and non-seasonal variation. J. Stored Prod. Res. In press.

Arbogast, R. T., S. R. Chini, and J. E. McGovern. 2004. *Plodia interpunctella* (Lepidoptera: Pyralidae): spatial relationship between trap catch and distance from a source of emerging adults. J. Econ. Entomol. In press.

Issues

The risks posed by chemical pesticides to environmental quality and human health have prompted initiatives to reduce pesticide use, primarily through integrated pest management (IPM). Implementation of IPM to control stored-product insects in warehouses, food processing plants, and retail stores will require regular monitoring to determine when, where, and what type of control measures to apply. Monitoring systems for these commercial facilities should be inexpensive, inconspicuous, and easy to employ. At the same time, they should detect infestation early, pinpoint trouble spots (foci of infestation, pest concentrations), and provide concise and easily understood documentation. These requirements can be met by a combination of trapping and spatial analysis of trap catch by contour mapping.

What Was Done

Experiments with a representative stored-product beetle, the cigarette beetle (*Lasioderma serricorne*), showed that the number of beetles captured in pitfall traps baited with pheromones and a food attractant oil, or in traps with only mineral oil, was inversely proportional to the distance from a source of dispersing beetles. However, this relationship was complicated by the consistently higher numbers captured at particular trap sites at the same distance from a source of beetles as other traps that captured far fewer beetles.

Impacts

These findings emphasize the fact that a fundamental understanding of an insect's orientation to various factors is basic to modeling its dispersal and understanding the spatial distribution of its populations.

Usefulness of Findings

The value of trapping and contour mapping of trap catch as a monitoring method lies in its ability to locate as well as detect infestation, and in the utility of contour maps for documentation and communication. The maps provide graphic, easily understood evidence of insect infestation and can also be used to show the effectiveness of control intervention. They are thus of considerable value in communicating insect problems to managers and to maintenance, sanitation, and pest control personnel. Information relating trap catch to severity and location of infestation is needed to optimize the value this monitoring method. The current findings will support improvement of the method.

NC-213 Objective 2

Project Objectives

Develop and evaluate automatic grain aeration control strategies for maintaining grain quality and controlling insects during storage.

From

USDA, ARS
Grain Marketing and Production Research Center
Manhattan, Kansas

By

Casada M.E., Engineering Research Unit
Arthur, F.H., Biological Research Unit

Results for 2004

In the study of available summer aeration hours in the hard red winter (HRW) wheat region, grain cooling was highly influenced by humidity and calculations based on the dry-bulb temperature (T_{db}) alone overestimated the number of available aeration hours for cooling the grain temperature to 23.9°C and below. The true available aeration hours based on the effective temperature (T_{eff}) averaged approximately 75% lower than predicted by T_{db} alone. T_{eff} was always lower for grain at 12% moisture content than grain at 10% moisture, therefore, aeration of grain at 12% moisture yielded significantly more available hours for aeration. Available aeration hours were very limited in the southern part of HRW wheat region, requiring high airflow rates (well above 0.11 m³/min/t) to achieve sufficient grain cooling during the summer. The most southerly parts of the region had no available hours for much of the summer during many years. This effect was more pronounced at 10% mc than 12% mc grain.

In preliminary results from the field tests, temperatures in the top of the grain mass for bins with downward airflow (suction) aeration systems were significantly lower than in bins with upward airflow during most of the aeration cycle. Temperature differences after the aeration cycle was complete were not significant. The maintenance cycle lowered the average bin temperature after the aeration cycle was complete, but the difference was not significant at all locations.

Plans for 2005

Continue collecting field data to evaluate the effect of airflow direction and use or absence of regular maintenance cooling cycles during the summer aeration. Conduct modeling studies to evaluate the effect of high nighttime humidity on reducing the effectiveness of summer aeration.

Publications

Akdogan, H., M.E. Casada, A.K. Dowdy, and B. Subramanyam. 2005. A novel method for analyzing facility heat treatment data. *Journal of Stored Products Research*. 41(2): 175-185.

Billate, R.D., R.G. Maghirang, and M. E. Casada. 2004. Measurement of particulate matter emissions from corn receiving operations with simulated hopper-bottom trucks. *Transactions of the ASAE*. 47(2): 521-529.

Brabec, D.L., R.G. Maghirang, M.E. Casada. 2004. Effectiveness of a high-pressure water-fogging system in controlling dust emissions at grain receiving. *Transaction of the ASAE* Vol. 47(2): 505-511.

Issues

Optimizing the design and management of grain storage systems requires proper analytical tools such as validated computer models of the stored grain environment. Several modeling and temperature accumulation studies indicate that an additional summer cooling cycle for stored wheat, in addition to cooling in early and late autumn, can limit population development of insect pests.

What Was Done

(1) Fifty years of historical weather data were evaluated to determine the effect of humidity on summer aeration strategies in the hard red winter wheat belt. A procedure was developed to calculate effective temperature (T_{eff}), which coupled dry-bulb (T_{db}), wet-bulb temperature (T_{wb}), and grain moisture content to predict the true final grain temperature after aeration. Hourly historical weather data was used to determine the hours of temperature accumulation below 23.9°C from mid-July through early-August in Kansas, Oklahoma, Texas, eastern New Mexico, and eastern Colorado along with nearby portions of surrounding states. (2) The first of two years of field validation tests were conducted evaluating the effectiveness of (a) upward versus downward airflow direction and (b) the use of maintenance aeration cycles during the summer after the initial cooling cycle.

Impacts

The potential to reduce energy consumed for grain cooling is estimated at 25-50 percent. The greatest impact is the assurance of timely grain cooling and prevention of grain quality losses from deterioration and insect infestations. Results from this project may lead to the development of new insect pest management and temperature management strategies for stored wheat.

Objective 3

Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain.

NC-213 Objective 3

Project Objectives

Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain. Operate quality analysis testing/instrument calibration services to support research and marketing activities. Achieve ISO 17025 certification with related statistical control of data management.

From

Iowa State University
Department of Agricultural Engineering
Department of Food Science and Human Nutrition

By

Hurburgh, C.R. Jr.

Results for 2004

The ISU Grain Quality Laboratory (GQL) analyzes grain samples for a variety of grain quality factors. The lab has steadily expanded its program offering no-charge analyses for locally operated third party strip-trial evaluations and for ISU-sponsored agronomic research studies. The latter is intended to provide seed data for ongoing projects that would not otherwise have been able to include a grain quality component.

For the 2003 crop, the breakdown of samples was:

	Corn	Soybeans
Strip-trials	491	516
Research projects	2,075	3,005
Total	2,566	3,521

The program was well received, with widespread publication of the data by sponsoring groups.

The first draft of the quality manual for the grain lab was completed. An analysis and action metrics for the quality control data has begun.

Plans for 2005

Complete the analysis of the quality control data. Finish the quality manual, and apply for the first ISO audit. Continue offering the testing services.

Publications

Hansen, Audrey, C.R. Hurburgh, Jr., R. Dzupin, G. Rippke, and R. Stephenson. 2004. Establishing a quality management system in a university based analytical laboratory. Pittcon 2004. Chicago, IL. (abstract 6700-300)

Hansen, Audrey, C.R. Hurburgh, Jr., R. Dzupin, G. Rippke, and R. Stephenson. 2004. Launching an internet enabled quality manual for a university based analytical laboratory. Pittcon 2004. Chicago, IL. (poster abstract (16000-100))

Issues

If quality systems are to be the operating method of the future, then supporting organizations, such as University labs, must take the lead in their actual implementation as well as training. Standardized, validated data can offer biological scientists avenues of study that were previously not possible with more expensive or less controlled testing systems.

Impacts

Success in grain quality testing research is translated into growth and discovery in other programs related to grain science.

NC-213 Objective 3

Project Objectives

The overall objective of this project is to identify methods of measuring shelled corn storability. When shelled corn subjected to conditions conducive to fungal growth, slower growth means greater storability. The specific objectives are: (1) to evaluate the use of a CO₂ Test Kit (Woods End Research, Mt. Vernon, Maine), for measuring CO₂ production (storability) of shelled corn; (2) to evaluate several rapid (< 15 min) tests that can be used together to provide a less precise but more rapid storability indication; and (3) to examine the correlations among the various tests used as storability indicators.

From

Purdue University Agricultural and Biological Engineering
Indiana Agricultural Experiment Station

By

Stroshine, R.L.
Moog, D.J.P.
Woloshuk, C.P. - Purdue University

Seitz, L.M. - USDA GMPRC, Manhattan, Kansas

Paulsen, M.R. - University of Illinois at Urbana

Results for 2004

Samples of shelled corn from commercial grain traders and the Purdue Agronomy farm were evaluated using the following tests that measure factors: percent kernel infection by plating, ergosterol content, percent weight of fines (4.76 mm and 6.35 mm sieves), mechanical damage by CFC fast green dye, electrolyte leakage, percent germination, Fourier Transform-NIR, NIR reflectance, and CO₂ test kit. Descriptions of the tests are included in the 2003 report and in a paper presented at the 2004 Quality Grains Conference (see Publication). These tests were used to evaluate 60 samples of shelled corn having a wide range of storability. Measurement averages, ranges, and coefficients of variation are listed in Table 1. Relationships among the tests and either percent kernel infection (KI) or ergosterol content (EG) were investigated using regression analysis. Table 2 summarizes the coefficients of determination for the regressions with the highest r^2 values. Percent germination had the best correlation with KI, and damage index had the highest correlation with EG. Of the CO₂ kit indices, slope 72-75 hr had the highest correlation with EG and the 74th hr reading had the highest correlation with KI.

Several indices were used to quantify the CO₂ kit measurements (Table 3) and then compared to both the sample's initial EG and the increase in EG during the CO₂ kit test. EG was best correlated with slope 48-51 hr while DEG was best correlated with the 74th hr. reading ($r^2=0.72$) and slope 72-75 hr ($r^2=0.65$). DEG is an indicator of fungal growth during the incubation period, and therefore a good measure of storability. The 3rd day CO₂ test kit reading is apparently slightly more accurate than the 2nd day reading.

Dr. Marvin Paulsen (Agricultural & Biological Engr. Dept., Univ. of Illinois) conducted NIR and FT-NIR tests. NIR tests were conducted with a Foss NIRSystems 6500 spectro-

Table 1. Summary of results of quality tests conducted on samples of shelled corn.

Quality Factor	No. of Samples	Average	Range	Std. Dev	Coeff. Of Variation
Ergosterol, ppm	61	2.413	0.04-12.54	2.98	123.5%
Difference in Ergosterol	34	2.58	-0.45-11.5	3.32	128.5%
Kernel Infection, %	61	31.50	0-100	27.68	87.9%
% Fine (16/64" seive)	59	1.14	0-7.61	1.50	131.4%
% Fine (12/64" seive)	59	1.55	0-9.74	1.38	88.8%
Damage Index	59	24.69	12.0-90.7	10.31	41.7%
Germination, %	61	52.00	0-99.0	33.83	65.0%
Electrolyte Lkg. 15min	59	73.36	36.8-122.2	17.45	23.8%
Electrolyte Lkg.0-15slope	59	3.99	1.77-7.30	1.15	28.7%
CO ₂ Kit, 74 th hr	39	2.10	1.0-3.33	0.60	28.7%
CO ₂ Kit, slope 72-75hr	39	1.16	0.5-1.70	0.34	29.0%

Table 2. Coefficients of determination between ergosterol level or kernel infection and the various measurements used to evaluate the storability of the samples.

FACTOR	Ergosterol Level (ppm)			%Kernel infection		
	r ²	Type**	n	r ²	Type**	n
Ergosterol Level (ppm)	--	--	--	0.724	C	60
%Kernel infection	0.724	C	60	--	--	--
% Germination	0.246	C	61	0.150	C	61
Damage Index	0.102	C	50	0.206	Q	58
% fines (16/64 seive)	0.040	C	59	0.096	C	59
Electrolyte Leakage (10 min)	0.103	C	60	0.096	C	60
CO ₂ Kit Measurements:						
Slope 48-52 hr	0.118	C	60	0.071	C	60
Slope 72-75 hr	0.168	C	39	0.122	C	39
74 th hr reading	0.159	C	39	0.200	C	39

** Note: Q=quadratic regression model, C=cubic regression model

Table 3. CO₂ test kit indices correlations with initial ergosterol and difference in ergosterol before and after CO₂ kit testing. (Regression models were quadratic).

FACTOR	Initial Ergosterol (ppm)		Difference in ergosterol (ppm)	
	r ²	n	r ²	n
Slope 48-51 hr	0.359	34	0.501	34
Slope 48-52 hr	0.016	34	0.402	34
51st hr reading	0.218	34	0.638	34
52nd hour reading	0.080	34	0.518	34
Slope 72-75 hr	0.106	34	0.653	34
Slope 72-76 hr	0.084	34	0.577	34
74th hr reading	0.098	34	0.716	34
75th hr reading	0.122	34	0.652	34

-photometer. A calibration equation for ergosterol (ppm) was developed for a set of 44 samples using partial least squares (PLS). There were too few samples to set up a validation data set. Therefore, the equation was used to predict itself. The coefficient of determination was 0.68 and the standard error of calibration was 1.05. A Perkin

Elmer Spectrum One spectrophotometer was used for the FT-NIR analyses. The original data set was randomly split with three-fourths placed in a calibration data set and the remaining fourth placed in a validation data set. A calibration was created and used to predict the validation data set. The validation set r^2 was 0.64, slightly lower than the NIR unit r^2 of 0.68. The Root Mean Square (RMS) Error of Calibration was 1.17 while the RMS Error of Prediction was 1.29. Both NIR and FT-NIR gave similar results, indicating prediction of ergosterol should be possible with a standard error of about 1.05 to 1.3 ppm.

Plans for 2005

Additional samples will be tested. Samples with greater deterioration, needed to improve the calibration of the NIR measurements, will be prepared by incubating samples rewetted to 16% after inoculation with moldy kernels. We will also evaluate the use of a spectrophotometer in the CO₂ kit test measurements. Stepwise multiple regression will be used to determine which of the more rapid tests best indicate storability.

Publications

Moog, D.J.P, Stroshine, R.L., Seitz, L.M., Paulsen, M.R., and Woloshuk, C.P. 2004. Storability Measurement of Shelled Corn. Proceedings of International Quality Grain Conference. Indianapolis, Indiana.

Issues

When shelled corn is placed in off-farm storage, there is usually very little information on duration and conditions of previous storage. Managers must rely on experience and the moisture content when assessing risk of storing the corn. A test that quantifies the likelihood of fungal deterioration would assist them in their decisions regarding storage.

What Was Done

A series of quality tests that measure factors affecting storability were conducted on 61 shelled corn samples and correlations among the factors were determined. NIR and FT-NIR could predict ergosterol (± 1.3 ppm) and the CO₂ test kit can predict storability. Electrolyte leakage and damage index are the best indicators among the rapid tests.

Impacts

Elevator managers could use the 3-day CO₂ test kit results to determine whether shelled corn can remain in storage with minimal risk. They could also use it to determine whether shelled corn is suitable for shipment to tropical climates where risk of fungal induced spoilage is greater. Rapid tests (<15 min) could be used for initial screening of samples.

NC-213 Objective 3

Project Objectives

Conduct basic and applied research in the biochemistry and technology of grain sorghum to identify and evaluate the biochemical components that govern processing, functionality, and susceptibility to mold. The information is used to improve sorghum quality and utilization for increasing domestic and export markets.

From

USDA
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center
Manhattan, KS

By

Bean, S.R.

Results for 2004

Production of sorghum waffles was optimized. Effects of extrusion processing on ethanol yields from sorghum were studied. Relationships between maize and sorghum kernel properties, protein, and starch content and composition to milling performance were investigated.

Plans for 2005

Investigate the role of amylose to amylopectin ratio in sorghum to ethanol yields. Investigate the mechanism behind protein-tannin binding in sorghum. Investigate the effect of sorghum tannins on feed efficiency. Investigate the effect of decorticating sorghum on ethanol yields.

Publications

Chung, O. K., Bean, S. R., and Park, S. H. Sorghum foods: New health benefits from an ancient grain. *Food Science Journal (Chinese)* 25:431-437. 2004.

Pedersen, J. F., Bean, S. R., Funnell, D. L., and Graybosch, R. A. 2004. Rapid iodine staining techniques for identifying the waxy phenotype in sorghum grain and waxy genotype in sorghum pollen. *Crop Science*. 44:764-747.

Robbins, R., and Bean, S. R. 2004. Development of a measurement system for phenolic acids: Quantitative high-performance liquid chromatography with photodiode array detection. *J. Chromatog. A*. 1038: 97-105.

Issues

Sorghum is a drought resistant, low input crop currently used as animal feed in the U. S. However, there is great potential for human food uses and bio-industrial uses for sorghum (such as ethanol). To fully utilize sorghum as a renewable resource, basic research into the functionality of sorghum proteins and other biomolecules is needed.

What Was Done

Optimization of sorghum waffle production was completed by varying ingredients, cooking time and temperature. Waffle weight, internal texture, and appearance were compared to commercially available frozen wheat waffles.

Sorghum waffles similar in weight and appearance to commercial wheat waffles could be produced by mixing batter into an egg white foam. The effects of extruding sorghum grain on ethanol production were also studied. Both conventional and supercritical fluid extrusion was found to increase ethanol yields compared to unprocessed grain.

Impacts

The production of wheat-free foods from sorghum provides persons with celiac disease new food choices. Developing high quality wheat-free food products from sorghum provides new markets for the U.S. sorghum crop and may improve the food choices available to persons with celiac disease. Ethanol production is a growing area for sorghum utilization. Processing of sorghum grain before fermentation is one way to improve ethanol yields and thereby the value of sorghum to the ethanol industry.

Overview

The production of wheat-free waffles from sorghum was optimized. Sorghum waffles comparable to commercially available wheat waffles could be made with the optimized formula. Methods for extrusion processing sorghum grain prior to fermentation were studied. Both normal and super critical fluid extrusion processing was found to increase ethanol yields from sorghum.

NC-213 Objective 3

Project Objectives

Develop fast reliable methods for the identification of quality traits of wheat starches.

From

USDA
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center
Manhattan, KS

By

Bechtel, D.B.
Wilson, J.D.

Results for 2004

Laser diffraction sizing (LDS) was used to measure particle size distributions of wheat flour and isolated starch to determine if the method could be used as a component for predicting end-use quality. Five hard red winter and five soft red winter wheats were milled into flour from which starch was isolated. Flour particle size distributions were measured using a dry module as well as flour suspended in isopropanol (AACC Method 55-40). Analysis using isopropanol as a suspension fluid caused smaller particles (<8 m in diameter) to be released from flour. Use of isopropanol caused a shift to larger particle sizes between 8 and 400 m in comparison to dry analysis. Isopropanol also caused clumping with spurious particles found between 250-400 m. LDS of isolated starch showed a separation of A- and B-type granules between 9.8 and 10.8 m for the soft wheats and between 8.2 and 9.8 m for hard wheats. Hard wheats had a larger volume of starch in the A-type fraction while the soft wheats had more starch in B- and C-type fractions. A demarcation between the B- and C-type starch was only observed for the soft wheats and that was when data was presented as percent surface area. LDS may prove to be a valuable tool in helping predict wheat end-use quality since flour and starch differences were observed between wheat classes as well as among wheats within a class.

Plans for 2005

Examine endosperm amyloplasts of various maize mutants to determine the ultrastructure associated with starch granule growth.

Publications

Bechtel, D.B. 2004. All-grain home brewing. Abstract No. 175. Page 99 in: Program Book of the 89th Annual Meeting of the AACC.

Bechtel, D.B. and Wilson, J.D. 2004. Laser diffraction sizing used to study wheat flour and starch particle size. Abstract No. 21. Page 121: in Program Book of the 89th Annual Meeting of the AACC.

Park, S.H., Singh, H., Wilson, J.D., and Bean, R.S. 2004. Rapid isolation of sorghum starch using sonication. Abstract No. 389. Page 160-161 in: Program Book of the 89th Annual Meeting of the AACC.

Issues

Determine the parameters associated with optimizing LDS measurements of wheat flour particles and isolated

starch.

What Was Done

Flour was analyzed by the official AACC method and compared to a new dry analysis method. Isolated starch from hard and soft red winter wheats were compared using LDS.

Impacts

The results indicated that the official AACC method causes artifacts where as a new dry analysis method does not. The methods used in this study can be used to investigate endosperm starch from other cereals.

Overview

LDS provides a quick and accurate method for the analysis of both wheat flour and isolated starch.

NC-213 Objective 3

Project Objectives

Evaluate kernel characteristics, milling properties, and dough and bread-, tortilla- and Asian alkaline noodle-making properties of hard winter wheat progenies. Determine protein and lipid contents, and composition and interaction among these components of cereal grains as they relate to storage, handling, and end-use properties.

From

USDA
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center
Manhattan, KS

By

O.K. Chung, O.K.
Seabourn, B.W.
Caley, M.S.
Ram, M.S.
Park, S.H.
Singh, H.

Results for 2004

The Hard Winter Wheat Quality Laboratory (HWWQL) continues to evaluate end-use intrinsic quality parameters of hard winter wheat lines from 14 federal, state, and private nurseries. Data were sent to breeders electronically, followed by written report upon special request. For the Southern and Northern Regional Performance Nursery (SRPN and NRPN) samples, several intra-zone production area composites were also tested for quality to study the environmental adaptability of each line. In addition, we have led both Wheat Quality Council (WQC) Sample evaluation for domestic customers and the U.S. Wheat Associates' Overseas Varietal Analysis Project for international customers.

Quality data of the SRPN and NRPN are posted on the Graingenes web site; a copy of the data may be obtained in electronic format via the internet by directing your browser to the Graingenes gopher at gopher://greengenes.cit.cornell.edu/. Using a simple, user-friendly relational database system, we provided simultaneous assessment of multiple quality traits. It was the 6th year for us to distribute the database to all wheat breeders at the annual Breeders Field Day. Breeders and other industry customers can easily access regional performance nursery data via the world-wide web from our web site. (<http://gqu1.usgmrl.ksu.edu/gqu/HWWQL/HWWQLHome.htm>). Web access to the data allows the HWWQL to more rapidly respond to customer needs.

For the second year, we have determined polyphenol oxidase (PPO) contents in wheat meals and the color (Minolta) values of Asian alkaline noodles at 0 and 24 hr for the 2003 crop NRPN and SRPN samples and also the 2003 Wheat Quality Council (WQC) samples. We have provided our customers with information containing these new quality test parameters. We have continued to conduct research on the development of small-scale experimental tortilla-making in collaboration with Texas A&M University.

In 2004, the HWWQL, in collaboration with the Grain Inspection, Packers and Stockyard Administration (GIPSA), continued an extensive study on a selected number of commercial wheats (100 Hard Red Winter and 98 Hard Red Spring wheats) to evaluate the potential for the rapid determination of wheat quality. This study incorporated all of the various quality parameters used to evaluate wheat and flour, as well as near-infrared analysis (NIR) and multivariate statistical models, to determine the crucial test or tests most capable of predicting the quality of wheat at

the earliest possible point in the marketing system. Initial results from this study are pending final review of the data.

Plans for 2005

Continue to evaluate intrinsic quality parameters of hard winter wheat breeding lines; continue to improve the activities of the HWWQL as a Regional Wheat Quality Laboratory with efficient service and regional collaboration; study the suitability of hard winter wheat in Asian noodle-making by testing the PPO levels in breeding lines and also determining noodle-dough color stability; developing a small-scale tortilla-making procedure and textural analysis of tortillas as the quality determinant; conduct studies on prediction of end-use quality using physical and chemical characteristics of wheat and milled flour, including SKCS data, spectral scans by an NIRSystem 6500, and computerized mixograph data; study free lipid composition of commercial hard winter and spring wheat flours; and study dynamic rheological changes and multiple interactions during dough mixing by FTIR and Raman spectroscopy.

Publications

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Xiao, S.Z., Park S.H., and Chung, O.K. Testing four solvents for solvent retention capacity (SRC) in hard winter wheat flour and their use in a regression equation to predict bread loaf volume. Abstract No. 224 Page 122 in: Program Book of the 89th Annual Meeting of the AACC.

Issues

The U.S. has lost a significant amount (40% from 1987 to 1997) of the world wheat export market, especially for the far-eastern Asian market. It is extremely important to improve U.S. wheat quality desired by our customers in both domestic and international markets.

What Was Done

Intrinsic end-use (milling and bread-baking) quality of about 1332 hard winter wheat breeding lines were evaluated at the ARS Regional HWWQL so that breeders could select their lines based on intrinsic quality in addition to agronomical quality. We have made progress in developing small-scale methods to evaluate non-bread products (tortillas and Asian alkaline noodles). Development of quality prediction system for the commercial HRW and HRS wheat was initiated and progressed.

Impacts

Securing and improving the quality of grains produced in the U.S. so that they meet the needs of both domestic and overseas customers is a very important but difficult task. Grain quality improvement begins with a sound breeding program and ends with growers. In 2004, the HWWQL evaluated intrinsic quality parameters of hard winter breeding lines (2003 crop) and our data of breeders' nursery samples are of prime importance for the release of breeding lines, some of which become released cultivars grown by farmers. During the three-year period from 2000-2002, the average U.S. wheat production was 66.5 million metric tons (about 2.24 billion bushels): nearly one-half of U.S. wheat production and 41% of U.S. wheat export comes from hard red winter wheat. Over 95% of all hard winter wheats have been evaluated for end-use quality before they were released as cultivars. Therefore, our efforts greatly impact the overall U.S. wheat industry.

Overview

We at the ARS Regional Hard Winter Wheat Quality Laboratory, Manhattan, KS, have evaluated intrinsic quality parameters of several thousand hard winter wheat lines (2003 crop) from federal, state, and private nurseries. This is the second crop year in which we have measured PPO contents and alkaline noodle color values at 0 and 24 hr after processing to improve new uses (non-bread products) of U.S. hard winter wheat quality in collaboration with breeders.

NC-213 Objective 3

Project Objectives

Develop sensors, instrumentation, and procedures for objective grading, on-line measurement, and end-use property assessment of single kernels or bulk samples.

From

USDA, ARS Grain Marketing and Production Research Center
Manhattan, Kansas
Engineering Research Unit

By

Pearson, T.C.
Dowell, F.E.
Armstrong, P.R.

Results and Impacts for 2004

Reducing Toxins in Corn. A high-speed single-kernel sorter was used to remove mycotoxins from corn. It was found that using spectral absorbances at 750nm and 1200nm could distinguish kernels with aflatoxin-contamination greater than 100ppb from kernels with no detectable aflatoxin with over 98% accuracy. When these two spectral bands were applied to sorting corn at high speeds, reductions in aflatoxin averaged 82% for corn samples with an initial level of aflatoxin over 10 ppb. Most of the aflatoxin is removed by rejecting approximately 5% of the grain. Fumonisin is also removed along with aflatoxin during sorting. The sorter reduced fumonisin by an average of 88% for all samples. This technology will help insure the safety of the US food and feed supply.

Automating Grain Grading. Digital imaging technology has found many applications in grain industry. In this study, images of durum wheat kernels acquired under three illumination conditions - reflected, side-transmitted, and transmitted - were used to develop artificial neural network (ANN) models to classify durum wheat kernels by their vitreousness. The results showed that the models trained using transmitted images provided the best classification for the nonvitreousness class - 100% for non-vitreous kernels and 92.6% for mottled kernels. Results of the study also indicated that, using transmitted illumination may greatly reduce the hardware and software requirements for the inspection system, while providing faster and more accurate results, for inspection of vitreousness of durum wheat.

Improving Measurement of Grain Traits. We compared two types of NIR instruments for their ability to predict concentrations of protein, moisture, and hardness of whole grain wheat; protein, ash, and amylose of wheat flour; and corn grit fat. The study used a Fourier transform-NIR spectrometer (FT-NIR) from Bruker Optics, Billerica, MA and a Model 6500 NIR from FOSS-NIR Systems, Inc., Silver Spring, MD. The FT-NIR instrument differs from the NIR instrument in the method of light spectra measurement. Wheat flour protein and ash; whole grain wheat protein and moisture were measured with excellent accuracy by both instruments while wheat flour amylose and whole grain wheat hardness measurement were less accurate. Corn grit fat measurement was poor for both instruments. Overall the FT-NIR and NIR instruments were essentially equal in measurement accuracy and there is no apparent advantage of one over the other.

Detecting Insects in Flour. Primary pests of stored cereals that develop and feed inside grain kernels are the main source of insect fragments in wheat flour. The Food and Drug Administration (FDA) has set a defect action level of 75 or more insect fragments per 50 gram of flour. The current standard flotation method for detecting insect fragments in flour is very labor intensive and expensive. We investigated the potential of near-infrared spectroscopy (NIRS) to detect insect fragments in wheat flour at the FDA defect action level. Fragments counts with both the NIRS and the standard flotation methods correlated well with the actual number of fragments present in flour samples. However, the flotation method was more sensitive below the FDA defect action level than the NIRS

method. Although the flotation method is very sensitive at the FDA action level, this technique is time consuming (almost 2 h/sample) and expensive. Although NIRS currently lacks the sensitivity of the flotation method, it is rapid, does not require sample preparation, and could be easily automated for a more sophisticated sampling protocol for large flour bulks. Therefore, this method should be reexamined in the future because NIRS technology is rapidly improving.

Applying Grain Inspection Technology to Eliminating Human and Animal Pests. Tsetse flies are important vectors of African trypanosomes, which cause sleeping sickness in humans and nagana, a fatal disease, in livestock. About 300,000 human deaths are estimated to occur annually. Approximately three million cattle deaths occur annually, causing a direct annual loss of about \$1.5 billion. Implementation of the sterile insect technique (SIT) for tsetse requires that only sterile male insects be released; thus, at some stage of the fly production process the females have to be removed. We examined the use of near-infrared spectroscopy technology to sex and sort the fly pupae. This technology was developed for measuring and sorting single grain kernels. Tsetse fly pupae up to 5 days before emergence can be sexed with accuracies that generally range from 80 to 100%. This system will enable effective separation of male and female pupae to be carried out with emerged females being returned to the colony and males being irradiated and released. This will significantly reduce the cost and efficiency of rearing tsetse flies for SIT programs.

Plans for 2005

Develop signal processing algorithm using voice recognition technology to detect wheat kernel defects using single kernel acoustics from impact emissions.

Develop a corn handling system and integrate a spectrometer to detect characteristics of single corn kernels using NIR spectroscopy.

Collect spectral data for white corn to select optimal pair of spectral bands for detecting and removing kernels with mycotoxin-producing molds.

Develop semi-automated instrumentation to collect data from single corn kernel to detect mutants for corn breeders.

Test moisture/size measurement abilities for groats to detect single-kernel oat milling parameters.

Develop an imaging system and collect data with a Flourosan to detect insect fragments in flour.

Do a literature review and collect samples and analytical data to predict end-use quality.

Publications

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Issues

The production and marketing of grain are major components of the U.S. agricultural economy. Improved utilization and market efficiencies with objective quality, functionality and grain grade assessments will increase food wholesomeness, safety, and market competitiveness. For example, accurate, rapid detection of attributes could assist in: marketing or segregating genetically modified grain; detecting food safety concerns such as aflatoxin or fumonisin in corn; or detecting attributes that can lead to quarantine of commodities such as Karnal bunt in wheat. This information is particularly useful in evaluating grain prior to purchase or trade in market channels. Single kernel assessments are needed to detect defects that may be present in only a small percentage of kernels or to detect mixtures of contrasting quality characteristics. New technology developed through this research will provide FGIS with several options for providing additional objective quality assessments of grain along with official grade services and thereby improve their services and operating efficiencies. The objective assessments of grain quality are useful to producers, breeders, growers, grain handlers, marketers, millers, bakers, and government agencies such as the Extension Service, FGIS, FSIS, APHIS and OSHA.

What Was Done

See "Results."

Impacts

See "Results."

NC-213 Objective 3

Project Objectives

Investigate the role of the albumin and globulin proteins (water and salt soluble), phenolics and non-starch carbohydrates of wheat flour on quality and functionality.

From

USDA
Grain Quality and Structure Research Unit
U.S. Grain Marketing Research Laboratory
Grain Marketing and Production Research Center
Manhattan, KS

By

Tilley, M.

Results for 2004

Glucose oxidase (GOX) has been proposed as an improver for the baking industry. The mechanism of improvements caused by GOX is not understood. Mixograph data demonstrates a significant change in dough strength upon addition of glucose oxidase and glucose. After mixing wheat flour with and without the addition of GOX the different protein classes were extracted and analyzed by capillary electrophoresis and size-exclusion (SE)-HPLC.

Plans for 2005

The biochemical interactions responsible for changes in protein properties, mixing behavior and the possible effects on end-use properties will be determined.

Publications

Chung, O.K., Lookhart, G.L., Dowell, F.E., Tilley, M., Bean, S.R., Seitz, L.M., Seabourn, B.W., Park, S.H., Steele, J.L., Casada, M.E., Ram, M.S., Maghirang, E.B., Pasikatan, M.C., Kim, Y.S., Bechtel, D.B., Perez-Mendoza, J., Xie, F., Lyne, R.K., Singh, H., Caley, M.S., Wilson, J.D., Brabec, D.L., Ohm, J.B., Throne, J.E., Baker, J.E., Pearson, T.C. and Haden, Z.L. 2004. Wheat research in the U.S. Grain Marketing and Production Research Center. Annual Wheat Newsletter 50:221-238

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Tilley, M. and Tilley K.A. Modifying crosslink formation in wheat dough by controlling innate enzyme activity. Proceedings of the 12th ICC Cereal and Bread Congress. (In press)

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Issues

Chemical oxidants are routinely added to flour to improve bread making performance. One of the major chemical oxidants, potassium bromate, is banned in Europe and is being phased out in the United States. With the elimination of potassium bromate and possibly other chemical oxidant additives, alternative oxidation methods must be found. Substitution of chemical oxidants with enzymes is a desirable approach since enzymatic reactions are very specific, with little or no reactivity outside of the substrate. The knowledge of how controlled protein oxidation will support the efforts in developing new baking additives.

What Was Done

Addition of oxidative enzymes to a dough system was performed and found to have an effect upon mixing behavior and protein properties.

Impacts

Enzymes are an attractive approach to replace chemical oxidants; however, understanding how endogenous and exogenous enzymes affect biochemical interactions that underlie changes in quality parameters is essential.

NC-213 Objective 3

Project Objectives

To define the quality characteristics of barley for its uses in various food products and to explore an effective way to retard discoloration in barley-based food products

From

Washington State University

By

Baik, B.K.

Results for 2003

We determined physical and chemical attributes of 13 barley genotypes and their relationships with quality parameters of abraded and cooked barley, and of bread and noodles incorporated with 30% barley flour. Waxy barley exhibited higher water imbibition of grains and softer texture of cooked grains than barley of regular endosperm. Incorporation of barley flour into bread lowered mixograph absorption by 6% with barley of regular endosperm and 2% with waxy barley. Loaf volume of bread baked from wheat and barley flour blends was much higher with barley of regular endosperm than with waxy barley. Bread incorporated with barley flour retained moisture better during storage than wheat flour bread and generally exhibited higher crumb moisture content at 7 days after baking. Noodles with proanthocyanidin-free barley showed whiter color of dough and noodles than those with proanthocyanidin-containing barley. Noodles with waxy barley flour exhibited the softest texture of cooked noodles. Beta-glucans content of barley related positively with water uptake of grains and crumb moisture content of bread, and negatively with hardness of cooked noodles.

Abrasion, heat treatment, use of chemical additives and adjustment of storage conditions were examined for the reduction of dark color development in barley gel and dough. The removal of the outer layers of grains by abrasion increased the L* (brightness) of barley flour dough by 0.1-7.1. Steam heating of abraded grains also increased the L* of barley flour gels by 1.8-3.4. Ascorbic acid at 1500 ppm was most effective for retarding discoloration of barley flour dough, followed by 50 ppm of 4-hexylresorcinol, which is an enzyme competitive inhibitor. The discoloration of barley flour dough was also effectively reduced by storing the dough at 4°C under nitrogen gas to exclude oxygen or under anaerobic conditions at 20°C.

Plans for 2004

Investigate relative contribution of genotype, environment and their interaction on total phenol content, polyphenol oxidase activity and discoloration potential of barley in food products. Identify and quantify phenolic acids and proanthocyanidins from various types of barley and to determine their relationship to discoloration potential of barley.

Publications

Quinde, Z., Ullrich, S. E., and Baik*, B.-K. 2004. Genotypic variation in color and discoloration potential of barley-based food products. *Cereal Chem.* 81:752-758.

Baik*, B.-K., Powers, J., and Nguyen, L. T. 2004 Extrusion of Regular and Waxy Barley Flours for Production of Expanded Cereals. *Cereal Chem.* 81:94-99.

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Baik, B.-K., Z. Quinde-Axtell, V.A. Jitkov, and S.E. Ullrich*. 2004. Barley germplasm variation related to food quality. ASA-CSSA-SSSA Annual Meeting, Seattle, WA, November. Poster presentation.
<http://www.asa-cssa-sssa.org/anmeet/search/view_abstract.php?id=1102>

Quinde, Z., and Baik*, B.-K. 2004. Retardation of dark discoloration in barley-based food products. AACC Annual Meeting, San Diego, CA, September. Poster presentation.
<http://www.aaccnet.org/meetings/2004/abstracts/a04ma248.htm>

Issues

There is a growing interest in consuming barley because of numerous potential health benefits. However, no quality standard of barley for food uses is available, nor has the attempt been made to establish one. We have limited experience in systematically breeding, supplying and maintaining barley for food uses.

What Was Done

Defined the influences of compositional characteristics, especially, amylose content, protein content, β -glucans content and proanthocyanidin content, on the quality attributes of food products, including water imbibition of grains, water absorption for making bread and noodles, bread crumb moisture content, color of noodles and texture of cooked noodles. We explored effective ways of controlling discoloration of barley-based food products. The removal of the outer layer of grains, heat treatment, exclusion of oxygen, low storage temperature and the use of ascorbic acid and 4-hexylresorcinol improve color characteristics of food products containing barley.

Impacts

The information obtained from this study will be useful for identifying raw materials suitable for making barley food products as well as provide barley breeders with guidelines for the development of varieties with superior food product quality.