Proceedings
2014 Sorghum Improvement Conference of North America (SICNA) Meeting

June 25-27, 2014--- Corpus Christi, TX

Venue: **Texas A&M AgriLife Research and Extension Center, Agnes, Corpus Christi, TX**

ACKNOWLEDGEMENTS

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Drs. Juan Landivar;Gary Odvody; Roger Monk	**-Local Arrangements; Field Tours**
Ms. Vicki Horn	**-Program and arrangements**
Drs. G. Burow, J. Burke & Z. Xin	**-Graduate Student Competition, Editors of Proceedings**
US Sorghum Checkoff /NSP	**-Registrations and brochures**

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Technology Transfer:	**Brian Arnall**
Agronomy / Physiology	**Ignacio Ciampitti**

Grad Student Competition Coordinator **Gloria Burow**

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INTRODUCTION

The 2014 Sorghum Improvement Conference of North America (SICNA 2014) meeting was held at the Texas A&M AgriLife Research and Extension Center, Agnes, Corpus Christi, TX on June 25-27, 2014. The meeting was attended by about 80 participants representing a diverse cross section of the sorghum industry including sorghum research community from both public and private sectors, producer stakeholders and commodity group leaders. SICNA 2014 was organized by Dr. William Rooney, Chair of SICNA leadership in cooperation with Dr. Juan Landivar, resident director of Texas A&M AgriLife Research and Extension Center, Corpus Christi, Texas. The conference was highlighted by keynote presentation from Dr. Bill F. McCutchen, Executive Associate Director, Texas A&M AgriLife Research on "Advances in Sorghum and Bioenergy Research at Texas A&M University". Field tours of sorghum experimental fields at Texas Agrilife, Corpus Christi and Pioneer Dupont facilities in Victoria, Texas were organized by Drs. Gary Odvody and Roger Monk, respectively. Some logistical and staff support for the conference were also provided by National Sorghum Producers, US Sorghum Checkoff and Cropping Systems Research Laboratory, USDA-ARS in Lubbock, TX. Ms Vickie Horn, (administrative assistant), Department of Soil and Crop Sciences, Texas A&M University is acknowledged for her excellent administrative efforts for the success of 2014 SICNA.

The conference also served as venue for graduate students working on sorghum from various US universities to present their research thru a graduate student oral research competition. The winners were: First place-- Mr. Brian K. Pfeiffer, Texas A&M University, for his research work on "The Inheritance of Black Pericarp Color and Nutritional Quality Traits", Second Place--Ms. Dorothy Herrman, Texas A&M University, for her research work on Improving Aqueous Stability of Sorghum 3-Deoxyanthocyanin Pigments for Food Colorant Application and Third Place—Mr. Nicholas Pugh, Texas A&M University, for his research on "Heritability of Popping Characteristics in Sorghum Grain". A cash award was presented to each of the graduate student winner. Additionally, the conference provided networking opportunities for graduate students and participants to promote collaborative and cooperative activities.

You will find here the **Proceedings of the 2014 SICNA Conference***,* comprising of abstracts of oral graduate students and poster presentations in various sessions and the overall program of activities for the meeting.

Please refer to any of the content herein judiciously by appropriate citation of each of the work in your research documents, manuscripts, articles or presentations. An example of a citation from this proceeding (this will vary based on journal format/requirements) is as follows;

Emendack, Y., Malinowski, D., Burke,J. J.. Burow, G., and Xin, Z. 2014. Morpho-physiological characterization of cold-and pre-flowering drought tolerance in sorghum inbreds. 2014 SICNA Proceedings (eds: GBurow, J. Burke and Z. Xin), p5., www.sicna.net

We hope you will find the 2014 SICNA Proceedings as a valuable resource for your sorghum research and extension related activities.

Editors
Gloria Burow, John Burke and Zhanguo Xin
Cropping Systems Research Laboratory, USDA-ARS
Lubbock, Texas, USA

2014 SORGHUM IMPROVEMENT CONFERENCE OF NORTH AMERICA MEETING

June 25-27, 2014

Texas A&M AgriLife Research and Extension Center, Agnes, Corpus Christi, TX

Wednesday, June 25

Registration, Station Tours, and Preliminary Grad Student Presentations

Venue: Texas A&M AgriLife Research and Extension Center, Agnes, Corpus Christi, TX

5:00-6:00 PM Registration

6:00-8:00 PM Preliminary Graduate Student presentations before student awards committee

6:00-7:00 PM Catered Dinner

7:00-8:30 PM Field Tours, Texas A&M AgriLife Research and Extension Center, Corpus Christi, Texas

Thursday, June 26

Scientific Sessions, Field Tours & Awards Program

Venue: Texas A&M AgriLife Research and Extension Center, Agnes, Corpus Christi, TX

Morning Session—Texas A&M AgriLife Research and Extension Center, Conference Room

7:30-8:30 AM Late registration, Foyer

8:10-8:45 AM Welcome, program update, and remarks

8:45-9:45 AM Graduate Student Competition—Top three presentations from Wednesday evening's program

9:45-10:00 AM BREAK

General Session by Disciplines

10:05-11:05 AM Chemistry & Utilization, *Dr. Robert Moreau,USDA-ARS, Wyndmoor, PA*

Title: The effect of soil microbiology on sorghum grain characteristics
Speaker: Dr. Ashley Galant, USDA/ARS/NPA, Manhattan, KS

Title: Sorghum Allelopathy: Biosynthesis and Secretion of Phenolic Lipid-Type Growth Inhibitors from Root Hairs
Speaker: Dr. Scott Baerson, USDA, ARS, Oxford, MS

Title: The Chemistry and Utilization of Sorghum Oil and Distillers Milo Oil
Speaker: Dr. Robert A. Moreau, USDA, ARS, Wyndmoor, PA

11:05-12:05 PM Breeding & Genetics, *Mr. Chad Hayes, USDA-ARS, Lubbock, TX*

Dr. Gloria Burow, USDA-ARS, Lubbock, TX
Dr. Melinda Yerka, USDA-ARS, Lincoln, NE, University of Nebraska
Dr. Gary Pederson, USDA-ARS, Griffin, GA

12:05 PM Catered Lunch

1:00-2:00 PM Entomology, *Dr. Scott Armstrong, USDA-ARS, Stillwater, OK*

Title: Insecticide efficacy trials for the sugarcane aphid on sorghum
Speaker: Dr. Raul Villanueva, Texas AgriLife Weslaco, TX

Title: Update on sampling and threshold research for sugarcane aphid on sorghum
Speaker: Dr. Mike Brewer, Texas AgriLife, Corpus Christi, TX

2:00-3:00 PM Plant Pathology, *Dr. Deanna Funnell-Harris, USDA-ARS, Lincoln, NE*

Title: Sorghum Pathology Under the Dry Conditions of the Texas Panhandle and Surrounding Areas
Speaker: Dr. Ron French, Plant Pathology Specialist, Texas A&M AgriLife Extension Service, Amarillo, TX

Title: Sorghum Downy Mildew: History and Status in Texas
Speaker: Dr. Gary Odvody, Department of Plant Pathology, Texas A&M Research and Extension Center at Corpus Christi, TX

Title: Effects of Soil Moisture on the Development of Sorghum Downy Mildew
Speaker: David Laughlin, Department of Plant Pathology, Texas A&M University, College Station, TX

<u>FIELD TOURS</u> – Busses will be stationed outside

3:10-6:00 PM Off-site Tour to Pioneer HiBred Taft Breeding Station and then Texas A&M AgriLife Crop Testing Program Grain Sorghum Variety Test near Gregory, TX

6:30-8:30 PM DINNER— Corpus Christi Holiday Inn, Corpus Christi, TX
<u>Awards Program</u>—
Outstanding Graduate Student Presentation
National Sorghum Producers *Outstanding Achievement in Sorghum Improvement*
KEYNOTE Presentation—Dr. Bill F. McCutchen, Executive Associate Director, Texas A&M AgriLife Research

Friday, June 27

General Session

8:00-9:00 AM Technology Transfer/Extension, *Dr. Brian Arnall, Oklahoma State, Stillwater, OK*

Title: Farmer Input in Long-term Reduced Till Cropping Strategies using Sorghums in the Lower Texas South Plains
Speaker: Calvin Trostle, Texas A&M AgriLife Extension, Lubbock, TX

Title: Development of a New Tool for Estimating Sorghum Yields at the Farm-Scale
Speaker: Ignacio Ciampitti, Kansas State University, Manhattan, KS

9:00-10:00 AM Agronomy and Physiology, *Dr. Ignacio Ciampitti, Kansas State Univ., Manhattan, KS*

Title: Effect of high temperature on Palmer amaranth control with HPPD inhibitors
Speaker: Curtis Thompson, Kansas State University, Manhattan, KS

Title: Development of an abiotic stress tolerant multi-purpose sorghum
Speaker: John Burke, USDA, ARS, Lubbock, TX

Title: The Effects of an Alternative Irrigation Strategy on Profile Soil Water Use by Grain Sorghum
Speaker: Jourdan M. Bell, Texas A&M AgriLife Extension and Research, Amarillo, TX

10:00 - 10:30 AM BREAK
10:30-11:30 AM Biotechnology, *Dr. Scott Sattler, USDA-ARS, Lincoln, NE*

Title: Characterization of sorghum compositional traits by transcriptome, phenome and genome-wide association analysis
Speaker: Ms. Nadia Shakoor, Chromatin Inc., Chicago, IL

Title: Development of Genomic Resources in Sorghum and Their Use in an Applied Breeding Program
Speaker: Dr. Patricia Klein, Texas A&M University, College Station, TX

Title: Pedigreed Mutant Library-A non-transgenic Resource for Sorghum Improvement
Speaker: Dr. Zhanguo Xin, USDA-ARS, Lubbock, TX

Sorghum Workshop for CEU credit

9:00 – 11:30 AM

Sorghum Physiology and Management School

Offered to AG/NR agents and to conference attendees

2 sessions (1.5 hrs each)

If large group, split into 2 groups, teach each session twice. If small, then teach each consecutively.

Session 1: Sorghum Morphology and Physiology (Led by Calvin Trostle)

Attendees will learn general morphology of sorghum plants, characteristics used determine stage of growth, become familiar with growth scales, and learn to identify the growing point of sorghum plants at various stages of development. Learning activities will include hands on dissection of sorghum plants and identification of important growth stages critical to crop management.

Session 2: Sorghum Ecology and Management (Led by Ronnie Schnell)

Attendees will learn principles of sorghum ecology and how management decisions affect these factors. Attendees will learn how populations, planting dates, hybrid maturity and other management decision affect yield and yield components. Examples of commonly observed field problems will be provided for hands-on inspection and diagnosis.

11:45 AM Closing Remarks then SAFE TRAVEL!!!

ABSTRACTS of Presentations and Posters

Agronomy and Physiology

#AP1_Morpho-physiological characterization of cold-and pre-flowering drought tolerance in sorghum inbreds

[1]Yves Emendack*, [1]Dariusz Malinowski, [2] John Burke, [2]Gloria Burow, Zhanguo Xin[2].
[1]Texas AgriLife Research, Vernon; Texas, [2]CSRL USDA-ARS, Lubbock, Texas.

Global warming and resulting shifts in seasonality and severity of drought occurrences suggest that sorghum lines with early-season cold germination tolerance, will likely experience pre-flowering drought stress, which might significantly reduce grain yield.

Eight cold tolerant sorghum inbred lines were grown in the field under sub-optimal temperatures, to determine early-season cold germination, and later subjected to pre-flowering drought, to establish a correlation between cold germination and pre-flowering drought stress tolerance using selected morpho-physiological traits.

Following germination and vegetative development, lines were subjected to limited and no irrigation treatments, and pre-flowering drought tolerance was assessed at five defined phenological phases of the reproductive stage, using morpho-physiological traits. Final germination percent (FGP) differed among lines (range 30-80%). FGP was positively correlated with leaf area index (LAI), height (HGT), and harvest index; (HI). These three traits and single plant biomass (SPB) also positively correlated with grain yield (SPY) under pre-flowering drought. Most significant correlations among measured traits were observed at the heading to flowering phase. Harvest index explained 75% and 91% variability in grain yield for the limited and no irrigation treatments respectively. Other predictors for grain yield were; FGP, HGT and SPB under limited irrigation, and FGP and HGT under no irrigation. The ability to cease growth (lines B1 and B2), maintain LAI (lines B1, B2, B4 and B6), and retain high CLC (lines B4 and B8) and high HI (line B2), will be important selection traits to develop sorghum cultivars for temperate and highland regions, with possibility of pre-flowering drought occurrence. Morpho-physiological traits determined in this experiment may add to the array of characteristics used in sorghum breeding for cold and pre-flowering drought tolerance.

#AP2_The Effects of an Alternative Irrigation Strategy on Profile Soil Water Use by Grain Sorghum

Jourdan M. Bell, Robert Schwartz, Kevin J. McInnes, Terry Howell,
and Cristine L.S. Morgan
Texas AgriLife Research, Amarillo, Texas

Development of efficient irrigation strategies is a priority for producers faced with water shortages. Managed deficit irrigation attempts to optimize water use efficiency (WUE) by synchronizing crop water use with reproductive stages. Soil water use and yield of grain sorghum [*Sorghum bicolor* (L.) Moench] were evaluated during the 2010 to 2012 growing

seasons under three sprinkler irrigation strategies: full (FI), deficit (DI), and managed deficit irrigation (MDI). Fully irrigated sorghum grain yields averaged 3.7 Mg ha^{-1} greater ($p < 0.001$) than deficit irrigated sorghum in all years. Seasonal crop water use under MDI averaged 29 mm greater than DI. Concomitant with increased water use principally during the reproductive period, MDI yields averaged 1.6 Mg ha^{-1} greater than DI, which was significant in 2010 and 2012 ($p \leq 0.006$). The WUE of FI sorghum was significantly greater than MDI in 2012 ($p = 0.003$) and DI in 2010 and 2012 ($p \leq 0.001$). In 2011, crop water uptake was restricted to above 0.6 m when water contents deeper in the profile were less than 42% PPAW. In 2010 and 2012, seasonal crop water uptake in the profile below 1.0 m was small (<14 mm) and did not appreciably increase in response to imposed soil water deficits. The rooting zone for evaluating plant water status and hence irrigation scheduling depended on initial profile water contents and possibly root density deeper in the profile. Results suggest that WUE's of grain sorghum are not compromised under MDI compared with FI in most cropping seasons.

Breeding & Genetics

#BG1_The Inheritance of Black Pericarp Color and Nutritional Quality Traits in Sorghum

Brian K. Pfeiffer* and William L. Rooney
Department of Soil & Crop Sciences, Texas A&M University
*presenting author

Black pericarp grain sorghum [*Sorghum bicolor* (L.) Moench] has high levels of phenolic compounds, especially 3-deoxyanthocyanidins (3-DOAs), which have application in food science and human nutrition as a high-antioxidant food additive, natural food colorant, and natural food preservative. The inheritance of this trait is complex and has not been studied, thus creating a barrier for further genetic improvement. In order to determine the genetic mechanisms governing this novel trait, a generation means analysis was performed using Tx378 (red), Tx3362 (black), and F_1, F_2, and backcross generations derived from these parents. These six generations were evaluated in 2013 in three diverse Texas growing environments. Significant additive, dominance, and epistatic effects were detected for grain color and associated grain composition traits. Segregation distributions confirmed black sorghum is recessive to red. Estimates of broad-sense heritability ranged from 55% (L^*) to 100% (visual score rating) among the four grain color traits and three phenolic composition traits measured. 3-deoxyanthocyanidn (3-DOA) content was moderate to highly heritable (0.77) and between two and ten genes are estimated to control the black pericarp trait. Despite the complicated mode of inheritance, enough variation exists for future improvement of black sorghum. Creation of high yielding hybrids with uniformly dark grain and high levels of phenolic compounds will be possible through standard plant breeding practices.

#BG2_Evaluation of Grain Weathering Resistant Sorghum Lines for resistance to grain mold fungi and quality traits

Tomar, S.S.[1], Perumal, R[1], Peterson G.C.[2], Rooney, W.L.[3], Bean S.R.[4] and Christopher R. Little[5]

[1] Kansas State University, Agricultural Research Center, Hays, KS; [2] Texas A&M AgriLife Research and Extension Center, Lubbock, TX; [3] Dep. of Soil and Crop Sciences, Texas A&M University, College Station, TX; [4] USDA-ARS, Center for Grain and Animal Health Research, Manhattan, KS; [5]Department of Plant Pathology, Kansas State University, Manhattan, Kansas

An experiment was conducted with 44 sorghum grain weathering resistant lines and 4 checks (Sureno, Tx2911, RTx430, and RTx2737) with two replications at the Texas Agrilife Research and Experiment Center, Lubbock, TX in 2013. Open heads were collected to screen for grain mold fungi and quality traits analysis with the objectives to identify the fungal complex involved in grain mold infection, identify resistant sources, and to assess the relationship between disease and seed quality traits. Fungal colonies growing from kernels were counted and classified into 21 groups based upon culture morphology. Using Internal Transcribed Spacer (ITS) primers (ITS 4 and ITS 5) these morphological groups were classified into fungal genera via sequencing. Sorghum lines were further analyzed using the single kernel characterization system (SKCS) for physical grain traits including hardness index (HI), kernel weight (KW), kernel diameter (KD), total protein percentage (TPP), and protein digestibility (PD) at the USDA, Manhattan, Kansas. Also, nine quality traits were analyzed [phenols, tannins, protein, moisture, fat, fiber, ash, starch, and 3-deoxyanthocyanin (3-Deo) content] by using near-infrared reflectance (NIR) spectroscopy at Texas A&M University, College Station. Results indicated that most of the lines in the test had low levels of infection from *Fusarium*, *Curvularia, Phoma, Aspergillus* and *Penicillium* species. However, these lines showed variable levels of infection by *Cladosporium (*5.3 to 24.5 %) and *Alternaria (*7.9 to 77.9 %*)*. The frequency of *Cladosporium* with protein percentage ($r = -0.48$; $P = 0.0004$) and *Aspergillus* with hardness index ($r = -0.32$; $P = 0.0200$) were negatively correlated, which suggests that these two fungi could play a role in seed quality deterioration. Sorghum lines Tx3371, Tx3373, Tx3374, Tx3376, Tx3407, Tx3400, and Tx3402 were identified as potential sources of grain weathering resistance as these showed minimal fungal infection and higher seed quality traits.

#BG3_Heritability of Popping Characteristics in Sorghum Grain

N. A. Pugh and W. L. Rooney
Texas A&M University

Popped sorghum (*Sorghum bicolor* L. Moench) represents a growing specialty niche market; however, there has not been selective breeding for popping quality traits in sorghum. Systematic improvement is based on the heritability of the traits which leaves an opportunity to investigate the heritability and if heritable, improve the popping quality of select sorghum varieties. Traits of particular interest to popcorn growers are popping efficiency (PE) and expansion ratio (ER), where PE is a measurement of the proportion of kernels in a sample that popped and ER is a measure of how much expansion each kernel exhibits after popping. Since

improvement of popping quality in sorghum grain requires that the traits of interest be heritable, one of the primary objectives of this study was to determine if popping quality traits in sorghum are heritable on an entry mean basis ($h^2 = \frac{\sigma_G^2}{\sigma_p^2}$). Using a heated air popping methodology to evaluate 130 recombinant inbred lines (RIL), preliminary results suggest that various popping quality traits are heritable, with PE being moderately heritable at $H^2 = .40$ and ER being highly heritable at $H^2 =89$. These early results show that it is therefore possible to genetically improve popping quality in *Sorghum bicolor* via selective breeding.

#BG4_Genetic Diversity of Korean Sorghum Varieties and Landraces

Jaemin Cho[a] *, Jungin Kim[a], Jeeyeon Ko[a], Koansik Woo[a], Seokbo Song[a], Jaesaeng Lee[a], Inseok Oh[a], Taewook Jung[a]
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Sorghum (*Sorghum bicolor* (L.) Moench) has been a type of crop that produced one of cereal grains which have been traditionally used for steaming with rice in Korea. The use of sorghum grain has been increased and diversified with the changing trend of consuming coarse cereals as a healthy food. In this study, genetic diversity of Korean sorghum varieties and landraces were investigated using 40 SSR markers to provide useful information for the breeding program in Korea. Total 373 individuals were used for the representative of both Korean (173 individuals) and World (164 individuals) collections, including 36 unknown origins. Korean collection generated 325 alleles with an average of 8.13 per locus whereas world collection produced 270 alleles with an average of 6.75 per locus. Polymorphism information content values of Korean and world collections were 0.44 with a range of 0.11-0.86 and 0.59 with a range of 0.18-0.87, respectively. Genetic distance was estimated based on the frequency of total 378 alleles. Clustering based on the genetic distance revealed 10 groups of Korean landraces and 11 groups (including two large clusters) of world collections. Grouping was in good agreement with populations revealed by Structure analysis and genetic background information. The acquired information about Korean and world collections from this study can provide a basis for sorghum improvement through the development of segregating population and hybrid development.

#BG5_Transgressive Co-segregation for Wax and Staygreen Traits Reveal a Possible Unique Marriage Between which we could Rescue Yield Losses Occasioned by Heat and Drought Related Seed Set Failure in Sorghum

Henry Awika[1], W. Rooney[1], and Dirk Hays [1]
Soil and Crop Sciences Department, Texas A&M University

Based on initial field phenotyping, QTL analysis and phenological observations of inbreds from TX642/TX7000 inbred (RILs) cross, we show that transgressive co-segregation for total compositional leaf wax combined with staygreen might lend a greater pre-and post-flowering drought and heat tolerance, than the non-staygreen and low wax variants. We phenotyped 100 RILS, and classified them into staygreen or non-staygreen based on visual highest staygreen or lowest staygreen scores, respectively. From each category, plants consistently within the upper 10^{th} percentile and the lower 10^{th} percentile of wax load at anthesis from all field locations were further screened in the greenhouse for wax load, staygreen and percent seed set and yield under normal greenhouse, enhanced drought and elevated heat conditions. Normal watering were done to 40 days after germination (DAG) and continued normally at 1 kilogram (kg) every 2 days under heat treatment and control, but reduced to ½kg every 4 days under drought till physiological maturity. Temperatures were 31^0C and 17^0C day and night respectively for drought and control treatments, and 42^0C/27^0C day/night respectively for the elevated heat treatment. Four staygreen isolines (Stg1, Stg2, Stg3, Stg4) were concurrently evaluated. Under elevated heat and drought, staygreen-high wax inbreds showed up to 20 per cent higher seed set than staygreen-low wax inbreds, non-staygreen high wax and non-staygreen-low wax inbreds. Individually, staygreen isolines (1, 2 and 4) also showed higher seed set than the pre-anthesis high wax TX7000 suggesting that staygreen genomic loci, if independently inherited might offer advantageous genetic interaction with wax that would significantly rescue yield.

Chemistry and Utilization

#CU1_ Effects of Sorghum Tannins on Wheat Protein & Starch Profiles During Tortilla Processing

Kristen L. Dunn[1,2], Audrey L. Girard[1,2], Scott R. Bean[3], and Joseph M. Awika[1,2]
[1]Cereal Quality Laboratory, Department of Nutrition and Food Science, Texas A&M University, College Station,
[2]Department of Soil and Crop Sciences, Texas A&M University, College Station, Texas
[3]Grain Quality and Structure Research Unit, USDA-ARS, Manhattan, Kansas

Sorghum tannins have been shown to bind with starch in pure starch systems to form resistant starch (RS). RS can reduce caloric density and increase dietary fiber of starchy foods, both beneficial in preventing and managing obesity and type 2 diabetes. However, little is known about the behavior of tannins in processed food matrices where protein is also present. Protein and starch profiles of flour tortillas made with no bran and 23% bran from wheat and white, black, and tannin (TN) sorghum were investigated. Insoluble (IP) and extractable proteins (EP) and *in vitro* starch digestibility were determined. Dough prepared with TN treatment contained more IP (46%) and less EP (54%) than the control and other treatments IP (33-39%) and EP (60-67%). The TN treatment had the largest decrease in total polyphenols (49%) after dough formation versus black sorghum (4%), the only other sample with a significant decrease ($p<0.05$). Extractable tannins in TN also decreased 55% in the dough. The increase in IP and decrease in tannins suggests that tannins complexed with proteins during gluten network formation. Formation of RS in TN treatments was not different from the control. However, TN samples had significantly higher slowly digestible starch (19%) than the control and other treatments (13%). This suggests that tannins from TN may preferentially bind protein over starch in a flour tortilla matrix in a way that increases slowly digestible starch. This type starch has been shown to increase satiety which may aid in preventing obesity and type 2 diabetes.

#CU2_Synergistic effect of combining sorghum and cowpea polyphenols on reducing LPS-induced inflammation in non-malignant colon myofibroblast in vitro

Sh. Agah,, L. Yang, and J. Awika
Department of Soil & Crop Science, Cereal Quality Laboratory, Texas A &M University, College Station, TX, USA

Overproduced Reactive oxygen species (ROS) are involved in a wide spectrum of diseases, including chronic inflammation and cancer. Sorghum & cowpea are both drought tolerant crops that contain significant quantities of distinctly different polyphenols with known bioactive properties. The objective of this study was to determine potential synergistic effect of combining sorghum & cowpea polyphenols in reducing ROS generation in non-malignant colon myofibroblast CCD18Co. White Sorghum (high in flavone) and white cowpea (high in flavonol) extracts were combined in different ratios (3:1-1:3). Intracellular ROS production & oxygen radical absorbance capacity (ORAC) were assessed for each treatment at different concentrations (0.1, 1, 10 &100 µg /ml). Combination of sorghum & cowpea extracts showed significantly ($P<0.05$) higher ROS inhibitory effect & ORAC antioxidant capacity than the additive effects of individual extracts. The mixtures with (1:1 & 2:1) ratios revealed 1.5-fold increase in ROS quenching. The combination of white sorghum & white cowpea (3:1 &1:3) ratios showed between (3.1-3.4) times higher values in inhibitory effect of ROS generation than the additive effects of individual extracts. The sorghum & cowpea combination also revealed 3-fold increase in ORAC value (180 µMol TE/g sample versus 60 µMol TE/g sample). Thus, synergistic effect in ROS quenching of combined sorghum & cowpea paralleled their antioxidant activity, indicating the consumption of food containing cereal and legume together might be more beneficial in reducing chronic diseases than predicted by either component alone.

#CU3_Improving Aqueous Stability of Sorghum 3-Deoxyanthocyanin Pigments for Food Colorant Application

Dorothy Herrman and J. Awika
Department of Soil & Crop Science, Cereal Quality Laboratory, Texas A &M University, College Station, TX, USA

The natural food color market experienced significant growth in the last decade with global sales of $600 million, an increase of 29% between 2007-2011. By 2011, most food and beverage launches contained natural colorants. Anthocyanins are among the most widely used natural colors. However, their stability to food processing conditions is limited. 3-Deoxyanthocyanins (3-DXNs) are found predominantly in sorghum and are unique pigments that tolerate food-processing conditions better than anthocyanins. However, 3-DXN pigments readily precipitate in aqueous solutions due to lower hydrophilicity limiting potential food application. The objective of this study was to determine effect of ionic gums and multivalent cations on aqueous stability of sorghum 3-DXNs. Ionic gums (acacia gum, alginate) at 0.01%, 0.05%, and 0.1%, and metal ions (Mg^{2+}, Fe^{2+}) at 0.2 mM were complexed with 3-DXNs in pH 3 and 5 buffers. Spectra were recorded with UV-Vis spectrophotometer. After 10 weeks, acacia gum at 0.05%, and 0.1% concentration, significantly increased aqueous stability of 3-DXNs. Alginate samples at pH 3 readily precipitated, while pH 5 samples with alginate concentration 0.1%, remained in solution after 10 weeks. Controls showed 90% precipitation within 1 hour. 0.01% concentration was ineffective for both gums. Acacia gum was likely more effective because of its amphiphilic nature resulting in emulsification of 3-DXNs. Neither metal ion provided significant stabilization. Iron resulted in undesirable pigment browning. Acacia gum is highly effective at stabilizing 3-DXAs in aqueous environments, increasing their potential application as natural food colorants.

#CU4_ Effects of the Interactions of Sorghum Condensed Tannins with Ungelatinized Corn Starch on Starch Digestibility

Derrick B. Amoako1 and Joseph M. Awika1,2
1Dept. of Soil & Crop Sciences, 2Dept. of Nutrition and Food Science
Texas A&M University, College Station, TX 77843

Condensed tannins (CT) from sorghum interact with amylose to increase resistant starch (RS) in cooked starch. A high proportion of slowly digestible starch (SDS) and RS relative to rapidly digestible starch (RDS) is considered desirable for increasing satiety and lowering starch digestion rate, beneficial for calorie control. This study investigated the effect of reacting CT from sorghum with ungelatinized starch on SDS and RS formation. Phenolic extract from high-tannin sorghum was mixed with normal (NC), waxy (WC), and high amylose (HAC55) corn starches in excess water and incubated at 55°C and 80°C (High amylose only, HAC80) for 3 and 6 hours. Samples were then centrifuged and residue oven dried at 40°C overnight. RDS%, SDS% and RS% of 3-hour treatment samples were not significantly different from 6 hours. All the samples had significantly more RS% (NC=89.5, WC=84.3, HAC55=90.6, HAC80=73.8) compared to controls (NC=53.03, WC=33.3, HAC55=81.8, HAC80=38.9). WC had the highest increase in RS% (50.1) over its control. HAC80 also had higher increase in RS% (34.9%) as compared to HAC55 (8.6%). This observation in WC and HAC80 suggest the impact of higher degree of starch granule swelling on increased CT-starch interaction. CT amount that interacted with the starch (NC=6.8, WC=7.9, HAC55=5.0, HAC80=10.7) (in mg CT/g of starch) confirms above phenomenon. SDS% of samples were lower than controls, and starch digestibility was not due to enzyme inhibition by CT. Sorghum condensed tannins (CT) can therefore be potentially used as ingredients for reducing caloric value of starchy foods.

#CU5_Economic Feasibility of Extruded Fortified Sorghum-based Food Aid Products

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Fortified blended foods, both corn-soy blends (CSB) and wheat-soy blends (WSB), are widely used around the world as supplementary food aid products by the United States Agency for International Development and the World Food Program. In this study, we assess the economic feasibility of the production of sorghum-soy blend (SSB) and sorghum-cowpea blend (SCB) as alternatives to CSB and WSB for Africa. Because our fortified sorghum-based food aid products are fully cooked using extrusion, they have a longer shelf life, are more easily digested, and are less reliant on heat sources during preparation. The cost effectiveness of SSB and SCB are compared to existing food aid products, taking into consideration ingredient, processing, and transportation costs of the products, as well as the nutritional profile. Results indicate that even with additional costs, certain sorghum-based blends are at least as nutrient cost effective as alternative food aid products. Additional market research indicates that food processors exist with the capacity and interest to produce SSB and SCB, and consumer acceptance in Africa should be high because sorghum is non-genetically modified and is already used for human consumption in certain areas. Therefore, sorghum-soy and sorghum-cowpea blends should be approved as alternative food aid products to CSB and WSB.

Entomology

#E1_Screening for Host-Plant Resistance to the Sugarcane Aphid In Grain Sorghum

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The sugarcane aphid has increased in distribution into the United States and caused economic damage to grain sorghum by infesting during the later part of the production season. Not only is there a reduction in grain yield due to infestations, but harvesting is negatively impacted because machinery including augers, are gummed-up from the honeydew covering the plant. Finding sources of host-plant resistance would have a significant impact in reducing this aphid problem. We report here some of the first efforts of identifying resistant sources of grain sorghum to the sugarcane aphid.

#E2_SEM Imaging Combined with SEM-EDS Analysis Enables the Prediction of the Resistance of Sorghum Varieties to Storage Insects in Granaries in Rural Africa

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In developing tropical countries, 30-40% of stored grain can be destroyed by insects. An important insect pest of stored sorghum (*Sorghum bicolor* (L.) Moench) is the maize weevil (*Sitophilus zeamais* Motschulsky). Weevil larvae and adults feed on the sorghum kernels in the field and in storage. To compare the rate of weevil damage for different varieties, weevils were placed in vials with sorghum kernels and checked every 3 weeks for 105 days for kernel damage and weight loss. Seven varieties of these kernels were dehydrated, razor-sectioned, treated with iodine vapor, and carbon-coated for observation using a JEOL 6400 scanning electron microscope (SEM). A sorghum variety developed in Mali (Seguifa) was sectioned, dehydrated, and embedded in resin. The resin coated kernel was sectioned with an ultramicrotome below the razor-sectioning. Improved resolution and sample integrity were noted for the embedded sample compared to the razor-sectioned samples. The microtomed block face was also vapor treated with iodine and carbon-coated. Cut surfaces of all eight sorghum samples were observed with secondary and backscatter SEM and analyzed by energy dispersive spectrometry (EDS). Because iodine binds to starch, the starch layer (aleurone) could be identified using backscatter and EDS spectra so measurements could be made from seed coat to aleurone layer. The greater distance from the seed coat to aleurone layer was correlated to a lessened weight loss. This procedure allows a prediction of the resistance of newly developed sorghum varieties to weevil predation without incurring the delay of 105 days for the standard test trials.