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Agricultural Research & Extension Center

Leodrey Williams

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Annual Procurement Conference Empowers Small Business Owners

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Chancellor Williams welcomes conference participants

Hundreds of small business owners and exhibitors assembled at the Southern University Smith-Brown Memorial Union on April 16, 2014 for the 10th Annual "CONNECTING BUSINESSES TO CONTRACTS" Procurement Conference hosted by the Southern University Ag Center. The event was featured on the evening news by NBC 33 TV News at 10 and FOX 44 in Baton Rouge. The full story is available at WGMT-TV – Online: Setting up for success: Southern University hosts conference to help small business owners

As always, the goal of the conference is to stimulate the economy by aligning existing and potential business owners, small contractors, non-profit organizations, and others with contracting officers, and purchasing agents, as well as providing an outlet to network and exchange information and ideas.

Keynote Speaker, Jackson addresses audience

This year, Lydia Jackson, Capital One Bank Community Reinvestment Act (CRA) Business Development Officer, served as the keynote speaker.

Jackson offered some sound advice to conference attendees including tips on doing business with Capital One Bank. These tips included being certified and committed to compete nationally or at least regionally; having a relationship with a bank before presenting a loan package; registering on the bank's website; and learning/ preparing to speak the lender's language. She directed small business owners to the Capital One Bank website where they can access a wealth of business resources and tools to help grow their businesses. In closing Jackson said, "We at Capital One are very proud to continue to be a part of this procurement conference. We recognize how important your economic growth and health is to the community and to our business." She expressed her desire to see the businesses grow and expand, create new jobs in the community and continue to do business with the bank and grow new customers for the company.

In the 2007 legislative session, Jackson, who is a former Louisiana senator, authored a bill to create the first refundable Earned Income Tax Credit in the South.

The conference attracted many Baton Rouge-based businesses along with others from across the nation. Activities included concurrent sessions, exhibitions, and luncheon.

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Procurement Conference

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Attendees gather at BEREAN's booth to learn about the new business.

Participants interact with exhibitors at conference

L-r: Jackson, Giddens, and London pose for a snapshot at the end of conference.

First time attendee, Marcus Evans of BEREAN Wellness, a Baton Rouge small business focusing on natural health remedies, said his expectations were "to create more awareness and to network."

Another Baton Rouge-based business, Cajun Consultants, that has attended the conference for several years and Omer Libich, field clerk, who represented the company this year said, "It is a lot of networking, a lot of new businesses and a lot of fun times; a great opportunity to see what's out there and what's here locally."

"The Center for Rural and Small Business and its partners were able to accomplish its overall goal on yesterday at the Annual Procurement Conference. We provided small businesses an opportunity to gain knowledge from well-developed workshops and the opportunity to network with individuals and other businesses," said Gloria London, Director, Center for Rural and Small Business Development. "This will spur further economic development throughout Louisiana. We have been sponsoring this event ten years and look forward to many more," she added.

Presenters and exhibitors who represented their companies included: Entergy, Inc., Regions Bank, Liberty Bank and Trust Company, SBA Surety Bond Brokers, South East Procurement Technical Assistant Center, USDA Rural Business Development, (Federal & State) Office of State Purchasing, Baton Rouge City Purchasing Department, Southern University Purchasing Department, LSU Purchasing Department, Louisiana Small Business Development Center, Louisiana State Contractor Licensing Board, Louisiana Housing Finance Agency, The Shaw Group, Capital One Bank, Louisiana Department of Labor, Louisiana Department of Economic Development.

Other exhibitors included: United States Department of Commerce, Secretary of State's Office, and Louisiana Department of Workers' Compensation, Department of Veterans Affairs, FEMA, DoE, Bureau of Prisons, GSA, Minerals Management Service, U. S. Coast Guard, Louisiana National Guard, Dept. of Navy, and Shaw Industries.

The event was coordinated by Gloria London, Eual Hall, and Lakeeshia Giddens who can be reached at (225) 771-4107 or 4105.

The Procurement Conference was hosted by the Center for Rural and Small Business Development at the Southern University Ag Center, the U.S. Small Business Administration, Louisiana Small Business Development Center of Baton Rouge, Louisiana Economic Development and the Louisiana Procurement Technical Assistance Center (PTAC).

Locals Boost 45th Annual Horse Show and Trail Ride

The Southern University Agricultural Research and Extension Center hosted the 45th Annual Horse Show and Trail Ride, April 11-13, 2014 at the Maurice A. Edmond Livestock Arena in Baker. This year, approximately 200 riders traveled with horse in tow from Arkansas, Mississippi, Georgia, Florida, Texas and New Mexico to join Louisianans in Baton Rouge for the event. The horse parade, including riders ranging in age from 5-80 years old, different horse riding associations, and six covered wagons, galloped around the Baker area for two hours. First and second place winners were selected by judges at the completion of the event.

Local entertainers, Leon Chavis and Tyree Neal performed at the event. Each year, the Southern University Posse Horse Rider Association helps host the event. Apart from riding associations, privately trained youth and adults also participate in the ride. One of the participants, 18-year old Dale Houston from Career Academy, said this is his second year on the ride and he loves it. While waiting under a shade tree for the ride to kickoff, Houston hung out with friend, 15-year old Daquan Smith from Glenn Oaks High School who said he's been riding since age 10 and plans to keep riding because it is fun.

Debra Lee, a member of the Southern University Posse Horse Riders Association was proud to announce that she has been enjoying this event for the past four years. "I hope to be here next year; this is our trail ride, the Southern University Posse helps host the Show," Lee said.

The event was coordinated by Christie Monroe who can be reached at 225-771-4350 or via email: christie_monroe@suagcenter.com

Parade en route the parade trail

Youth riders, Smith and Houston poised for parade

Debra Lee, SU Pose arrives ready to ride

Monroe sets the parade in motion

Southern University Hosts USDA/1890 Task Force Meeting

The Southern University, Baton Rouge Campus hosted one of the series of the USDA/1890 Task Force Meetings on March 27, 2014. The role of the Task Force is to bring together USDA officials and 1890 land-grant university leaders to discuss and provide guidance about issues of mutual interest to USDA and 1890 Institutions. This joint effort aims to ensure that the partnership between the two entities is productive through the use of collaborative research, grant and employment opportunities for students, faculty, and research staff.

The group meets four times a year in diverse locations across the nation to work and initiate opportunities in research, extension, research, academics and capacity-building. Membership in the task force consists of 11 USDA officials, seven 1890 institution presidents and three ex-officio members, with the executive committee serving as the administrative arm of the task force.

Dr. Juliette Bell, Task Force Co-chair and President of University of Maryland, Eastern Shore, and Mr. Thomas Tidwell, Co-chair and Chief of US Forest Service presided over the meeting.

The welcome and orientation were brought by Dr. Joe Leonard, Assistant Secretary for Civil Rights, USDA and Dr. Ronald Mason, President of the Southern University System. Dr. Gregory Parham, Assistant Secretary for Administration, USDA addressed the team, followed by a report by the Executive Committee. The Executive Committee is co-chaired by Ms. Angela Coleman, Associate Deputy Chief, US Forest Service; and Dr. Moses Kairo, Dean, Agricultural and Natural Sciences, University of Maryland, Eastern Shore.

Also in attendance were Dr. Clarence W. Hawkins, Louisiana State Director, USDA Rural Development; Administrators, faculty and staff from the Southern University Ag Center and SU Baton Rouge Campus.

Dr. Juliette Bell reported that "the meeting was very engaging and provided opportunity for USDA and 1890 presidents to have an in-depth discussion about the future of both entities." And she was very pleased about the experience.

The afternoon agenda included an executive committee report and discussion focusing on new initiatives for the partnership; Summer Feeding Program presented by Ms. Audrey Rowe, Administrator, Food and Nutrition Service, USDA; Tree Campus USA Proposal, by Ms. Angela Coleman, Associate Deputy Chief, US Forest Service; and Mr. Dan Lambe, Vice President of Programs, Arbor Day Foundation. Dr. Bell and Mr. Tidwell gave closing remarks with an outline of next steps.

When asked what the goal of the meeting was, Mr. Tidwell responded "This meeting brings leaders together to strengthen leadership in agriculture and reach out to the potential leaders in order to remain the world leader in agricultural sustainability." We need to train, mentor, and prepare students to assume leadership positions.

USDA/1890 Program's mission is to attract students into careers in agriculture and related fields; share expertise and resources in areas such as agricultural research, extension and teaching programs, technology development, limited-resource farmers and minority farmer programs, and rural development programs; and to increase the involvement of the 1890 Land-Grant Institutions and Tuskegee University in the delivery of USDA programs.

In response to the question of the caliber of students that Southern University selects to participate in the 1890 National Scholar's Program, Ms. Phyllis Holmes says she is "very impressed with your scholars. They are well prepared academically and professionally, and they are very polite. I think it is the southern culture." Ms. Holmes serves as the Acting Director, 1890 National Scholar's Program, Office of Advocacy and Outreach, USDA.

The 2014 Farm Bill gave Central State University, Ohio the land-grant status as the 19th 1890 Institution. This year, for the first time, Central State University participated in the Task Force Meeting.

Small Farmer Leadership Institute Graduate Spreads Influence Nationwide

Jenga Mwendo enrolled in the Small Farmer Leadership Institute Class III at the SU Ag Center in 2009, graduating in 2011. The same year that she registered for the Leadership Institute, Mwendo founded Backyard Gardeners Network (BGN) in New Orleans, LA. The organization utilizes volunteers in the areas of Education, Music, Sociology and Marketing/ Communications to engage the community.

The 2014 Aetna's African American History Calendar spotlights the SU Ag Center Institute graduate Jenga Mwendo in the month of March. The calendar entitled "Community transformations: African Americans creating sustainable neighborhoods," encourages healthy living. Aetna is an American managed health care company which takes healthy living seriously. Aetna is a member of the Fortune 100. The calendar is available online at www.aetnaafricanamericanhistorycalendar.com

The Lower Ninth Ward native returned to New Orleans in 2007 to help rebuild the community after the 2005 Katrina disaster. Mwendo is director of BGN and community organizer who focuses on strengthening the community through urban agriculture. The non-profit organization's mission is community building, neighborhood revitalization and cultural preservation through urban gardening. They organize food demonstrations, educational workshops, potluck meals, and live musical entertainment.

"We get to share home-cooked foods with each other," she said, adding that her 9-year-old daughter has been a big part of her work. The kids in the neighborhood now appreciate what it takes to grow good food."

"If you have your own food source, you can bounce back a lot quicker after hurricanes," Mwendo said.

Jenga enjoys living in New Orleans "despite all the obstacles." To learn more about BGN, visit backyardgardenersnetwork.org at http://backyardgardenersnetwork.org/

Following her graduation from the Leadership Institute in 2011, Mwendo was among 14 fellows selected by the Institute for Agriculture and Trade Policy (IATP) Food and Community to receive an award.

The 2011-2013 class of Fellows was a mix of grassroots advocates, thought leaders, writers, and entrepreneurs. The award came with a two-year fellowship that provided an annual stipend of $35,000 in addition to communications support, trainings, and travel. The program supports leaders working to create a food system that strengthens the health of communities, particularly children. For this class of fellows, the selection committee focused on work that creates a just, equitable and healthy food system from its roots up. Over 560 individuals applied for fellowships that year.

Southern University Ag Center's Small Farmer Agricultural Leadership Institute, a two-year course of study specifically designed to guide small, socially disadvantaged, limited resource and minority farmers through the transformative process of becoming successful agricultural entrepreneurs, has produced outstanding community leaders across the nation since its inception.

Dr. Dawn Mellion-Patin directs the Institute which is supported by the USDA Outreach and Assistance for Socially Disadvantaged Farmers and Rancher Competitive Grants Program, National Institute of Food and Agriculture.

SU Ag Center Researcher Leads Students to Winning Performance at National Conference

Left-right: Adria Smith, Pickney Perez, Aramis Harris, Megan Thomas, Jeremy Thomas, Donzell Lee, Tewanda Pinson, Darius Knox, Patience Muse, and Robert Hobbs, Jr.

SU Ag Center researcher, Dr. Patricia E. McLean-Meyinsse, mentors college students, leading the S. U. Ag STARS to another successful performance in undergraduate research competitions at professional meeting.

Southern University students, dubbed the Ag STARS (Shaping Tomorrow's Agricultural Research Scientists), earned **second and third** place positions in the Undergraduate Oral Research and Poster Competitions at the 29th annual Minority in Agriculture, Natural Resources and Related Sciences (MANRRS) Conference held March 27-29, 2014 in Birmingham, Al. The second and third place oral papers were titled: "Examining University Students' Body Mass Indices and Frequency of Reading Nutrition Facts Labels" and "An Empirical Investigation of U.S. Demand for Beef," respectively. The second place poster was titled: "An Economic Analysis of Chicken Consumption in the United States from 1970-2012."

A non-competitive poster titled, "Assessing Financial Literacy Among A Selected Group of Undergraduate Students" was also presented at the MANRRS Conference.

The 2nd place recipient in the oral competition was Adria Smith, senior, agricultural economics, Salina, Kansas. The 3rd place recipients for the oral competition were Pickney Perez, junior, agricultural economics, Zachary, Louisiana, Robert Hobbs, Jr, senior, agricultural economics, Collinston, Louisiana, and Jeremy Thomas, junior, agricultural economics, Opelousas, Louisiana. Members of the 2nd place team for the poster presentation were Megan Thomas, sophomore, agricultural economics, Opelousas, Louisiana, Tewanda Pinson, junior, agricultural economics, Houston, Texas, and Donzell Lee, senior, animal science, Tallulah, Louisiana.

Authors of the non-competitive poster were Aramis Harris, junior, agricultural economics, Washington, Louisiana, Patience Muse, senior, agricultural economics, Greensburg, Louisiana, and Darius Knox, Junior, agricultural economics, Zachary, Louisiana.

Ag STARS members must maintain a cumulative grade point average of 2.50 and above and must be majoring in or intend to major in agricultural economics, animal sciences, or plant sciences.

Each participant is required to attend weekly mentoring sessions, and in turn, receive a $2,500 stipend per semester.

The program's primary goal is to use interdisciplinary research in the food and agricultural sciences to enhance participants' critical-thinking, analytical, writing, and oral communication skills. The Ag STARS Program is funded by a grant under the U.S. Department of Agriculture's Capacity Building Grant Program.

Patricia E. McLean-Meyinsse, professor, Agricultural Economics, is the principal investigator for the grant; she was also the faculty advisor for the students' papers and posters.

Wisteria Alliance Workshop Teaches Container and Herb Gardening Techniques

Invigorating old plants

More than 30 community members gathered at SU Ag Center on April 5, 2014 with indoor and outdoor plants in pots asking for restoration guidance at the Wisteria Alliance training. The workshop started in the morning with lectures and presentations on raised bed and container gardening. Stephanie Elwood, extension associate, presented on raised bed while Mila Berhane, senior research associate, presented on container and herb gardening. After lunch break, the classroom moved outdoors for hands-on demonstrations, where, the two experts engaged workshop participants in potting and re-potting plants.

The training series continues to teach gardening techniques to interested individuals in the community.

As always, workshop participants went home with free seedlings to grow their own food or ornamentals. Yardbird Farm owner from Zachary, Elaine Muhaimin, expressed her satisfaction with the workshop. After arranging her potted plants to take home, Yas-Sin said, "We are ready for spring planting!"

Some participants came from as far away as ColFax, Louisiana to take advantage of the training. Lunch consisted of some great tasting dishes prepared with several of the herbs discussed during the workshop.

This free workshop was organized by Zanetta Augustine, extension associate, and Dawn Mellion-Patin, extension specialist-agriculture, who can be reached at 225-771-2242.

SU Ag Center Partners with St. Landry School Board, Town of Washington

Working in Greenhouse

Southern University Agricultural Research and Extension Center has signed a Memorandum of Understanding with St. Landry School Board, and the Town of Washington to construct a greenhouse. A city beautification project is proposed for the Town of Washington where a greenhouse facility to grow ornamental plants will be located at the Washington Career and Technical Education Center on 605 Buhot, within the St. Landry Parish School District. Faculty, staff and students of the Washington Career and Technical Education Center will maintain the greenhouse and propagate plants. The beautification project maintenance will be administered by Washington City employees. Southern University Ag Center has begun, and will continue to provide technical assistance and on-site training in greenhouse and ornamental maintenance. SU Ag Center's Extension Associate, Stephanie Elwood and Senior Research Associate, Mila Berhane began assisting with the greenhouse rejuvenation, and implemented the initial workshop focusing on greenhouse sanitation, plant propagation, and watering. Additional trainings will include hands-on experience of the complete plant propagation operation, starting with greenhouse seedling preparation, planting and maintenance.

For further details, contact Stephanie Elwood at 225-771-2134.

SU Ag Center Project Exposes Students to National Conference

Students at McWayne Science Center

Birmingham Botanical Gardens

Set for Gala Awards Dinner

The Southern University Agricultural Research and Extension Center's *Academy for Academic Enhancement of High School Students in the Food and Agricultural Sciences (Ag Academy)* participated in the 29th Annual Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) Career Fair and Training Conference in Birmingham, AL, March 27-29.

As Junior MANRRS associates, students were exposed to vast developmental opportunities in the fields of Agriculture and Science. This year's theme, "Embracing Today's Challenges to Embark on Tomorrow's Opportunities", set the tone for a rewarding experience. During the High School Symposium, students joined in discussions about problem-solving and professional development, leadership and networking potentials, and the significance of ethical decision making.

The current-trend titled sessions such as "*Doing the NAE NAE:* A New Agricultural Experience, *Maintaining Your Swag, and Gateway to College",* kept students intrigued and interactive throughout each assembly.

Junior MANRRS participants also journeyed to two Science Centers for exciting innovative experiments. The McWayne Science Center provided interactive exhibits, inventive and environmental science demonstrations. The Birmingham Botanical Gardens combined Chemistry, Art and Botany to engage the students in discovery classes which allowed the utilization of scientific tools for chromatic and somatic observation, bird watching, the adaptation of trees and environmental data collection.

After three full days of meeting new people and realizing new possibilities, the culminating event was the Gala Awards Dinner. Dressed to impress, the students received additional inspiration through the sincerity of each Speaker as they shared stories of determination for success.

Our participants also got a chance to show off their table etiquette skills which were taught in previous summer training. When asked of their overall experience this weekend, the students expressed absolute gratitude for the opportunity to be a part of such a meaningful event. Seven of ten students made a verbal commitment to include Southern University in their college application process this month with the hope of becoming members of an auxiliary that will not only enhance their education process, but will augment their ethical philosophies to assist in becoming community leaders creating a better quality of life for others.

SU Ag Center mentors accompanying students to the conference included Zanetta Augustine, leader, assisted by Kim Butler, Tiffany Franklin and Janana Snowden.

SU Ag Center Researchers Mentor College, High School Students

Shania Graig, SU student works on project in SUAREC enter lab.

Caroline Babin, St. Joseph's Academy junior presents at state science fair.

SU Ag Center researchers mentor college students through the USDA (Evans Allen) funded project entitled *Nutritional Content, Antioxidant Activity and Microbiological Safety of Goat Meat and Value-Added Goat Meat Products.* Fatemeh Malekian, professor, nutrition, and Margarita Khachaturyan, research associate, mentored Shaina Graig, and Caroline Babin.

Dietary habits are major factors in development of obesity and cardiovascular diseases. Red meats such as beef and pork are associated with an increased risk of heart disease. Although it has not been researched as extensively as beef or pork, data show that goat meat has high nutritional value and greater unsaturated to saturated fatty acid ratio as opposed to traditional red meats. However, goat meat is generally unavailable in retail markets and annual consumption of the meat is low in the USA (USDA, 1998).

The unavailability and low consumption may be due to factors such as consumers' unfamiliarity or dislike of goat meat. Goat meat has the potential to improve health of susceptible population without taking meat products out of their daily diet by replacing traditionally consumed meats. The objective of this study was to compare the nutritional composition of a goat meat product, to similar pork product, and to evaluate consumer acceptability of the prepared goat meat product.

Shaina Graig, an undergraduate student majoring in Animal Science in the College of Sciences and Agriculture, accepted the challenge to conduct a study as her Honors College project. The title of her research project was, *Nutritional Analysis and Consumer Acceptability of Goat Meat Patties Compared to Pork Patties.*

Shaina, who graduated in May, 2014 worked in the Food Composition Laboratory at Southern University Agricultural Research and Extension Center for the past three years under the supervision of Khachaturyan and Malekian.

Craig has gained experience on the goat meat project, learned to operate all the instruments, and co-authored a poster titled "Antioxidant Activity and Simultaneous Determination of Vitamin E and Cholesterol in Rice Bran Added Goat Meat Products."

Shaina prepared goat and pork patties in the Southern University meat laboratory under supervision of Albert Howard, she then cooked the patties and conducted consumer acceptability test in the metabolic kitchen. She also analyzed the patties protein, fat, moisture, ash, Carbohydrate.

The result of her consumer acceptability showed that there was no significant difference in the aroma, taste, juiciness and overall acceptability between goat and pork patties. There was a significant difference in tenderness between goat and pork patties. The goat patties were less tender. Also there was a significant difference in fat and moisture content. Goat has less fat and more moisture. The results are promising. Even though goat meat patties are a little tougher but everything else was equal or better than pork patties (especially with fat content).

The researchers also mentored Caroline Babin, a junior student at St. Joseph's Academy by guiding her to conduct a science project titled *The Effect of the Housing of the Chicken on its Egg's Nutritional Composition.* The project won Babin 1st place in Biochemistry at the 2014 Louisiana State Science and Engineering Fair, held March 24-26 at the LSU Union.

CoC Network Holds Kick Butts Day Activities in Baton Rouge

Poland addresses audience on Kick Butts Day

"Kick Butts Day" is a national initiative to prevent young people from ever picking up a cigarette. In Louisiana, many organized activities marked the event. The SU Ag Center celebrated national Kick Butts Day 2014 with the Communities of Color Network in Baton Rouge with two activities conducted by regional coordinator, Frankie Poland.

Poland conducted a workshop with the youth of Oasis Christian Church in Baton Rouge. The workshop centered on the dangers of tobacco use. The workshop included group discussions regarding the dangers of secondhand smoke exposure and about new tobacco products on the market. The group played tobacco related games that dealt with the diseases caused by tobacco use and games identifying the more than 4000 poisons in cigarette smoke. Winners and participants received prizes for playing. Brochures were made available to participants regarding ways to avoid tobacco use.

In addition, Poland participated in the Kick Butts Day at the Louisiana Capitol, which was sponsored by the Louisiana Campaign for Tobacco-Free Living. Kick Butts Day is a national day of activism that empowers youth and young adults to stand out, speak up and seize control against "Big Tobacco." She served at the information desk where staff engaged the youth in conversations, and answered their questions on tobacco related issues. Poland distributed wristbands, pencils with a quit smoking message along with "no smoking signs" to participants.

SU Ag Center Establishes Community Garden at Westside Homeschool

The official Westside Homeschool Community Garden is now established. The group has eight families with 17 children homeschoolers helping out with the garden. The garden was started on Monday April 21, 2014 on the west side of the river under the direction on Mrs. Christie Monroe, Livestock Program Manager at SU Ag Center. The Westside Homeschool group was started in 2012 by a couple of moms on the west side of the Mississippi River who are home-schooling their children. Its mission is to bring homeschooling families in the area together for fun and fellowship while playing hard and having fun learning. The home schoolers are from East Baton Rouge, West Baton Rouge and Pointe Coupee Parishes. The group consists of children ranging from Kindergarten to High School age.

One of the parents contacted Mrs. Monroe following the group's previous participation in the Louisiana Hall of Ag at the Annual Livestock Show. The students decided they would like to plant a garden. Mr. Kevin Belizard from the SU Ag Center Research unit assisted with the preparation of the soil, and as they say, the rest is history. The group planted squash, banana peppers, bell peppers of all colors. The group also has cantaloupes and watermelons. It has plans for okra, eggplants and sweet corn. The goal of the group is to provide their families with enough produce and eliminate purchase of produce at the stores.

SU Ag Center Research Creates Impact, Opportunities

Dr. Chin with calyx harvest

Tour group in hibiscus plot on SU campus

The impact of Dr. Chin's research at the SU Ag Center was mentioned in the May 1, 2014, Volume 1, Issue 2 of the NIFA Ed-Facts, p.4. Kit Chin at Southern University Research and Extension Center, an 1890 land-grant university in Baton Rouge, Louisiana, used funding from NIFA's 1890 Research Capacity grant to study the roselle hibiscus. This plant, with its striking red calyx-enclosed fruits, could give Louisiana farmers a new niche crop that **supports trade, local agriculture, and economic development.** His research found roselle hibiscus accessions from Nigeria, Jamaica, and Senegal thrive in Louisiana's climate. More than 65 farmers, homemakers, and retired church volunteers from various parishes attended the project director's workshop and grew hibiscus in their home gardens. A 12-member roselle hibiscus grower's cooperative also visited the lab.

One Ph.D. student, Ryan Nicolas, joined four Southern University business majors to develop a hibiscus business plan for Louisiana.

The team placed third among 13 student groups presenting at the 2013 Opportunity Funding Corporation's Venture Challenge. "This NIFA-funded project has given me the focus of my doctorate work," Nicolas said. "Because Dr. Chin's hibiscus research project received a NIFA grant, many doors of opportunity opened for me. I never thought I would be doing so many interesting things in science and entrepreneurship. It would not have happened if Dr. Chin had not been able to pursue his research goals." The full publication is available online for download at: https://dl.dropboxusercontent.com/u/75269546/2014/NIFA-EdFacts.pdf

The research project was funded by USDA/**National Institute of Food and Agriculture (NIFA).** Ryan Nicolas is currently a Ph.D. candidate at Southern University focusing his dissertation research on roselle hibiscus under the supervision of Drs. Yadong Qi and Kit Chin.

SU Ag Center Revitalizes Community Garden to Teach Youth How to Grow Produce

The SU Ag Center has established a community garden in Opelousas to teach young people how to grow their own produce. The First Harvest Community Garden is planting and welcomes anyone who wants to grow their own food. The Opelousas *Daily World* featured this effort on May 8, 2014 in an article entitled Community Garden Seeks Helping Hands. The full article is available at dailyworld.com

The SU Ag Center provided a tractor, driven by Kevin Belizeard, to turn the soil in the garden. Its agricultural extension has taken the community garden under its wing.

"This is very good soil," said C. Rubin Walker, an organic farming expert with the university, as he dropped off four large sacks of his special fertilizer made from crawfish waste.

All the garden needs now is more people hungry for the experience of growing their own food.

The garden has existed since 1991, but most of the young people who used to work the land have graduated and moved on to careers elsewhere.

Organizer Eva Iford is eager to introduce the joys of farming to another generation. crop.

Communities of Color Statewide Initiative: "Putting Your Heart into Your Health"

In April, under the direction of Linda Early Brown, Communities of Color Network (CoC) regional coordinators held a variety of events in recognition of the statewide initiative," Putting Your Heart Into Your Health." The purpose of the program was to educate Louisiana residents about the health benefits of smoking cessation, not only to smokers, but to their families as well.

Dr. Fatemeh Malekian, Professor of Food Science & Nutrition, collaborated with CoC in this endeavor. During her presentations, Dr. Malekian addressed the significant roles that proper nutrition, healthy eating and physical activity play during the quit smoking process.

Owens

Monroe: on April 5, LaTonya Owens conducted a workshop. She partnered with a variety of health professionals including Rodney Anthony, a fitness trainer who demonstrated easy-to-do exercises where each participant received a cardio workout plan. LSU Nutrition Agent, Brittney Seay presented information on healthy eating. Dentist, Dr. Monica Davenport-Wesley spoke about the effects of tobacco use on the mouth. Blood pressure readings were made available by the Morehouse Community Center.

Harrell

Alexandria: on April 8, Shawntell Harrell hosted a Dinner at New Bethel Community Missionary Baptist Church. Among the participants were her special quests with whom she collaborated. It is a group of health conscious church members who are using the Dietary Approaches to Stop Hypertension (DASH) program to maintain a healthy lifestyle. The lessons learned through the power point presentations given by Harrell and Dr. Malekian served to further assist in that healthy living goal. Members were served a delicious healthy meal amid a lively question and answer session. They received tips on physical activity to maintain healthy weight.

Poland

Baton Rouge: on April 12, Frankie Poland held a Luncheon for area residents. During the presentation on tobacco cessation, Poland addressed concerns raised by the guests regarding the challenges of quitting and provided them with helpful tips to deal with quitting. To emphasize the importance of physical activity, quests were asked to participate in simple exercises led by members of the Nu Gamma Omega Chapter of Alpha Kappa Alpha Sorority, Inc. Using the guidelines given by Dr. Malekian, in her presentation, guests were served a delicious meal illustrating how appealing and appetizing a nutritious meal can be. T-Shirts were given as door prizes and fresh fruit was distributed to guests upon leaving.

Holt

Shreveport: on April 16, Urina Holt invited the community to attend a Dinner. The presentations began with a Pre-test of the audience to measure their knowledge regarding tobacco cessation and healthy nutrition. Following the engaging presentations, the listeners' knowledge of lessons learned was challenged again with a Post-test and with favorable results. Holt asked the audience to make a commitment to do their part to help create a tobacco-free environment. A nutritious meal was served. A physical trainer demonstrated exercise tips that everyone could perform at home. Door prizes included T-shirts and water bottles.

At each event, a "Putting Your Heart Into Your Health" gift bag was presented to participants which included a "Good Nutrition Starts with MyPlate" paper plate, a MyPlate magnet, a stress box of cigarettes, tips on quitting smoking and cessation resource information.

CRSBD Holds Small Business and Non-Profit Start-up Workshop in Concordia Parish

The Center for Rural and Small Business Development held a Small Business & Non-Profit Start-Up Workshop on March 8 inside the E-Learning Center Mobile Unit in the parking lot of the Concordia Bank & Trust in Ferriday, La.

Participants received technical assistance in the form of the applications and forms needed to legally register a business and non-profit organization. Additionally, they received information on application for the 501(c)3 tax exempt status with the federal government, marketing information, business plan development information, one-on-one counseling, copies of the Small Business Administration's Business Resource Magazine, information on how to create and read a cash flow and profit and loss statements, CRSBD staff business cards and brochure.

Additionally, the E-Learning Center participated in the 2014 Health Crusaders Tour on March 19. The tour was held at the Smith-Brown Memorial Student Union on the Southern University Baton Rouge campus.
Participants received technical assistance in the form of one-on-one counseling from the Center's staff, CRSBD and E-Learning Center brochures, the forms and applications needed to legally register a business, marketing information and business cards for the CRSBD staff.

Also, CRSBD staff members LaKeeshia Giddens and Sonja Butler participated in the 1st Job/ Resource Fair at the East Baton Rouge Parish Prison on March 18.

The purpose of this event was to assist about 60 men and women, who will be released from prison within six months, with finding their first post-prison job.

Giddens and Butler were available to talk with individuals who were interested in starting a business. Individuals who visited their table were provided with limited one-on -one counseling, the forms and applications needed to legally register a business in the state of Louisiana, and brochures from the CRSBD and its' E-Learning Center.

EBR Event

Ferriday Workshop

SU Ag Center Plants Seeds for the Future in Opelousas

An article featuring the efforts of the SU Ag Center to enhance the quality of life for residents at the Opelousas Lighthouse Mission was published in the April 23 issue of the *Daily World* newspaper.

The workshop assembled more than 40 participants, and the presenters were Chris Robichaux, Stephanie Elwood, and Mila Berhane from the SU Ag Center and Bryan Mims from LA Department of Agriculture. Mims shared information on availability of opportunities for communities to apply for green cities program grants.

The workshop was sponsored by SU Ag Center and Sustainable Agriculture Research & Education.

SU Ag Center Teams up with St. Helena Central High Woodworking Academy

Students in woodworking class

Art comes in many forms and, St. Helena Central High Woodworking Academy has spotlighted exceptional work in many of those forms. The woodshop at the S.H.C.H. always seems to be buzzing with the sound of power tools every time Ahmad R. Robertson visits Terry Guy's class.

Robertson provides hands-on-training to youth by teaching them once a week and offering advice and leadership on marketing their artwork at St. Helena Central High.

Robertson has acquired valuable skills from Building Opportunities Through Leadership and Development classes and is utilizing the skills to enhance the learning outcomes among this group of students. His goal is to motivate and empower the youth and provide them with basic agricultural skills and knowledge.

The High School's woodshop projects are a rite of passage for many young men and women. There is not much that's more therapeutic than the scent of piles of sawdust, and splinters in your fingers. Something about a handcrafted woodshop project makes students keep them around for years. The students are currently working on architecting Shaker Plant Stands.

"I gave them a successful blueprint to complete the project this semester. Also we showed them how to market their projects and become effective future Agriculture leaders," Mr. Guy said.

Ahmad R. Robertson serves as Assistant Area Agent, Agriculture & Natural Resources, in Tangipahoa and St. Helena Parishes, and can be reached at (985)748-5462; or (225) 222- 4136 or Ah mad_robertson@suagcenter.com

Successful Grandparent Training Held in Desoto Parish

Patricia Lee, Assistant Area Agent, DeSoto and Caddo Parishes held a Foster grandparent training in DeSoto Parish for 46 Foster grandparents for their monthly training where they were provided information on How to Live Healthy with Diabetes. Seniors were taught about carb counting, how the A1C Test Helps, Grains that are starches, starchy vegetables and beans. Seniors also gained knowledge on how to use their hands to measure meal sizes. Finally, seniors were provided some low carb recipes to try out at home.

Advisory board meeting

Grandparent training

Lee also conducted an advisory board meeting with 14 board members in attendance to set strategic goals for the next year that will meet the needs of the residents of Caddo and DeSoto Parishes. The meeting was held on April 4, 2014 in Caddo Parish Extension Office.

Faculty and staff activities and accomplishments

Publications

Fatemeh Malekian, Professor, Food Science and Nutrition, published an article entitled "Composition and Fatty Acid Profile of Goat Meat Sausages with Added Rice Bran," in the *International Journal of Food Science*, vol. 2014, Article ID 686298, 8 pages, 2014. doi:10.1155/2014/686298. The article can be accessed directly at: http://www.hindawi.com/journals/ijfs/2014/686298/

The article supports the body of knowledge that claims a relationship between obesity, obesity related diseases, and diet. Goat meat has the potential to replace the traditionally consumed red meats such as pork and beef. In this study, goat meat sausages were formulated to contain 0, 1.5 or 3 percent stabilized rice bran. Proximate and fatty acid composition, α-tocopherol, cholesterol concentration, and antioxidant activities of cooked goat meat sausages containing varying percentages of rice bran were measured. It was observed that fat percentage in the goat meat sausages increased in response to increasing rice bran percentages. Saturated fatty acids concentration decreased linearly, while unsaturated fatty acids and omega-3 and omega-6 fatty acids increased linearly in response to increasing rice bran percentages. The study found that goat meat sausages with added rice bran have a more beneficial fatty acid composition in regard to more mono- and polyunsaturated fatty acids. Based on the results from this study and because of these factors, adding 3% stabilized rice bran to goat meat sausage is recommended to provide more health benefits.

The article was co-authored by Margarita Khachaturyan, Sebhatu Gebrelul, and James F. Henson, SU Ag Center.

Malekian also co-authored an article entitled "Proximate and Fatty Acid Compositions and Sensory Acceptability of Hispanic Consumers towards Rib-eye Steaks from Forage-finished Steers," in the *International Journal of Food Science and Technology*. The abstract is available on line at: http://onlinelibrary.wiley.com/doi/10.1111/ijfs.12552/abstract.

Proximate and fatty acid compositions and sensory acceptability of rib-eye steaks (fresh and 6 months frozen-stored) from three forage-finished steers were evaluated. The study found that all forage-finished steaks had significantly higher n-3 fatty acids, lower n-6/n-3 ratios, but similar PUFA compared to commercial steaks. Purchase intent was positively affected when consumers were informed of the health benefits of forage-finished steaks but negatively affected by the fact that steaks were previously frozen -stored before cooking. The acceptability of forage-finished beef was not affected by 6 months frozen storage at _20 °C. This study demonstrated that forage-finished steaks are potentially healthier than grain-finished commercial steaks. Besides, forage-finished steaks, especially those obtained from the S3 production system, have a market potential towards Hispanic population residing in the USA.

Other co-authors are: Damir D. Torrico, Wannita Jirangrat, Marlene E. Janes, Witoon Prinyawiwatkul, School of Nutrition and Food Sciences, Louisiana State University Agricultural Center, Baton Rouge; Guillermo Scaglia, Iberia Research Station, Louisiana State University Agricultural Center, Jeanerette; Kenneth W. McMillin, School of Animal Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA.

The publications are enclosed in PDF format for easy access.

Faculty and staff activities and accomplishments contd.

Publications contd.

Renita Marshall, DVM, has co-authored an article entitled "Effect of Replacing Corn and Soybean Meal with Brewers Rice and Dried Distillers Brewer's Yeast on Performance of Growing-finishing Pigs," in the *American Journal of Animal and Veterinary Sciences*, Volume 9, Issue 2, Pages 110-115. Other co-authors are Ondieki Gekara, and Talesha Dokes, Department of Agriculture, University of Arkansas, Pine Bluff.

The objective of this study was to determine the effect of replacing corn and Soybean Meal (SBM) with Brewers Rice (BR) and Dried Distillers Brewer's Yeast (DDBY). Sixty-four Yorkshire x Duroc x Hampshire crosses were randomly assigned to corn/SBM (CSM), BR/SBM (RSM), corn/DDBY (CBY) or BR/DDBY (RBY) diets. Compared with pigs finished on corn based diets, pigs fed BR based diets gained faster and had better gain to feed ratio. Pigs finished on RBY diet had the least fecal DM output and greatest ATTD, followed by RSM, CBY and CSM pigs, respectively. Pigs finished on RBY diet lost the least amount of N and P in the feces, followed by pigs finished on RSM, CBY and CSM, respectively.

In conclusion, brewers rice and dried distillers brewers yeast can replace all corn and soybean meal, respectively, in diets for growing-finishing pigs and reduce fecal DM output and fecal loss of N and P with no negative effects on animal growth and productivity. In this study, brewers rice/dried distillers brewers yeast based diets may have provided animals with highly digestible nutrients and less manure, contributing to reduced environmental pollution. However, the superior performance of brewers rice and dried distillers brewers yeast over corn and soybean meal, respectively, may need further investigation to determine the effect of diet on carcass quality and other characteristics including eating attributes.

Follow the link below to access the article appearing in the latest edition of AJAVS:
Follow the link below to access the full article online:
http://thescipub.com/abstract/10.3844/ajavsp.2014.110.115.

De'Shoin York Friendship, Associate Specialist, Nutrition has been selected to serve on the Land Grant SNAP-Ed Program Development Team as the 1890 Representative. The purpose of the team is to: Serve as sounding board for national leadership; Establish a communication conduit to effectively and appropriately share accurate information; Grow leadership and systems capacity - Land-Grant Universities; with NIFA, with FNS and other potential partners; Strengthen administrative/coordinator integration; Support use of developed resources/actions (multi-state, state/national efforts); Contribute to the development of resources/completion of projects for SNAP-Ed; Help position universities/NIFA for other nutrition education opportunities and resources

Friendship has also been selected to serve on the National USDA-NIFA Nutrition and Physical Activity Policies and Programs Sub-Committee. The committee guides program leaders concerning policy and programmatic issues relative to nutrition and physical activity from a scientific and practice-based perspective.

She also presented a session entitled "Cooking Camps" at the National Expanded Food and Nutrition Education Program (EFNEP) Conference in Arlington, VA, Feb. 23 - 27. The session focused on the successes and best approaches used while conducting summer youth cooking camps. De'Shoin presented the session with Sharman Charles, Karen Stevens and Heli Roy, LSU Ag Center.

Faculty and staff activities and accomplishments contd.

SU Ag Center Chancellor, Staff Participate in 2014 NERAOC

The SU Ag Center Chancellor and staff from research and extension represented the Center at the conference the 2014 National Extension and Research Administrative Officers Conference held April 27-May 1 in Indianapolis, Indiana. The conference was attended by about 500 participants targeted administrative staff all over the United States, its territories and the Islands who work in areas such as evaluation, finance, grants, human resources, etc. The conference is held annually to bring the officers of the United States Department of Agriculture/ National Institute of Agriculture (USDA/NIFA) to the same table with Land-Grant institutions (1862, 1890, 1994, HIS, 2008), experiment stations, territories to discuss important issues affecting agricultural research and extension. The theme of the 2014 conference was "Driven to Success."

This year's conference was really critical given the fact that the United States Congress, after debating for about two years, finally passed the *Farm Bill* dubbed ***The Agriculture Act of 2014***.

The Farm Bill is the primary agricultural and food policy tool of the federal government, and is an omnibus, multi-year piece of authorizing legislation that governs an array of agricultural and food programs. NERAOC provides an avenue for the USDA/NIFA experts to inform partners about new policies and procedures and how they may impact funding of several programs. USDA/NIFA is stepping up its mandate for actual evaluation to show outcomes and impacts on funded projects/ activities. Information obtained is usually used to defend USDA/ NIFA budget before Congress and the Office of Management and Budget.

SU Ag Center was well represented for the planning and conducting of the conference, Linda Batiste served in the planning committee. Our staff made presentations at the conference including, Gina E. Eubanks and Linda Batiste, "Ethics: Don't Come to the Job Without It"; Linda Batiste in collaboration with LSU Ag Center staff presented on Wellness, and also Leading from any chair.

Oscar Udoh presented on USDA Success in Communities; and Adell Brown's presentation, Organization and Transition Changes was delivered by Linda Batiste. Other presenters shared their knowledge of best practices on subjects relating to international programs, impact reporting, networking for effective performance measurement, management in the midst of dwindling resources, diversity, information technology, etc.

The case of program fund misuse by one 1890 Institution South Carolina State University received serious attention from all in attendance. South Carolina State University had to refund $6.5 million of agricultural research and extension funds that was spent on non-agricultural related purposes. The administration had used the money to plug budget deficits for several years. This action was deemed illegal by both the Federal Auditors and the State Attorney General.

Bridget Udoh, Communications Specialist attended and participated in the Association of International Agricultural, Extension Education (AIAEE) 30th Annual Conference in Miami, FL, April 27 -May1, 2014.

This year's conference was themed "Integrated Agricultural Systems for Environmental Sustainability and Production." Activities included numerous posters, concurrent, professional development sessions and a cultural tour. The 160 attendees came from 13 countries, diverse institutions and agencies.

The Association for International Agricultural and Extension Education, established in 1984, is a professional organization for agricultural and extension educators who share a common goal of strengthening agricultural and extension education programs and institutions worldwide.

Faculty and staff activities and accomplishments contd.

SU Ag Center Faculty Recognized at System Awards Program

L-r: Renita Marshall, Sung No, Yadong Qi

The Southern University System held its 2014 Awards Program to honor the 2013-2014 outstanding faculty and staff in Research and Academic Achievement on April 24.

The SU System and campuses held a recognition banquet in the gymnasium at Southern University New Orleans. Albert Sam II, M.D., a member of the Louisiana Board of Regents was the guest speaker.

For the second year, the SU System presented $1,500 achievement awards in outstanding research, outstanding teaching, and outstanding service.

Dr. Yadong Qi earned the SUS Award for Research. Qi has worked with the SU Ag Center since 2004 where she serves as a professor and post-doctoral advisor in urban forestry. Within the past five years, Dr. Qi has served as PD and Co-PD for nine projects totaling $2.93 million. She has published 21 papers including 10 in refereed journals, two book chapters, and nine technical proceedings papers. She is one of the key founders of the USA's first urban forestry Bachelor of Science degree programs where she played a key role in the development of the undergraduate curriculum during the program's establishment in 1992.

Renita Marshal, DVM, associate professor, SU Ag Center, earned special recognition for excellence in research.

Most Outstanding Researchers in the Southern University Agricultural Research and Extension Center, were Kit Chin, professor, plant and soil sciences and Yadong Qi, professor and post-doctoral advisor in urban forestry.

Outstanding Extension Specialist was Kasundra Cyrus, extension specialist/family and human development.

SCHEDULE OF EVENTS

May 17: Wisteria Alliance training series. Contact Dawn Mellion-Patin at 225-771-2242

June 12-14: Family and Youth Exposition. Contact Wanda Burke at 225-771-2242.

June 28: Wisteria Alliance training series. Contact Dawn Mellion-Patin at 225-771-2242

Attachments

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Research Article

Composition and Fatty Acid Profile of Goat Meat Sausages with Added Rice Bran

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A scientific consensus on the relationship between obesity, obesity related diseases, and diet has emerged. One of the factors is overconsumption of the red meats such as pork and beef. Goat meat has the potential to replace these traditionally consumed meats. Rice bran is a rich source of antioxidants such as vitamin E. In this study, goat meat sausages were formulated to contain 0, 1.5 or 3 percent stabilized rice bran. Proximate and fatty acid composition, α-tocopherol, cholesterol concentration, and antioxidant activities of cooked goat meat sausages containing varying percentages of rice bran were measured. Data were analyzed using a fixed effects model. The fat percentage in the goat meat sausages increased in response to increasing rice bran percentages ($P < 0.001$). Saturated fatty acids concentration decreased linearly ($P < 0.01$), while unsaturated fatty acids and omega-3 and omega-6 fatty acids increased linearly in response to increasing rice bran percentages ($P < 0.05$). The concentration of α-tocopherol in sausages increased linearly in response to increasing rice bran percentages ($P < 0.01$). Also, antioxidant activity increased linearly in sausages in response to added rice bran ($P < 0.01$). The cholesterol concentration of sausages did not vary significantly in response to added rice bran.

1. Introduction

A scientific consensus on the relationship between diet and obesity related diseases such as diabetes, heart disease, stroke, and some forms of cancer has been documented [1]. The obesity rate in Louisiana is 28.9%, which is the eighth highest in the USA. Furthermore, Louisiana is in the top seven states in obesity-related medical expenditure [2]. Foods from animal sources have been a part of human diets for years. Even though the percentage of fat in meat has decreased in recent years, the polyunsaturated to saturated fatty acid ratio in meat is usually less than 0.2 when the fat content is above 2% [3]. Blood cholesterol level depends less on the intake of cholesterol from foods and more on the amount of saturated fats consumed, especially the ratio of polyunsaturated to saturated fats [4]. A study has shown that with proper dietary intervention, the mean blood cholesterol level of 90% of a test population was reduced by 3% to 23% [5]. Dietary habits are major factor in the development of obesity and cardiovascular heart diseases.

During the past few decades, epidemiological studies have suggested that a healthy diet and lifestyle are critical for the prevention of many diseases such as breast cancer. Breast cancer is one of the most common cancers and is the second leading cause of death in women. Dietary fat is one of the most studied factors. The most promising dietary fatty acids to reduce the risk of breast cancer are omega-3 polyunsaturated fatty acids [1].

Lean goat meat is low in fat and saturated fatty acids, but high in unsaturated fatty acids such as linoleic and oleic that have been shown to possess hypocholesteremic properties [6, 7]. The chemical composition of goat meat is as follows: moisture 74.2–76.0%; protein 20.6–22.3%; fat 0.6–2.6%; ash 1.1% [8]. Goat meat cuts have protein levels comparable to similarly prepared beef, lamb, and veal but have lower fat content [9]. In addition, the percentage of saturated fat in goat meat is lower than in chicken, beef, pork, or lamb [10, 11].

Considering its high nutritional value and its greater unsaturated to saturated fatty acid ratio, goat meat has the potential to improve the health of susceptible populations

without taking meat products out of their daily diet. Consumption of goat meat is becoming popular and is often available at the fine dining level [12].

Currently, there is an increased interest in the use of dietary antioxidants, including vitamins C and E, to prevent cardiovascular diseases [13]. There are many natural antioxidants which can be added to the meat products to increase their health benefits. Some examples are rosemary oil [14], rice bran oil [15], rice bran oil plus rice bran fiber [16], oat bran [6], and oat flour [17]. A number of studies have shown that vitamin E, as a chain-breaking antioxidant, prevents the propagation of free radical reactions [18–20]. Vitamin E inhibits lipid peroxidation *in vitro* and *in vivo* because of its radical scavenging and antioxidant properties [21].

As a major isoform of Vitamin E, α-tocopherol is effective *in vivo* only against free radical-mediated oxidation. It inhibits LDL oxidation *in vitro* and has therapeutic effects against atherosclerosis [22]. The rice bran oil antioxidants are very efficient in reducing low density lipoprotein (LDL) and total serum cholesterol [23]. Rice bran oil contains about 0.1–0.14% vitamin E components and 0.9–2.9% oryzanol. The concentrations can vary substantially according to the origin of the rice bran [24, 25]. Vitamin E is a generic term for a group of four tocopherols (α-, β-, γ- and Δ-) and four tocotrienols (α-, β-, γ- and Δ-), of which α-tocopherol has the highest biological activity [26].

Rice bran, a byproduct of the rice milling process, is a naturally rich source of antioxidants along with vitamins and minerals. Additionally, it contains 14–16% protein without gluten, 12–23% fat, and 8–10% crude fiber [27]. Nutritional studies in animals and humans have demonstrated the cholesterol lowering potential of rice bran and rice bran fractions [28, 29]. Rice bran fractions such as rice bran oil and soluble fiber are crucial factors in the regulation of plasma cholesterol levels, and the insoluble fiber plays an important role in intestinal regulation [23, 30]. Rice bran also has some beneficial dietary components. These components lowered blood pressure and improved the lipid profile by decreasing the low density lipoprotein (LDL) level in hypertensive rats [31]. Substituting saturated fatty acids in the diet with unsaturated fatty acids such as oleic, linoleic, and linolenic acid lowered low-density lipoprotein-cholesterol in human subjects [32]. The protein in rice bran does not contain gluten, therefore, it is a healthy food choice for people with celiac disease. Approximately, 1 in 133 people in the United States has celiac disease, an immune-mediated disorder associated with gluten, a protein present in wheat, barley, and rye. Most affected individuals experience a remission of the disease after excluding gluten from their diets [33]. In June 2008, the United States Department of Agriculture Food Safety and Inspection Service (USDA FSIS) approved the use of stabilized rice bran as a binder to a maximum of 3.5% in various meat products such as sausage, meatballs, meat loaf, and meat patties [34]. Stabilized rice bran can hold moisture up to three times its weight which can contribute to the juiciness of the goat meat products. Rice bran also has a meat-like texture when it is cooked [35].

The goal of this study was to formulate a healthy goat meat sausage with a higher level of antioxidant activity, a higher level of unsaturated fatty acids, and a lower fat content compared to beef sausages as well as a gluten free product by incorporating varying amounts of stabilized rice bran to the formulation. Nutritional characteristics of raw and cooked goat meat sausages with added rice bran were determined by analyzing the samples for proximate composition and cooked goat meat sausage for fatty acid composition, α-tocopherol and cholesterol concentration, and antioxidant activity.

2. Materials and Methods

2.1. Preparation of Sausages. Goats were reared at the Southern University Agricultural Research and Extension Center (SUAREC) goat farm until slaughter and preparation of products. All meat was prepared in the state inspected Southern University Meat Processing Laboratory. Shoulder, leg, and other parts of one-to-three-year-old goats were deboned and ground.

Rice bran was obtained from Planters Rice Mill in Abbeville, LA and stabilized using microwave heat [36]. The stabilized rice bran was sieved with a 20 mesh screen in order to remove broken rice and husks and to obtain a uniform particle size.

Chili seasoning was obtained from Symrise Inc., Teterboro, NJ. Chili seasoning (3% by weight), salt (1.6% by weight), and water (3.3% by weight) were incorporated into the ground goat meat. Chili seasoning and salt were added for taste, rice bran was added as a binder, and water was added to provide moisture in the mix. The meat samples were divided into three groups. Group 1 was the control with 0%, group 2 with 1.5%, and group 3 with 3% (by weight) stabilized rice bran. The meat/rice bran mixtures were packed into collagen casing. Raw sausages were cooked in a preheated (53.3°C) "Koch" stainless steel cooker/smoker (Koch Supply, North Kansas city, MO). The temperature was increased manually at 2.7°C per hour until the temperature of the cooker reached 65.5°C. The smoker was then turned on and the temperature increased until the internal temperature of the sausages reached 70°C for at least 15 seconds. The cooking and smoking time was 6 to 7 hours. Approximately, 500 g of each raw and cooked sausage were homogenized in a Robot Coup R2 food processor (Robot Coup USA Inc., Ridgeland, MS) for two minutes to obtain a homogeneous sample. Three aliquots were prepared for the raw and cooked sausages and were frozen at −20°C until further analysis.

2.2. Proximate Analysis. On the day of analysis, samples were taken out of the freezer early in the morning and were thawed at room temperature. Samples were analyzed using standard American Official of Analytical Chemists (AOAC) approved methods (983.23, 992.15, 920.15, and 985.14) with modifications [37]. Lipids were extracted using a chloroform/methanol solution with butylated hydroxytoluene (BHT), as an antioxidant, and determined gravimetrically. Aliquots were taken from lipid extracts for determination of fatty acids. Protein content was determined using thermal conductivity on a Series II Nitrogen Analyzer 2410 (PerkinElmer Instruments, Norwalk, CT). Ash content was

determined with using a Phoenix microwave furnace (CEM corp., Matthews, NC). Moisture content was determined using a Smart system 5 (CEM corp., Matthews, CT). Percentage of carbohydrate was determined by difference using formula: %Carbohydrate = 100 − (%Moisture + %Fat + %Ash + %Proteins). Each sample was run in triplicate.

2.3. Fatty Acid Determination. Lipid extracts aliquots (prepared during total lipid extraction according to Section 2.2) were used for the determination of fatty acid composition using a Varian Saturn 2100 (Agilent Technologies Inc. Wilmington DE) Gas Chromatography/Mass Spectrophotometer (GC/MS) with a fused silica column (30 × 0.25 mm) [38]. GLC-490 Reference Standard and C23:0 methyl esters (Internal Standard) were purchased from Nu-Check Prep. Inc. (Elysian, Minnesota, USA) and used for determination of fatty acids. Each sample was run in triplicate.

2.4. Simultaneous Determination of α-Tocopherol and Cholesterol. Cholesterol and α-tocopherol were measured simultaneously on an 1100 Agilent High Performance Liquid Chromatography (HPLC) system (Agilent Technologies Inc. Wilmington DE). Homogenized sausage samples were prepared, extracted and quantified [39]. A ZORBAX RX–SIL 5 μm, 4.8 × 250 mm column was used. The mobile phase was composed of 99% hexane and 1% isopropyl alcohol (HPLC grade) at a flow rate of 0.5 mL/min. The total running time was 12 minutes. The detector was a diode array detector (DAD) operating at $\lambda = 202$ nm. The injection volume was 5 μL with a needle cleansing system and thermostat temperature of 20°C. The α-tocopherol and cholesterol standards and other chemicals were purchased from Sigma Aldrich Co. (St. Louis, MO). Standards were dissolved in hexane. Solutions with 500 ppm of each standard were diluted volumetrically. A calibration curve for each component was made. Analytes were detected using DAD and peak identification which was accomplished by comparing the retention times and HPLC peaks with those obtained from standard solution of mixture analyzed under the same conditions. Quantitative determination was performed using the standard curve. Each sample was run in triplicate.

2.5. Antioxidant Activity Determination. The DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging method was used to measure the antioxidant activity [40] with a slight modification. The chloroform/methanol lipid extraction solution without BHT was used for extraction of components having antioxidant activity. Absorption of the intermediate colored complex was measured on UV-Vis Beckman Coulter spectrophotometer (Loveland, Colorado) at 515 nm and the results were expressed in terms of micromole equivalents of Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) per 100 grams of sample [40]. The DPPH radical and Trolox were purchased from Sigma Aldrich Co. (St. Louis, MO). Each sample was run in triplicate.

2.6. Experimental Design and Statistical Analysis. The study was conducted as a two-factor experiment in a completely randomized design with three replicates. The two factors were sausage preparation (raw or cooked) and three levels of rice bran inclusion (0, 1.5 and 3%). The experimental data were analyzed using PROC GLM of SAS version 9.3 [41]. The data were fitted to a fixed model with the factors sausage preparation and rice bran level treated as fixed effects. The treatment means were compared using the least squares means method of PROC GLM. The effects of the rice bran percentages were compared with trend analysis using orthogonal polynomial contrasts.

3. Results and Discussion

3.1. Proximate Analyses. The results of the proximate analyses of stabilized rice bran, goat meat, and chili seasoning are presented in Table 1. The proximate analysis percentages for rice bran are similar to those found in the literature [42], but the percentages for goat meat analysis differed from those obtained by Devendra [8]. Goat meat moisture and protein percentages were lower than those reported by Devendra, while fat percent was higher and ash percent was similar [8]. According to Devendra, goat meat had lower fat content than fat content in this study because in their study the tissue was more concentrated in viscera than the muscle. In this study, a mixture of shoulder, leg, and other parts of meats of one-to-three-year-old goats was used, while Devendra used meat from kids (young goat). The composition of meat depends on the age of animal and the part of the animal used [43].

The proximate analyses of sausages with added rice bran are presented in Table 2. The moisture content of the raw sausages decreased slightly in response to increased rice bran percentage. In contrast, the moisture content of cooked sausages decreased linearly in response to increasing rice bran percentages. This was due to the addition of ample water to the mixture before rice bran is added at three different levels and 6-7 hours of cooking and smoking process. Also, the results of this study for cooked goat meat sausage are similar to other studies [6]. The percentages of fat, ash and protein were greater in the cooked sausages than the raw sausages. This probably was due to the moisture loss during the treatment and cooking process. The fat content of both raw and cooked sausages increased linearly in response to increasing rice bran percentages as a result of addition of fat from rice bran. Thus, sausages with added rice bran might have a more beneficial fatty acid composition in regard to more mono- and poly unsaturated fatty acids [15] as discussed in Section 3.2. The ash percent of raw sausages did not vary significantly across the rice bran percentage, The ash percent of cooked sausages decreased linearly in response to the increasing rice bran percentage, even though the variation among means was small. This could be due to a very sensitive equipment Phoenix microwave furnace (CEM corp., Matthews, NC), the variability within the replicates were so small that significant differences ($P < 0.001$) were detected. There was no significant effect of added rice bran on the protein content of raw sausages and cooked sausages. On the other hand, the cooking and smoking process increased the percentage of protein. The carbohydrate percentage of

Table 1: Proximate composition of stabilized rice bran, goat meat, and chili seasoning (Means ± s.e.).

Proximate analysis	Stabilized rice bran	Goat meat (% by weight)	Chili seasoning
Moisture	18.4 ± 0.08	70.8 ± 0.20	4.3 ± 0.50
Fat	15.6 ± 0.10	10.9 ± 0.46	5.2 ± 0.01
Ash	9.6 ± 0.03	0.9 ± 0.01	13.1 ± 0.04
Protein	11.5 ± 0.18	14.6 ± 0.78	10.0 ± 0.08
Carbohydrates	45.1 ± 0.03	2.8 ± 0.15	66.3 ± 0.50

Table 2: Proximate composition of raw and cooked goat meat sausages with added rice bran (Means ± s.e.)[§].

(a)

Proximate analysis	Raw				
	Percent rice bran				
	0	1.5 (% by weight)	3	Mean[†]	Linear effect[‡]
Moisture[#]	$72.2^{a} \pm 0.009$	$70.9^{a} \pm 0.09$	$70.1^{a} \pm 0.04$	71.1 ± 0.31	$-^{***}$
Fat[#]	$8.9^{b} \pm 0.28$	$9.7^{b} \pm 0.35$	$10.5^{b} \pm 0.21$	9.7 ± 0.27	$+^{***}$
Ash	1.5 ± 0.01	1.5 ± 0.01	1.5 ± 0.02	$1.5^{B} \pm 0.01$	ns
Protein	13.1 ± 1.29	13.3 ± 2.05	11.8 ± 1.06	$12.8^{B} \pm 0.80$	ns
Carbohydrates	4.3 ± 1.14	4.6 ± 2.08	6.1 ± 1.32	$5.0^{A} \pm 0.83$	ns

(b)

Proximate analysis	Cooked				
	Percent rice bran				
	0	1.5 (% by weight)	3	Mean[†]	Linear effect[‡]
Moisture[#]	$63.6^{b} \pm 0.50$	$62.9^{b} \pm 0.13$	$58.3^{b} \pm 0.04$	61.6 ± 0.86	$-^{***}$
Fat[#]	$13.1^{a} \pm 0.03$	$12.3^{a} \pm 0.06$	$15.1^{a} \pm 0.20$	13.5 ± 0.42	$+^{***}$
Ash	2.1 ± 0.01	2.0 ± 0.02	2.0 ± 0.02	$2.0^{A} \pm 0.02$	$-^{***}$
Protein	20.5 ± 1.00	21.1 ± 0.20	21.6 ± 0.32	$21.1^{A} \pm 0.34$	ns
Carbohydrates	1.0 ± 1.00	1.7 ± 0.40	3.0 ± 0.56	$1.8^{B} \pm 0.46$	ns

[§]All sausages contain chili seasoning (3% by weight) and salt (1.6% by weight).

[†]Different upper case letters (A and B) following a raw and cooked mean (across percent rice bran levels) indicates that those two means differ ($P < 0.05$).

[#]Moisture and Fat exhibited a significant preparation by percent rice bran interaction; therefore raw and cooked means were not compared. Different lower case letters (a and b) following a percent rice bran mean (within a percent rice bran level) indicates that raw and cooked differ ($P < 0.05$).

[‡]The − sign indicates a negative response and the + sign a positive response to increasing percent rice bran levels.

[‡]*, **, *** indicates the linear effect, significant at the 0.05, 0.01, 0.001 level of probability, respectively. ns: not significant.

raw and cooked sausages did not changed significantly in response to the increasing rice bran percentages. This could be due to cooking and smoking process. Cooking process decreased the carbohydrate percentage from raw to cook. In this study we did not measure cooking yield due to complexity of the cooking and smoking process.

3.2. Fatty Acids. Fatty acids are important components of meat lipids [10] which can have an important influence on human plasma cholesterol level. For instance, saturated fatty acids increase cholesterol levels in contrast to total monounsaturated fatty acids (MUFA) and total polyunsaturated fatty acids (PUFA). Not all saturated fatty acids have the same influence on the cholesterol level; C16:0 and C14:0 can increase cholesterol levels, while C18:0 does not have such effect [10].

Fatty acid content, as percentages of total fatty acids, for goat meat reported in the literature are oleic acid (C18:1) 28–50%, palmitic (C16:0) 15–31%, stearic (C18:0) 6–17%, and linoleic (C18:2) 4–15% [10]. The high concentration of C18:0 in goat meat will not increase cholesterol levels in human, and more importantly, the ratio of (C18:0 + C18:1) to C16:0 could have beneficial health effects when it falls between 2 and 3 [10]. Meat can be also classified to have health benefits by concentration of desirable fatty acids (DFA) which include the total of C18:0 and all unsaturated fatty acids. These DFA are considered to have either neutral or cholesterol lowering effects [10].

Table 3: Fatty acid composition of cooked goat meat sausages with added rice bran (Means ± s.e.)[§].

Fatty acids	Percent rice bran			Linear effect[‡]
	0.0	1.5	3.0	
		Saturated fatty acids		
C14:0	2.37 ± 0.04	2.48 ± 0.01	2.28 ± 0.03	ns
C16:0	24.40 ± 0.77	23.75 ± 0.20	23.19 ± 0.11	ns
C18:0	38.25 ± 0.14	34.76 ± 0.35	36.00 ± 0.10	$-^{***}$
		Mono and poly unsaturated fatty acids		
C16:1	1.17 ± 0.01	1.41 ± 0.01	1.27 ± 0.02	$+^{**}$
C18:1	29.51 ± 0.78	32.52 ± 0.3	32.09 ± 0.30	$+^{*}$
C18:2n6	3.02 ± 0.15	3.56 ± 0.14	3.67 ± 0.17	$+^{*}$
C18:3n6	0.27 ± 0.04	0.32 ± 0.03	0.27 ± 0.02	ns
C18:3n3	0.30 ± 0.02	0.38 ± 0.02	0.46 ± 0.10	ns
C20:2n6	0.03 ± 0.01	0.03 ± 0.02	0.06 ± 0.004	$+^{*}$
C20:3n6	0.09 ± 0.01	0.07 ± 0.01	0.00 ± 0.00	$-^{***}$
C20:4n6	0.57 ± 0.06	0.65 ± 0.02	0.63 ± 0.03	ns
C20:5n3	0.01 ± 0.00	0.06 ± 0.03	0.06 ± 0.01	$+^{**}$
		Sums and ratios of fatty acids		
∑ Sat	65.02 ± 0.79	61.00 ± 0.31	61.48 ± 0.20	$-^{**}$
∑ MUFA	30.69 ± 0.77	33.93 ± 0.32	33.36 ± 0.30	$+^{*}$
∑ PUFA	4.28 ± 0.15	5.07 ± 0.08	5.15 ± 0.23	$+^{**}$
DFA	73.2 ± 0.80	73.6 ± 0.19	74.5 ± 0.12	ns
(C18:0 + C18:1)/C16:0	2.78 ± 0.15	2.83 ± 0.04	2.94 ± 0.02	ns
∑ n6	3.97 ± 0.02	4.63 ± 0.09	4.64 ± 0.20	$+^{*}$
∑ n3	0.31 ± 0.02	0.44 ± 0.02	0.51 ± 0.09	$+^{*}$
∑ n3/∑ n6	0.08 ± 0.00	0.09 ± 0.00	0.11 ± 0.02	ns
∑ PUFA/∑ Sat	0.06 ± 0.01	0.08 ± 0.00	0.08 ± 0.00	$+^{**}$

[§]All sausages contain chili seasoning (3% by weight) and salt (1.6% by weight).
[‡]The − sign indicates a negative response and the + sign a positive response to increasing percent rice bran levels.
[‡]Indicates the linear effect, *,**,***Significant at the 0.05, 0.01, 0.001 level of probability, respectively.
∑ Sat = sum of saturated fatty acids; ∑ MUFA = sum of monounsaturated fatty acids; ∑ PUFA = sum of polyunsaturated fatty acids.
DFA (Desired fatty acids) = C18:0 + ∑ MUFA + ∑ PUFA; ∑ n6 = sum of omega-6 fatty acids; ∑ n3 = sum of omega-3 fatty acids. ns: not significant.

Essential omega-6 and omega-3 fatty acids play a crucial role in the human body. They carry fat soluble vitamins and support immune systems. These fatty acids cannot be synthesized by human organisms and need to be consumed in the diet [35]. The C20:4 eicosatetranoic fatty acid is an essential fatty acid [10] which can be derived either from C18:2 linoleic fatty acids or directly from the diet. Goat muscle contains nearly twice as much C20:4 as lamb muscle [10]. The C18:2 and C20:4 fatty acid contents in goat meat used for this study were lower than in the literature which may be explained by the utilization of different parts of the goat and older goats that contain less total PUFA.

The fatty acid compositions of cooked goat meat sausages with added rice bran are presented in Table 3. Goat meat, stabilized rice bran, and chili seasoning were analyzed for fatty acid composition also (data not shown). The fatty acid results for rice bran were comparable to previously published results [36]. The fatty acids composition of goat meat sausages without rice bran was comparable to goat patties without oat bran [6]. The individual fatty acid components and sums and ratios of individual fatty acids are presented as a percentage of total fatty acids. The percentage of total fatty acids of 5 of the 12 individual fatty acids increased linearly in response to the increasing rice bran percentages, while only 2 fatty acids decreased with increased rice bran. The percentage of total fatty acids for the sum of the saturated fatty acids (∑Sat) in unmixed rice bran was 22.7% (data not shown) compared to 65.2% for goat meat sausage without rice bran as shown in Table 3. Consequently, it was expected that incorporation of rice bran to decrease the saturated fatty acids content of goat meat sausages. In this study, the total saturated fatty acids decreased significantly ($P < 0.001$) in response to increasing rice bran percentage of the goat meat sausages (Table 3). The percentage of total fatty acids for the ∑MUFA in unmixed rice bran was 49.8% (data not shown) compared to 30.7% in goat meat sausages without rice bran as shown in Table 3. Therefore, the incorporation of rice bran, into goat meat sausages was expected to increase the ∑MUFA of the goat meat sausages. In this study, the percentage of total fatty acids for ∑MUFA increased significantly ($P < 0.05$) in response to increasing rice bran percentages of the goat meat sausages (Table 3). The percentage of the total fatty acids of the monounsaturated fatty acids C16:1 and C18:1 increased linearly. The percentage of total fatty acids for 3

Table 4: α-Tocopherol, cholesterol, and antioxidant activity of rice bran and cooked goat meat sausages with added rice bran (Means ± s.e.)[§].

	Rice bran	Goat meat sausage Percent rice bran			Linear effect[‡]
		0	1.5	3	
			(mg/100 g)		
α-Tocopherol	7.37 ± 0.21	0.96 ± 0.08	0.99 ± 0.08	1.40 ± 0.02	$+^{**}$
Cholesterol		51.4 ± 0.90	51.4 ± 1.78	51.0 ± 2.18	ns
			(μmoles of Trolox equivalent/100 g)		
Antioxidant activity	236.95 ± 0.26	13.5 ± 0.38	14.3 ± 0.005	22.7 ± 0.02	$+^{***}$

[§]All sausages contain chili seasoning (3% by weight) and salt (1.6% by weight).
[‡]The + sign indicates a positive response to increasing percent rice bran levels.
[‡]Indicates the linear effect, *,**,***Significant at the 0.05, 0.01, 0.001 level of probability, respectively.
ns: not significant.

of the 7 polyunsaturated fatty acids C18:2n6, C20:2n6, and C20:5n3 increased linearly in response to increasing rice bran. In contrast, the percentage of total fatty acids of one polyunsaturated fatty acid C20:3n6 decreased linearly.

The (C18:0 + C18:1) to C16:0 ratio did not vary significantly in response to the increasing rice bran percentages. Thus, the (C18:0 + C18:1) to C16:0 ratio remained in the healthy range of 2-3 [10]. In this study, the ratio was from 2.7–2.9 across the rice bran percentages, which is in agreement with reported values [10]. The percentage of total saturated ($\sum$Sat) decreased linearly with increasing rice bran. The percentage of total MUFA and total PUFA increased linearly with increasing rice bran from 30.7% at zero percent rice bran to 33.4% at 3% rice bran. Subsequently, the percentage of total PUFA increased from 4.3% at zero percent rice bran to 5.2% at 3% rice bran. The percentage of total omega-6 and total omega-3 in sausages increased linearly with increased rice bran from 3.97% and 0.31% at zero percent rice bran to 4.64 and 0.51% at 3% rice bran, respectively. These differences were significant ($P < 0.05$). The omega-3 to omega-6 fatty acid ratio (n3/n6) did not change significantly. The total DFA concentrations in this study increased linearly from %73.2 to %74.5 at zero percent rice bran to 3% of rice bran, respectively, which was not significant. These data are similar to data range presented by Banskalieva et al. [10]. In this study, the ratio of $\sum$PUFA/$\sum$Sat was lower than in some reported literature [10] and similar to others [44]. The ratio of $\sum$PUFA/$\sum$Sat increased linearly with increasing rice bran at a significant level ($P < 0.001$). This could be an additional health benefit of incorporating rice bran in the sausages. There was a linear increase in the fat percent of sausages in response to increasing rice bran percentages (Table 2). However, the percent of total saturated fatty acids decreased in response to increasing rice bran percentages of the sausages. The percentage of total unsaturated fatty acids, both MUFA and PUFA, and both total omega-6 and omega-3, increased in response to increasing rice bran percentages.

3.3. α-Tocopherol and Cholesterol Concentrations and Antioxidant Activity. The α-tocopherol concentrations of rice bran and cooked sausages with added rice bran are presented in Table 4. The concentration of α-tocopherol in rice bran was 7.37 mg/100 g which is similar to that presented in Gerhardt and Gallo [30] and Zigoneanu et al. [26]. The concentration of α-tocopherol increased linearly in response to the increasing rice bran percentages of the sausages. High temperatures can cause α-tocopherol degradation, but a previous study has shown no significant degradation with the cooking conditions used in this experiment [45]. The cholesterol concentration did not vary significantly in response to the increasing rice bran percentages. The antioxidant activity of unmixed rice bran and goat meat were 237.0 and 5.1 moles of Trolox equivalent per 100 g, respectively. The antioxidant activity increased linearly from 13.5 to 22.7 moles of Trolox equivalent/100 g in response to increasing rice bran percentages of the sausages (Table 4).

4. Conclusions

Goat meat sausages with 3% of stabilized rice bran had higher concentration of α-tocopherol, higher antioxidant activity, higher total omega 3/omega 6 ratio, higher total MUFA and total PUFA content, nonsignificant higher concentration of DFA, and an acceptable ratio of (C18:0 + C18:1) to C16:0 compared to zero percent rice bran. The (C18:0 + C18:1) to C16:0 ratio remained in the healthy range of 2 to 3 [10] across the rice bran percentages. Thus, sausages with added rice bran have a more beneficial fatty acid composition in regard to more mono- and polyunsaturated fatty acids as discussed in Section 3.2. Based on the results from this study and because of these factors, adding 3% stabilized rice bran to goat meat sausage is recommended which will provide more health benefits.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Original article

Proximate and fatty acid compositions and sensory acceptability of Hispanic consumers towards rib-eye steaks from forage-finished steers

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Summary Proximate and fatty acid compositions and sensory acceptability of rib-eye steaks (fresh and 6 months frozen-stored) from three forage-finished steers [S1 (bermudagrass + ryegrass, etc.); S2 (bermudagrass + ryegrass + berseem, etc.); S3 (bermudagrass+berseem+soybean+brown midrib sorghum, etc.)] and one commercial steak (C), cooked by one-sided and/or two-sided grilling, were evaluated. All forage-finished steaks had lower [omega-6/omega-3] ratios than C. Sensory liking was assessed by Hispanic consumers. Raw C steak had higher fat and lower protein contents than others (S1, S2 and S3). Concerning raw steaks, S3 had higher liking scores for overall appearance and fat appearance than others. Two cooking methods did not cause significant differences in sensory liking. Juiciness and overall liking of cooked C and S3 (one-sided grilling) steaks were not significantly different. Purchase intent (after knowing health benefits of forage-finished steaks) increased from 62.0–73.8% to 69.8–85.7%. Forage-finished steaks showed a potentially healthier lipid profile than grain-finished steaks and had market potential towards Hispanic population.

Keywords Beef, consumer acceptance, fatty acid profile, forage-finished beef, rib-eye steaks.

Introduction

Reduction in consumption of saturated fatty acids, trans-fatty acids and cholesterol in human diets has been highly recommended because a number of studies have associated these compounds with atherosclerosis and various cardiovascular diseases (CVD) (Daley *et al*., 2010). Correspondingly, numerous studies have demonstrated the necessity to increase intakes of polyunsaturated fatty acids (PUFA), especially those belonging to the omega-3 (*n*-3) group, in foods for infants and adults (Riediger *et al*., 2009). Calder & Yaqoob (2009) reported that frequent consumption of long-chain *n*-3 fatty acids modifies, in a beneficial manner, a number of risk factors related to CVD, including blood pressure, platelet reactivity, thrombosis, plasma triglyceride concentrations, vascular functions, cardiac arrhythmias and inflammation. In addition, a balance of the omega-6/omega-3 (*n*-6/*n*-3) fatty acids ratio must be taken into consideration. A compilation of studies made by Simopoulos (2008) indicated that a balance of *n*-6/*n*-3 (approximately a ratio of 1) plays an important role in decreasing the risk of CVD.

Simopoulos (2008) reported a trend of increasing *n*-6 and decreasing *n*-3 intakes in Western diets. The *n*-3 enrichment of meats can be achieved by modifying diets of animals (Riediger *et al*., 2009). An extensive review of fatty acid profiles in forage- and grain-finished beef revealed that no significant changes in the global concentration of *n*-6 fatty acids were observed between these two feeding regiments in the majority of the studies; however, forage-fed beef consistently had higher concentrations of PUFA and *n*-3 fatty acids, producing a more favourable *n*-6/*n*-3 ratio (Daley

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et al., 2010). Differences in chemical composition of the meats such as fat content and fatty acid composition may cause differences in flavour between forage- and grain-fed beef (Maughan *et al*., 2012). In some studies, sensory panels were not able to detect a lack of beef flavour in forage-fed beef but rather a manifestation of an off-flavour described as gamey, barny, bitter, grassy and milky (Brown *et al*., 1979; Melton *et al*., 1982; Maughan *et al*., 2012). Sensorial differences between forage- and grain-fed beef can most likely be explained by the production systems which also affect the levels of energy intake, days on feeding, growth rate, age of the animal, fat deposition, fat composition and carcass weight (Calkins & Hodgen, 2007).

Some studies (Bowling *et al*., 1977; Killinger *et al*., 2004; Kerth *et al*., 2007; Maughan *et al*., 2012) reported that US consumers favour grain-finished beef over forage-finished beef in certain sensory attributes including flavour, juiciness, tenderness and overall acceptability; however, other studies indicated no significant differences in overall acceptability of the forage- and grain-fed steaks and consumers rated both steaks as desirable (Bidner *et al*., 1981, 1986). In the US, one important factor that affects consumption of forage-finished beef is its availability throughout the year, as some forage production is seasonal. One alternative solution is frozen storage of forage-finished beef. However, freezing and frozen storage can affect the structural and chemical properties of muscle foods, including changes in muscle fibre, lipids and proteins. All of these alterations can significantly influenced the quality attributes of meat and meat products (Miller *et al*., 1980), hence their sensory acceptability.

Information related to the health benefits of forage-finished beef in conjunction with the growing demand for natural, environmental friendly products and production systems is currently an important driver of consumer willingness to buy (Umberger *et al*., 2009). Sensory perceptions, along with memory, culture, and emotions, are what consumers associate with food quality, and they have great influence in determining consumer acceptance and purchase intent for food products (Herrera-Corredor *et al*., 2010). According to the US Census Bureau (2013), Hispanic population in the US is expected to grow from 47.8 million in 2010 to 102.6 million in 2050, representing an increase from 12.5% to 24.4% of the total population in the US, which make Hispanics an important ethnic group to consider for product marketing. To date, information on sensory acceptability of forage-finished beef perceived by the Hispanic consumers residing in the US is very limited. Thus, the objective of this study was to evaluate proximate and fatty acid compositions and sensory acceptability (of Hispanic consumers) of rib-eye steaks from forage-finished steers, and one commercial steak cooked by 'one-sided grilling' vs. 'two-sided grilling'. In addition, sensory acceptability of cooked rib-eye steaks that were previously 6 months frozen-stored was also assessed.

Materials and methods

Steers, feeding systems and rib-eye steaks

A total of fifty-four fall born steers (3/8 Gelbvieh, 3/8 Red Angus and 1/4 Brahman) were purchased from a single source to minimise initial variations. Steers were blocked at weaning by weight into nine groups (six steers/group), of which three groups were randomly assigned to one of the three forage feeding systems (S1, S2 and S3). Table 1 shows the description of each system where S1 and S2 had three paddocks and S3 had five paddocks. The experiment was carried out in the Gulf coast region of Louisiana, USA. 'The forage systems used in this experiment were selected for mainly two reasons: high production and excellent adaptation. The bermudagrass is an excellent pasture in summer in the southeast region. Soybeans and sorghum sudan in S3 were used to increase forage production and its nutritive value. Ryegrass is an annual winter grass and is the best (by far) adapted to this region. Addition of clovers was to extend the grazing season. The use of berseem clover was mainly due to its excellent adaptation in this area. Red and white clovers are commonly used in the southeast region.'

At an age of 17–19 months, two steers per group were randomly selected from each forage feeding system and sacrificed at a commercial plant by humane procedures under meat inspection supervision. Six rib-eye steaks (0.75 inches of thickness) from each side (left and right) of each carcass were used for two studies. Left-sided steaks were used for the fresh beef consumer study (the 1st study), and right-sided steaks were stored for 6 months at −20 °C for the 2nd consumer study. A commercial grain-finished USDA Choice rib-eye steak (C; Winn-Dixie, Baton Rouge, LA, USA) was used as a control.

Proximate and fatty acid analyses of rib-eye steaks

The raw rib-eye steaks were analysed in duplicates for all three forage systems (S1, S2 and S3) and one commercial sample (C) for a total fat content using a chloroform methanol extraction (AOAC #983.23, 1995), the protein content using thermal conductivity (Perkin Elmer 2410 Nitrogen Analyser Ser. II, Norwalk, CT, USA; AOAC # 992.15, 1995), the ash content using a CEM Phoenix Microwave Ashing System (AOAC # 920.153, 1995) and the moisture content using CEM SMART System 5 (AOAC #985.14, 1995). The fatty acids profile was determined by gas chromatography (a Hewlett-Packard 6890 GC using a fused

Table 1 Description of samples from the forage feeding systems and a commercial sample used in the study

Treatment labels	Description
S1	Rib-eye steaks obtained from steers that were fed with: Paddock A: bermudagrass (*Cynodon dactylon*, BG); Paddock B: annual ryegrass (*Lolium multiflorum*, RG; seeding rate of 23 kg ha^{-1}); Paddock C: BG + RG (seeding rate of 14 kg ha^{-1}).
S2	Rib-eye steaks obtained from steers that were fed with: Paddock A: BG; Paddock B: RG (seeding rate of 14 kg ha^{-1}) + rye (*Secale cereale*; seeding rate of 14 kg ha^{-1}) + berseem (*Trifolium alexandrium*; seeding rate 7 kg ha^{-1}), red (*Trifolium pratense*; seeding rate 5 kg ha^{-1}) and white (*Trifolium repens*; seeding rate 3 kg ha^{-1}) clovers; Paddock C: dallisgrass (*Paspalum dilatatum*) + berseem, and white clovers.
S3	Rib-eye steaks obtained from steers that were fed with: Paddock A: BG; Paddock B: dallisgrass + berseem, red and white clovers; Paddock C: RG + rye + berseem, red and white clovers; Paddock D: forage soybean (*Glycine max*, seeding rate 30 kg ha^{-1})/RG (for summer and winter, respectively); Paddock E: brown midrib sorghum (*Sorghum bicolor* (L.) *Moench.*) × sudangrass (*Sorghum sudanese Piper*) hybrid (seeding rate 14 kg ha^{-1})/RG (for summer and winter, respectively)
C	Commercial USDA Choice rib-eye steaks obtained from Winn–Dixie (Baton Rouge, Louisiana, USA)

silica column, 30 × 0.25 mm) and mass spectrophotometry (MS) of the fatty acid methyl esters (Firestone, 2006). For simplification, only polyunsaturated fatty acids (PUFA), *n*-3 (combined C18:3, C20:5 and C22:6) and *n*-6 (combined C18:2 and C20:4) fatty acids, and the *n*-6/*n*-3 ratio were reported. There are little trans-fatty acids in raw beef and meat products compared with other processed products, particularly hydrogenated or fried foods, which are relevant to human health (Fritsche & Steinhart, 1997). Thus, the total trans-fatty acids content was not measured in this study.

Sample preparation and consumer studies of raw and cooked rib-eye steaks

For the cooking procedures, frozen steaks were thawed (3.9 °C for 12 h) and cooked by either 'one-sided grilling' or 'two-sided grilling'. For the 'two-sided grilling' method, thawed steaks were placed in a preheated clam-shell-style grill (Model GR144; George Foreman® Healthy Cooking, Miramar, FL, USA) for 6 min, resulting in a final internal temperature of 71.1 °C (degree of doneness = medium; USDA, 2011). For the 'one-sided grilling' method, thawed steaks were placed in a preheated iron stove plate (Frigidaire; Electrolux Home Products, Augusta, GA, USA). Each side of the steak was heated for 6 min, resulting in a final internal temperature of 71.1 °C (degree of doneness = medium; USDA, 2011). The two cooking methods were used in the 1st consumer study, whereas only 'one-sided grilling' cooking method was used for the 2nd consumer study. After cooking, about 4–5 transversal slices (0.20 inches of thickness) of each steak treatment were served to the consumers.

Consumer evaluations were conducted at the Sensory Analysis Laboratory in the School of Nutrition and Food Sciences, Louisiana State University, Baton Rouge, LA, USA. For both studies (fresh and frozen-stored steaks), Hispanic population ($N = 112$ for the 1st study and $N = 51$ for the 2nd study) were recruited from Baton Rouge, Louisiana, USA. The tests were conducted in a large conference type room illuminated with cool, natural, fluorescent lights. The questionnaires were written in English; however, Spanish translation was provided as needed. Consumers were briefed about the questions, particularly, the sensory attributes and their meanings, and sample handling during the evaluation. For each session, 5–10 consumers participated. A balanced incomplete block (BIB) design, Plan 11.10 ($t = 8$, $k = 4$, $r = 7$, $b = 14$, $\lambda = 1$, $E = 0.86$, Type I), was used (Cochran & Cox, 1957) for the 1st study. Each consumer tested only four samples (of eight samples: {three forage treatments + one commercial grain-fed sample} × two cooking methods). This BIB design was repeated 8 times, resulting in a total of 56 observations per treatment. For the 2nd study, a randomized complete block design (RCBD) with consumers as blocks was used as consumers only tested three samples (rib-eye steaks from three forage systems cooked using the 'one-sided grilling' method). In summary, for the 1st study, the BIB design was used to obtain fifty-six responses from 112 consumers; for the 2nd study, the RBD design was used to obtain fifty-one responses from fifty-one

consumers. Crackers, water and expectoration cups were provided to consumers to use during the test to minimise any residual effects between samples.

Questionnaires were divided into two parts. Part I: consumers were asked to provide demographic (age, gender and country of origin) and product information including the most preferred cooking method (grilling, skillet, roasting and frying; by ranking, 1 = most preferred and 4 = least preferred) and degree of doneness (rare, medium rare, medium, medium well and well done; by ranking, 1 = most preferred and 5 = least preferred). Additionally, only for the 1st study, acceptance and preference (by ranking, 1 = most preferred and 4 = least preferred) for overall appearance and overall appearance of the fat, and willingness to buy (yes/no) the raw rib-eye steaks based on visual appearance were assessed by 70 randomly selected consumers of 112. Visual appearance of raw S1, S2, S3 and C was visually assessed from photographs (Fig. 1, size of each picture of '8 × 11'). Part II: consumers were asked to evaluate acceptability of cooked steak samples in the following order: overall appearance, overall beef flavour, juiciness, tenderness and overall liking using a nine-point hedonic scale (1 = dislike extremely, 5 = neither dislike nor like, 9 = like extremely) (Peryam & Pilgrim, 1957). Consumers were also asked to rate the intensities of juiciness and tenderness using the just-about-right scale (JAR) with three categories (not enough, just about right and too much). Subsequently, they determined overall acceptance and purchase intent of each steak using a binomial (yes/no) scale (Sae-Eaw *et al.*, 2007). Additionally, purchase intent (yes/no) of consumers after knowing the health benefits (a better ratio of *n*-6/*n*-3 fatty acids) of forage-finished beef and after knowing that the steaks were previously frozen-stored was determined.

Figure 1 Pictures of the different rib-eye steak treatments (789 = S1, 128 = S2, 843 = S3 and 405 = C). Treatment labels are specified in Table 1).

Statistical analyses

All data were analysed at $\alpha = 0.05$ using the SAS software 9.1.3 (SAS Inst., 2003). Frequency tables were constructed from the demographic and product information data. Analyses of variance (ANOVA) and the *post hoc* Tukey's studentised range test were used to locate differences among steak samples. A penalty analysis was used for analysing JAR ratings in conjunction with means consumer acceptance scores (Rothman & Parker, 2009). Multivariate analysis of variance (MANOVA) was used to determine whether significant differences existed among steak samples when correlations among all sensory attributes were tested simultaneously. Descriptive discriminant analysis (DDA, Huberty, 1994) was used to determine sensory attributes responsible for the underlying difference among steak samples. The Kruskal–Wallis test was used for testing the global hypothesis that all rank sums are not different. The critical difference for the multiple rank comparisons was obtained from Christensen *et al.* (2006). The Cochran's *Q*-test and the simultaneous confident intervals were used to determine differences in percentages of willingness to buy for all steak samples.

Results and discussion

Proximate and fatty acid analyses of rib-eye steaks

The raw S1, S2 and S3 rib-eye steaks had significantly higher moisture content compared to C (74.07–75.35% vs. 66.76%), while C had significantly higher fat (14.16% vs. 2.42–3.80%, on wet basis) but lower protein (18.80% vs. 22.22–22.76%, on wet basis) contents compared to S1–S3 samples (Table 2). Our results are comparable to those reported by Brown *et al.* (1979) where fat content (on wet basis) was higher (19.49% vs. 18.44%), while protein content was lower (17.77% vs. 18.07%) for high-energy full grain-finished beef compared with low-energy grass-finished beef, both having a moisture content of 61.74–62.44%. Total ash

Table 2 Mean values* for proximate and fatty acid compositions of the raw rib-eye steaks

Treatment*	Moisture	Fat†	Protein†	Total ashes†
Proximate composition (%)				
S1	74.07 ± 0.99^{a}	3.80 ± 0.89^{b}	22.22 ± 0.46^{a}	1.00 ± 0.05^{a}
S2	75.13 ± 0.45^{a}	2.42 ± 0.34^{b}	22.76 ± 0.32^{a}	1.02 ± 0.09^{a}
S3	75.35 ± 0.47^{a}	2.76 ± 1.12^{b}	22.56 ± 0.80^{a}	1.02 ± 0.02^{a}
C	66.76 ± 0.60^{b}	14.16 ± 0.39^{a}	18.80 ± 0.28^{b}	0.76 ± 0.06^{a}
Treatment*	**Σn-6 (%)‡**	**Σn-3 (%)‡**	**Σn-6/Σn-3‡**	**PUFA(%)‡**
Fatty acids				
S1	3.87 ± 0.23^{bc}	1.75 ± 0.18^{a}	2.23 ± 0.22^{b}	5.74 ± 0.35^{a}
S2	4.30 ± 0.88^{ab}	1.96 ± 0.26^{a}	2.21 ± 0.40^{b}	6.36 ± 1.04^{a}
S3	3.29 ± 0.30^{c}	1.52 ± 0.26^{a}	2.19 ± 0.25^{b}	4.94 ± 0.55^{a}
C	5.39 ± 0.42^{a}	0.51 ± 0.05^{b}	10.55 ± 0.38^{a}	5.96 ± 0.51^{a}

Data are mean ± standard deviation values of duplicate samples.
Mean values with the same letter within the same column (proximate or fatty acids composition) are not significantly different ($P \geq 0.05$).
*Treatment labels are specified in Table 1.
†Based on a wet basis.
‡Σn-6 = Total percentage of omega-6 fatty acids; Σn-3 = Total percentage of omega-3 fatty acids; Σn-6/Σn-3 = a ratio of Σn-6 and Σn-3 fatty acids; PUFA = Total percentage of polyunsaturated fatty acids.

Table 3 Mean consumer acceptance scores for overall visual appearance and overall visual appearance of the fat of raw rib-eye steaks and their positive purchase intent (%)

Treatment*	Overall appearance*	Overall appearance of the fat*	Purchase intent (% yes)†
S1	5.92 ± 1.85^{b}	5.11 ± 2.02^{b}	61.43^{b}
S2	5.63 ± 1.86^{b}	4.86 ± 1.86^{b}	45.71^{b}
S3	6.89 ± 1.70^{a}	5.94 ± 1.82^{a}	85.71^{a}
C	5.44 ± 2.14^{b}	4.94 ± 2.19^{b}	47.14^{b}

Data are mean and standard deviation values of $N = 70$ randomly selected consumers out of 112.
Mean scores with the same letter within the same column are not significantly different ($P \geq 0.05$).
All values are based on a nine-point hedonic scale where 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely.
*Treatment labels are specified in Table 1.
†Purchase intent (%yes) with different letters indicating significant differences [Cochran's Q-test and simultaneous confidence interval testing (df = 3) = 28.91, $P \geq 0.05$].

content (0.76–1.02%) was not significantly different for all steaks.

By feeding cattle on high-concentrate diets, animal overall fatness, muscle mass and carcass weight increase resulting in an increase in marbling scores (Kerry & Ledward, 2002). As for the fatty acids, S1 and S3 had significantly lower *n*-6 compared to C (3.29–3.87% vs. 5.39%, Table 2). However, all forage-fed steaks (S1, S2, and S3) had significantly higher *n*-3 fatty acids compared to C (1.52–1.96% vs. 0.51%). All steaks did not differ in the content of PUFA (4.94–6.36%); however, the *n*-6/*n*-3 ratios of all forage-fed steaks were significantly lower than C (2.19–2.23 vs. 10.55, Table 2). Several studies reported that grass- and grain-finished beefs did not show significant differences in the total amount of *n*-6 fatty acids; however, grass-finished beef possessed a higher *n*-3 fatty acids content compared to its grain-finished equivalent, thus resulting in lower *n*-6/*n*-3 ratios (1.7–2.0 vs. 6.9–10.4) (Nuernberg *et al*., 2005; Garcia *et al*., 2008; Alfaia *et al*., 2009; Tansawat *et al*., 2013). Chin *et al*. (1994) reported that ruminant fat is the largest natural source of conjugated linoleic acid (CLA), which has been reported to be a potential anticarcinogenic and antiatherogenic substance (French *et al*., 2000). In our study, all forage-fed steaks had significantly higher CLA (C18:2 cis9 trans11 + C18:2 trans10 cis 12) than the grain-fed sample (0.84–1.16% vs. 0.48%, data not shown); similar findings were reported by Tansawat *et al*. (2013). The subsequent part of this research further analysed consumer acceptance and preference of the rib-eye steaks obtained from S1, S2 and S3 forage systems compared with one commercial steak.

Study I: Consumer acceptability of rib-eye steaks (freshly harvested beef)

Hispanic consumers ($N = 112$) participated in this study, and their characteristics were as follows: 61.6% females and 38.4% males; 24.75% were Hondurans, 12.87% Colombians, 8.91% Ecuadorians, 8.91% Mexicans, and the remaining were Belizeans, Bolivians, Brazilians, Costa Ricans, Salvadorians, Guatemalans, Nicaraguans, Peruvians, Dominicans and Venezuelans (data not shown in Table).

Based on visual observation of the raw rib-eye steaks (Fig. 1), S3 had significantly higher mean scores

for overall appearance (6.89) and overall appearance of the fat (5.94) compared with other treatments (5.44–5.92 and 4.86–5.94, respectively, Table 3). Furthermore, S3 had the highest affirmative purchase intent (85.71%) compared with that of S1 (61.43%), S2 (45.71%) and C (47.14%) (Table 3). Table 4 shows the rank sums for overall appearance and overall appearance of the fat of the raw rib-eye steaks. S3 was most preferred for overall appearance and overall appearance of the fat (more yellow) compared with other treatments. Tansawat *et al*. (2013) reported that grain-fed rib steaks had higher fat content and were lighter, redder and more yellow than pasture-fed rib steaks. Moloney *et al*. (2013) reported that the type of silage affects fat colour. Results (Tables 3 and 4) collectively indicated that S3 was the most visually accepted and preferred raw rib-eye steak for Hispanic consumers over other forage-finished steaks (S1 and S2) and C.

The mean acceptance scores of sensory attributes (overall appearance, overall beef flavour, juiciness, tenderness and overall liking) of rib-eye steaks (S1, S2, S3 and C) cooked by two methods ('one-sided grilling' and 'two-sided grilling') are shown in Table 5. Generally, for all sensory attributes, no significant ($P \geq 0.05$) differences were found between the two cooking methods, except for juiciness for S3 where the 'one-sided grilling' sample had a higher mean score compared with the 'two-sided grilling' sample (6.68 vs. 5.71, $P < 0.05$). For overall appearance (5.76–6.45) and overall beef flavour (6.09–6.76), no significant differences were found ($P \geq 0.05$) among all steak treatments. The major differences between volatile compounds from fat of forage-fed steers compared with grain-fed steers are the higher concentration of 2,3-octanedione, and various diterpenoids present in the meat samples of forage-fed animals (Larick *et al*., 1987). Higher intensity values for barny, bitter, gamey and grassy were observed in the grass-fed meats (Maughan *et al*., 2012). Brown *et al*. (1979) described that a lower quantity of free sugars in grass-feed steers resulted in the production of lower quantities of desirable beef flavour volatiles; however, sensory panels were not able to detect this lack of flavour. Melton (1983) indicated that corn could be replaced partially or totally with high-quality alfalfa or timothy hay in cattle diets without a substantial change in flavour of the beef. Although no significant differences in acceptance of overall beef flavour were found ($P \geq 0.05$) among all steak treatments, it was not necessarily implied that their flavours were not different; sensory descriptive flavour profiles should be further evaluated.

Table 4 Rank sum analysis* for overall visual appearance and overall visual appearance of the fat of raw rib-eye steaks

	Overall appearance	Overall appearance of the fat
Kruskal–Wallis test†	$\chi^2 = 44.64$	$\chi^2 = 34.64$
P-value	$P < 0.0001$	$P < 0.0001$
Critical difference‡	30	30
Treatment§	**Rank sum***	
S1	174[b]	167[b]
S2	195[ab]	204[a]
S3	125[c]	134[c]
C	207[a]	196[ab]

Rank sums were computed from $N = 70$ randomly selected consumers out of 112.

Rank sums with the same letter within the same column are not significantly different ($P \geq 0.05$).

*Rank values range from 1 (most preferred) to 4 (least preferred).

†Kruskal–Wallis test was used for testing the global hypothesis that all rank sums are not different ($N = 70$ and df = 3).

‡The critical difference for the multiple comparisons was obtained from Christensen *et al.* (2006) with $N = 70$, Number of samples = 4, and $\alpha = 0.05$.

§Treatment labels are specified in Table 1.

For juiciness and tenderness, C (for both cooking methods) and S3 (only 'one-sided grilling') consistently (not significantly different in all cases) had higher mean scores compared with other treatments (6.57–6.96 vs. 5.71–6.30 and 6.51–6.89 vs. 5.82–6.09, respectively, Table 5). 'Among forage-finished steaks, the slightly higher scores (but not significant) for juiciness and tenderness of S3 (only one-sided grilling) may be attributed to the type of grass/forage. The grazing period that potentially affects beef characteristics is the last 60–80 days before the animal is harvested. This means that, in this study, only ryegrass in S1 and only ryegrass and clovers in S2 and S3 contributed to texture differences. More in-depth studies are needed to determine how these grasses contribute to texture differences.' In terms of texture measured by instrumentation, S1, S2 and S3 rib-eye steaks were not significantly different in Warner–Bratzler shear and slide shear (3.19–3.42 kg and 19.82–23.96 kg, respectively, data not shown). French *et al*. (2001) reported that no significant differences were found in sensorial tenderness and juiciness of steaks from grass- and grain-fed steers.

For overall liking scores, C and S3 (only 'one-sided grilling') had the scores over 6.6 (moderately liked) and generally higher than other treatments. Bowling *et al*. (1977) described that overall palatability was scored higher for grain-finished compared with forage-finished beef (6.1 vs. 5.1, on a eight-point hedonic scale). Kerth *et al*. (2007) reported that grain-finished steaks were rated more acceptable to consumers compared with forage-finished steaks (76.46 vs. 51.34 out a maximum score of 100). In a recent study, an averaged 7.05 (moderately liked) and 6.08 (slightly liked) score was, respectively, rated for grain- and grass-fed meats

Table 5 Mean consumer acceptance scores for sensory attributes of cooked rib-eye steaks for the 1st consumer study

Treatment*	Overall appearance	Overall beef flavour	Juiciness	Tenderness	Overall liking
S1-'one-sided grilling'	6.26 ± 1.72^{a}	6.14 ± 1.68^{a}	6.21 ± 1.56^{abcd}	6.09 ± 1.47^{ab}	6.14 ± 1.54^{bc}
S1-'two-sided grilling'	5.84 ± 1.81^{a}	6.27 ± 1.51^{a}	6.30 ± 1.74^{abcd}	6.04 ± 1.54^{ab}	6.16 ± 1.55^{abc}
S2-'one-sided grilling'	6.09 ± 1.66^{a}	6.47 ± 1.35^{a}	5.96 ± 1.96^{bcd}	5.89 ± 1.99^{b}	6.11 ± 1.66^{bc}
S2-'two-sided grilling'	6.04 ± 1.67^{a}	6.18 ± 1.47^{a}	5.89 ± 1.86^{cd}	5.82 ± 1.70^{b}	6.07 ± 1.45^{c}
S3-'one-sided grilling'	6.32 ± 1.82^{a}	6.67 ± 1.64^{a}	6.68 ± 1.64^{ab}	6.51 ± 1.76^{ab}	6.65 ± 1.67^{abc}
S3-'two-sided grilling'	6.04 ± 1.97^{a}	6.09 ± 1.70^{a}	5.71 ± 1.69^{d}	5.88 ± 1.75^{b}	6.05 ± 1.73^{c}
Commercial-'one-sided grilling'	5.76 ± 1.87^{a}	6.76 ± 1.57^{a}	6.57 ± 1.72^{abc}	6.89 ± 1.55^{a}	6.67 ± 1.61^{ab}
Commercial-'two-sided grilling'	6.45 ± 1.69^{a}	6.71 ± 1.71^{a}	6.96 ± 1.41^{a}	6.79 ± 1.58^{a}	6.93 ± 1.54^{a}

Data are mean and standard deviation values ($N = 56$).

All values are based on a 9-point hedonic scale where 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely.

Mean scores with the same letter within the same column are not significantly different ($P \geq 0.05$).

*Treatment labels are specified in Table 1.

on a nine-point hedonic scale, implying a slightly lower degree of liking for the meat obtained from the grass-fed cattle (Maughan *et al*., 2012). In contrast, Bidner *et al*. (1981) reported that grain- and grass-finished steaks did not show significant differences in overall desirability by consumer panels. Differences in consumer acceptance among steaks could be due to differences in consumer demographics, inherent variability of meats (Maughan *et al*., 2012) or quality and types of the grasses for feeding cattle (Melton, 1983). For this study, the affirmative purchase intent of all cooked steaks treatments was >60% (data not shown). By comparing grass- and grain-finished steaks, Umberger *et al*. (2002) found that approximately 23% of consumers were willing to pay more for grass-fed beef. In this study, we did not measure price-willing-to-pay, but we found that there was an increase from 62–73.8% to 69.8–85.7% (data not shown) in the purchase intent after knowing the health benefits of rib-eye steaks obtained from forage-fed systems.

Based on the penalty analysis (Fig. 2) using JAR scale ratings and mean acceptance scores, a large number of consumers (up to 50%) perceived that the cooked rib-eye steaks were not juicy enough, resulting in a mean drop of 1.31–1.70 on a 9-point overall liking scale for S1-'one-sided grilling,' S2 and S3-'two-sided grilling'. Similarly, up to 46.43% of consumers perceived a lack of tenderness in the steaks, resulting in a mean drop of 1.16–2.27 for S1-'two-sided grilling,' S2 and S3. In brief, overall liking scores of S2 and S3 were negatively affected by the lack of juiciness and/or tenderness. Conversely, for C, <21.82% of consumers perceived the steaks to be 'not juicy enough' and <16.36% perceived the steaks to be 'not tender enough' (Fig. 2). Kerth *et al*. (2007) indicated that the sensory characteristics that influenced consumer preferences for steaks are flavour, tenderness and juiciness, in that order. Bidner *et al*. (1986) reported that no significant difference in tenderness was found between grass- and grain-finished steaks by a descriptive sensory panel; however, there were small differences in juiciness between these two steaks which did not affect their acceptability.

MANOVA was performed to determine whether the eight treatment combinations (four types of steaks * two cooking methods) differed considering simultaneously all sensory attributes (overall appearance, overall beef flavour, juiciness, tenderness and overall liking). There existed overall differences among all combinations (Wilk's lambda P-value < 0.05, Table 6). Descriptive discriminant analysis (DDA, Table 6) identified tenderness, juiciness and overall liking as the main sensory criteria differentiating among all cooked rib-eye steak treatments with pooled within canonical structure r's values of 0.830, 0.721 and 0.648, respectively.

Study II: Consumer acceptability of cooked rib-eye steaks (previously frozen-stored for 6 months)

Hispanic consumers ($N = 51$) participated in this study and their characteristics were as follow: 52.9% females and 47.1% males; 20.83% were Ecuadorians, 16.67% Hondurans, 10.42% Colombians, 10.42% Brazilians, and the remaining were Bolivians, Costa Ricans, Cubans, Guatemalans, Jamaicans, Mexicans, Nicaraguans, Panamanians, Peruvians, Puerto Ricans, Dominicans and Venezuelans. Among the four cooking methods of the rib-eye steaks, grilling was significantly ($P < 0.05$) most preferred, followed by skillet, roasting and frying (Table 7). Regarding the degree of doneness, consumers preferred, respectively, from most to least: medium well, medium, well done, medium rare and rare (Table 7).

Table 8 shows the mean acceptance scores of overall appearance, overall beef flavour, juiciness, tenderness and overall liking of S1, S2 and S3 which had been 6 months frozen-stored before cooking with the

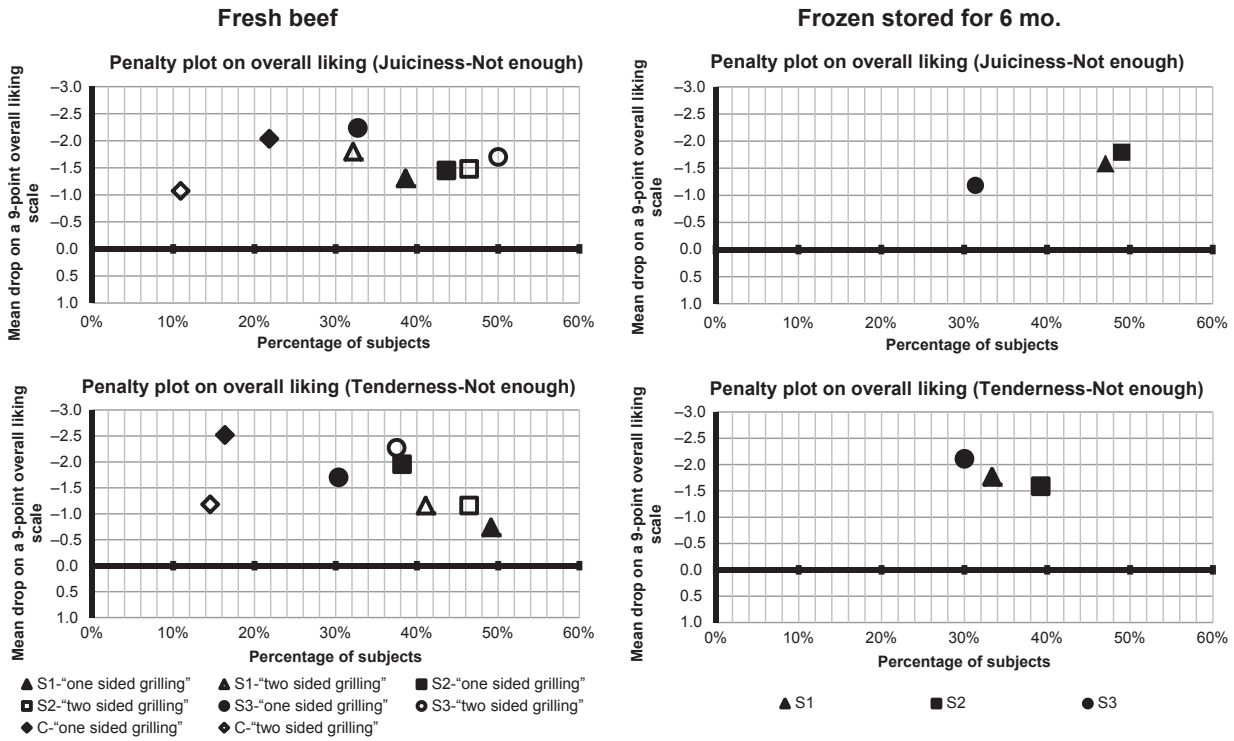

Figure 2 Penalty plots showing mean drops of overall liking scores as affected by juiciness and tenderness JAR scores of the rib-eye steaks (treatment labels are specified in Table 1).

Table 6 Pooled within canonical structure (*r*'s) describing variables that underlie group differences

	Fresh beef			Frozen-stored for 6 months	
Variables	**Can 1***	**Can 2***	**Can 3***	**Can 1***	**Can 2***
Overall appearance	−0.028	0.543	0.219	0.611	−0.267
Overall beef flavour	0.504	−0.082	−0.219	0.483	0.211
Juiciness	***0.721***	***0.596***	−0.211	***0.814***	0.041
Tenderness	***0.830***	0.095	0.291	***0.805***	−0.471
Overall Liking	***0.648***	0.267	0.264	***0.910***	0.049
Cumulative variance explained (%)	58.18	82.53	91.62	62.58	100.00

Bolded and italicised values indicate attributes largely contributing to the overall differences among all rib-eye steaks.
Can 1, Can 2 and Can 3 refer to the pooled within canonical structure in the 1st, 2nd and 3rd canonical discriminant functions, respectively.
*Based on the pooled within group variances with $P < 0.01$ of Wilks' lambda from MANOVA.

'one-sided grilling' method. No significant differences were found ($P \geq 0.05$) among steak treatments in terms of the mean consumer acceptance scores for overall appearance (5.76–6.35), overall beef flavour (6.43–6.84), juiciness (5.92–6.63) and tenderness (5.94–6.73) (Table 8). However, S3 and S1 consistently showed slightly higher (but not significant) mean scores compared to S2. For overall liking, S3 showed a significant ($P < 0.05$) higher mean score compared to S2 (6.69 vs. 5.92) but was not significantly different ($P \geq 0.05$) from S1 (6.69 vs. 6.45). From the MANOVA results, overall differences did not exist among all treatments (Wilk's lambda *P*-value of ≥ 0.05) when all attributes (overall appearance, overall beef flavour, juiciness, tenderness and overall liking) were considered altogether.

The purchase intent of cooked S3 (75.00%) was significantly higher than S2 (48.65%) but not significantly different from S1 (65.85%, data not shown). After tasting the samples, the purchase intent of the rib-eye

Table 7 Rank sum analysis* for preferred cooking methods and degree of doneness of rib-eye steaks (frozen-stored for 6 months)

	Cooking method	Degree of doneness
Kruskal–Wallis test†	$\chi^2 = 91.05$	$\chi^2 = 84.65$
P-value	$P < 0.001$	$P < 0.001$
Critical difference‡	26	31

Method	Rank sums*	Degree	Rank sum*
Grilling	68^{c}	Rare	215^{a}
Skillet	125^{b}	Medium rare	170^{b}
Roasting	134^{b}	Medium	124^{cd}
Frying	172^{a}	Medium well	98^{d}
		Well done	142^{bc}

Rank sums were computed from $N = 51$ observations. Rank sums with the same letter within the same column are not significantly different ($P \geq 0.05$).

*Rank values range from 1 (most preferred) to 4 (least preferred) for cooking method and from 1 (most preferred) to 5 (least preferred) for degree of doneness.

†Kruskal–Wallis test was used for testing the global hypothesis that all rank sums are not different ($N = 51$ and df = 3 for cooking methods and df = 4 for degree of doneness).

‡The critical difference for the multiple comparisons was obtained from Christensen *et al.* (2006) with $N = 51$, Number of samples = 4 for cooking method and five for degree of doneness, and $\alpha = 0.05$.

steaks increased (from 48.65–75.00% to 68.63–82.35%) after knowing the health benefits of steaks obtained from forage-fed systems, but it decreased (62.75% for all steak treatments) after knowing that the steaks were previously frozen-stored before cooking.

From the penalty analysis, a large number of consumers (up to 50%) perceived the cooked rib-eye (S1–S3) steaks to be 'not juicy enough', which was similarly noted for the cooked fresh (not previously frozen) steaks (Fig. 2). This lack of juiciness resulted in a mean drop of 1.18–1.79 for all samples (S1, S2 and S3) on a nine-point overall liking scale. Similarly, a lack of tenderness in the steaks produced a mean drop of 1.59–2.11 for all samples (Fig. 2). To sum up, overall liking of all forage-fed steaks was negatively affected by a lack of juiciness and/or tenderness.

Frozen storage can significantly affect beef lean (drip loss, % solids and N in drip, extractable protein, water binding, emulsion capacity) and fat (beef thiobarbituric acid and peroxide values), as well as sensory perception (Miller *et al.*, 1980). However, in this present study, mean overall liking scores between freshly harvested and previously 6 months frozen-stored rib-eye steaks (S1, S2 and S3 cooked by the 'one-sided grilling' method) were somewhat similar (6.11–6.65 vs. 5.92–6.69, Table 5 vs. 8). These results preliminarily implied that consumer acceptance of forage-finished steaks was not affected by the frozen storage (6 months at −20 °C), which may guarantee availability of these steaks all year round.

Conclusions

All forage-finished steaks (S1, S2 and S3) had significantly higher *n*-3 fatty acids, lower *n*-6/*n*-3 ratios, but similar PUFA compared to commercial (C) steaks. Concerning raw steaks, S3 had higher overall appearance scores than other samples. Concerning cooked steaks, the two cooking methods did not cause significant differences in liking scores. For juiciness and tenderness, C (for both cooking methods) and S3 (only 'one-sided grilling') consistently had higher mean scores compared with other treatments. Purchase intent was positively affected when consumers were informed of the health benefits of forage-finished steaks but negatively affected by the fact that steaks were previously frozen-stored before cooking. The acceptability of forage-finished beef was not affected by 6 months frozen storage at −20 °C. This study demonstrated that forage-finished steaks are potentially healthier than grain-finished commercial steaks. Besides, forage-finished steaks, especially those obtained from the S3 production system, have a market potential towards Hispanic population residing in the USA.

Table 8 Mean consumer acceptance scores for sensory attributes of rib-eye steaks, frozen-stored for 6 months and cooked by the 'one-sided grilling' method for the 2nd consumer study

Treatment*	Overall appearance	Overall beef flavour	Juiciness	Tenderness	Overall liking
S1	6.35 ± 1.66^{a}	6.61 ± 1.55^{a}	6.41 ± 1.58^{a}	6.73 ± 1.51^{a}	6.45 ± 1.57^{ab}
S2	5.76 ± 1.97^{a}	6.43 ± 1.33^{a}	5.92 ± 1.70^{a}	5.94 ± 1.87^{a}	5.92 ± 1.65^{b}
S3	6.33 ± 2.00^{a}	6.84 ± 1.53^{a}	6.63 ± 1.67^{a}	6.55 ± 1.88^{a}	6.69 ± 1.58^{a}

Data are mean and standard deviation values ($N = 51$). All values are based on a nine-point hedonic scale where 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely.

Mean scores with the same letter within the same column are not significantly different ($P \geq 0.05$).

*Treatment labels are specified in Table 1.

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EFFECT OF REPLACING CORN AND SOYBEAN MEAL WITH BREWERS RICE AND DRIED DISTILLERS BREWERS YEAST ON PERFORMANCE OF GROWING-FINISHING PIGS

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ABSTRACT

The objective of this study was to determine the effect of replacing corn and Soybean Meal (SBM) with Brewers Rice (BR) and Dried Distillers Brewers Yeast (DDBY), respectively, on ADG, G:F, Apparent Total Tract Digestibility (ATTD), fecal DM output and fecal loss of N and P of growing-finishing pigs. Sixty four Yorkshire x Duroc x Hampshire crosses (BW = 73±5.7 kg) were randomly assigned to corn/SBM (CSM), BR/SBM (RSM), corn/DDBY (CBY) or BR/DDBY (RBY) diets. Compared with pigs finished on corn based diets, pigs fed BR based diets gained faster (0.868 vs. 0.730 kg.pig^{-1}; $p<0.01$) and had better gain to feed ratio (0.30 vs. 0.25; $p<0.01$). Pigs finished on RBY diet had the least fecal DM output (0.245, 0.352, 0.575, 0.639 kg.pig^{-1}; $p<0.001$) and greatest ATTD (91.5, 87.8, 80.0, 77.9%; $p<0.001$) followed by RSM, CBY and CSM pigs, respectively. Pigs finished on RBY diet lost the least ($p<0.001$) amount of N (0.010, 0.013, 0.019, 0.021 kg.pig^{-1}) and P (0.010, 0.014, 0.016, 0.019 kg.pig^{-1}) in the feces followed by pigs finished on RSM, CBY and CSM, respectively. In conclusion, BR and DDBY can replace all corn and SBM in swine diets with no negative effects on performance of growing-finishing pigs.

Keywords: Corn, Brewers Rice, Soybean Meal, Dried Distillers Brewers Yeast, Growing-Finishing Pigs, Fecal Dm, Fecal N and P

1. INTRODUCTION

Swine diets are generally formulated on least cost basis and to obtain optimal nutrient use and minimize excretion of dietary nutrients. However, some nutrients are utilized less efficiently and are excreted in excess through the feces contributing to environmental pollution. Nitrogen and P are the most significant contributors to environmental pollution although other nutrients such as Ca, K, Cu and Zn are also of concern (Schutte *et al*., 1993). Dietary nutrients are excreted in excess because they are utilized less efficiently or nutrients supplied in the diet exceed the amounts needed by the animal (Lenis and Schutte, 1990; Kerr, 1995). Approximately 50 to 80% of N and 40 to 80% of P consumed is excreted, a substantial amount through the feces (Yano *et al*., 1999). Surplus N in manure leaches into ground and surface water, resulting in high nitrate levels in ground water and O_2 depletion by O_2-depleting plants growing in surface water (Aarnink and Verstegen, 2007).

Modifications of swine diets to replace feedstuffs used less efficiently or the more expensive feedstuffs continue to attract considerable research over the years. Other investigations have looked to include only nutrient amounts in diets to match animal needs; reports show a significant reduction in the excretion of nutrients such as N and P when dietary levels were restricted (Sutton *et al*., 1999; Cole *et al*., 2003; Aarnink and Verstegen, 2007). In addition, prices of

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traditional feedstuffs in swine diets, corn and Soy Bean Meal (SBM), continue to rise owing to their alternative uses as renewable energy sources. Alternative but effective energy and protein feedstuffs need to be investigated for their optimal utilization by pigs. Brewers Rice (BR), a by-product of rice processing and Dried Distillers Brewers Yeast (DDBY), a by-product of beer manufacturing, can be suitable and cheaper alternatives to corn and SBM, respectively. Although BR has a lower energy density compared to corn, its starch is more readily available because of a lower amylose to amylopectin ratio (Goddard *et al*., 1984) and lower Non-Starch Polysaccharides (NSP) and resistant starch (RS; Berry, 1986). These biochemical differences make BR more digestible than corn because rice contains about 20% amylose compared to more than 25% for corn (Rooney and Pflugfelder, 1986; Bjorck *et al*., 1994). Literature is lacking on the effect of replacing corn and SBM with BR and DDBY, respectively, on pig performance, fecal DM output and fecal loss of N and P by growing-finishing pigs. We hypothesized that replacing corn and SBM with BR and DDBY, respectively, will increase nutrient utilization (G:F and ATTD) and reduce fecal DM output ,and loss of N and P with out any negative effects on pig productivity. The objectives of this research were to determine the effect of; (1) replacing corn and SBM with BR and DDBY, respectively, on fecal DM output and loss of N and P in growing-finishing pigs and (2) replacing corn and SBM with BR and DDBY, respectively, on ADG, G:F and ATTD of growing-finishing pigs.

2. MATERIALS AND METHODS

The experiment used growing-finishing managed to meet the recommendations of the University of Arkansas at Pine Bluff (UAPB) Institutional Animal Care and Use Committee.

2.1. Animals, Housing and Experimental Design

Animals used in this experiment were a mixture of barrows and gilts of approximately ¾ Yorkshire×⅛ Duroc×⅛ Hampshire breeding. The animals weighed 73±5.7 kg^{-1} on day 0. Sixteen animals were born and raised on the UAPB Farm while forty eight animals of similar breeding were sourced from a nearby private farm. Experimental animals were housed in semi-open concrete floor pens measuring 2.13×6.26 m of which 2.13×2.13 m portion is open section and a similar area is under roof. All animals were grouped by weight and randomly assigned to four experimental diets. The design of this experiment was a randomized complete block with each pen consisting of four pigs considered the experimental unit. There were four diet treatments in this experiment, replicated four times, for a total of sixteen pens. This study was conducted between November 2, 2012 and November 30, 2012 and lasted 28 days.

2.2. Diets

Experimental diets were mixed at the UAPB Farmusing ingredients sourced locally. The treatment diets were: (1) Corn/Soybean Meal (CSM; control); (2) Brewers Rice/Soybean Meal (RSM); (3) Brewers Rice/dried distillers Brewers Yeast (RBY); and (4) Corn/dried distillers Brewers Yeast (CBY). All diets were formulated to contain 14% CP; dietary Ca and P met the National Research Council (NRC, 2012) recommendations for pigs in this class. Feed was weighed and fed manually to the animals daily at 0900 h. Daily feed amounts offered were based on the daily nutrient requirements for growing-finishing pigs following NRC (2012) recommendations. Animals were fed at 3.7% of BW on a DM basis. Feed intake at this level was calculated to supply adequate nutrients to support maintenance and attain more efficient ADG. The feed amounts were adjusted midway through the experimental period, to match changing animal needs due to increased growth. Drinking water was provided at all times via wall mounted nipple drinkers.

2.3. Variables Measured

Variables determined included: ADG, G:F, ATTD, fecal DM output and fecal loss of N and P and feed and fecal N and P. To determine ADG, animals were weighed on days 0, 14 and 28. The ATTD of DM, N and P was the calculated percent difference between intake DM, N and P and fecal DM, N and P. The fecal loss of N and P was calculated from average fecal output excreted during the five days of the sampling period. Fecal DM output was determined by multiplying the average total feces collected by the DM percent of each fecal sample.

Feed and fecal samples were dried and ground to pass through a 2 mm screen using the Wiley mill (Thomas Scientific, Swedesboro, NJ). Ground samples from five sampling days were composited into one sample each. Composite fecal and feed samples were analyzed for DM, N, P, Neutral Detergent Fiber (NDF) Acid Detergent Fiber (ADF) and ash.

Samples for P analysis were digested in nitric acid (HNO_3) on a hot block heated to more than 60°C for up

to 1½ h with appearance of reddish smoke signaling that initial digestion was complete. Hydrogen peroxide (H_2O_2) was added at this point and further digestion allowed to continue until about 5 mL of sample was left in the tube. The digested solution was diluted to bring the volume to 25 mL. The diluted sample was run through the Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) analyzer for final determination of P concentration.

2.4. Sampling Procedures

Animals were weighed at the start (day 0), day 14 and end of the experiment (day 28). Sub-samples of each feed were placed in a bag and stored in a freezer at-20°C, until further lab analysis. Total feces were collected within each pen during the last five days of the experiment. The feces were collected at the same time, in numerical order starting with the same penevery collection day. All feces were gathered and placed in pre-weighed buckets. Once the weight was determined, the feces were mixed within the bucket and a sub-sample prepared for lab analysis. The fecal sub-samples were stored in a freezer at-20°C, awaiting further lab analysis. During the sampling period the pens were not allowed to be washed down to ensure that all the feces excreted by the pigs during the sampling period were collected.

2.5. Statistical Analysis

Data was analyzed as a randomized complete block design, with pen comprising of four pigs as the experimental unit and block based on initial pig BW. All data were subjected to Analysis Of Variance (ANOVA) generated using the GLM procedures of SAS (SAS Inst. Inc., Cary, NC). The error term of pen within diet was used to test the effect of treatments on response variables determined. Treatment differences were considered significant at $p<0.05$. Least significance difference was used to separate means when a significant F-value for treatment means ($p<0.05$) was observed in the ANOVA.

3. RESULTS

Compared to pigs finished on corn based diets, pigs finished on brewers rice based diets gained faster ($p<0.01$); the protein source had no negative effect on pig ADG (**Table 2**). Fecal loss of dietary N was reduced ($p<0.001$) the most for pigs finished on RBY diet and reduced the least for CSM and CBY pigs, RSM pigs were intermediate (**Table 3**). Response to dietary P was somewhat different; pigs finished on RBY diet had the least ($p<0.001$) loss of dietary P followed by RSM, CSM and CBY in that order. Consequently, digestibility of dietary N and P was greater ($p<0.001$) for BR based diet compared with corn based diets.

4. DISCUSSION

Possible reasons why pigs fed BR based diets had a significant reduction in fecal DM output was probably due to lower NDF and ADF (fiber) levels (**Table 1**) compared to corn based diets. Fiber has a negative correlation with digestibility and this inverse relationship probably explains why corn with higher fiber content was less digested compared with BR. Greater ATTD for BR based diets meant that less feces was excreted compared to corn based diets. These findings compare favorably with our previous work (Gekara *et al*., 2013) and those of Yano *et al*. (1999), although the latter group used chickens in their studies.

Greater ATTD for RBY pigs followed by RSM, CSM and CBY, in that order, may have been due to differences in the concentration of NSP, mainly the cell wall carbohydrates, RS to amylase digestion and other complexes (Englyst *et al*., 1992; Gallant *et al*., 1992; Brown, 1996). Brewers rice based diets probably had a lower amylose (Goddard *et al*., 1984), NSP and RS (Berry, 1986) concentration making BR more digestible than corn based diets. Regular rice contains about 20% amylose compared to more than 25% for corn (Bjorck *et al*., 1994; Rooney and Pflugfelder, 1986).

The significant reduction in the fecal loss of N and P may have been due to differences in ATTD and dietary NDF and ADF. Brewers rice based diets had a greater N and P digestibility and lower levels of NDF and ADF compared with corn based diets. Fiber (mainly ADF) and digestibility are negatively correlated, thus, the significantly lower ADF levels in RBY and RSM diets compared with CSM and CBY diets probably explains the corresponding differences in animal response. Furthermore, a probable more favorable N to P ratio (Bjorck *et al*., 1994; French, 1973) in BR based diets compared with corn based diets may have resulted in greater digestibility and lower excretion of N and P in the feces. Additional research should determine the extent of N and P bound to NSP and how this affects availability of N and P in corn and BR relative to utilization in swine.

Table 1. Composition of experimental diets

	Experimental Diet[1]			
Item	RBY	CBY	CSM	RSM
Brewers rice (%)	-	76.80	-	77.74
Corn, dented yellow (%)	78.20	-	77.15	-
Soybean meal (%)	10.00	13.60	-	-
Alfalfa pellets (%)	8.15	5.60	8.00	4.46
Dried distillers brewers yeast (%)	-	-	11.15	14.55
Dicalcium phosphate (%)	2.45	2.15	1.75	1.50
Limestone (%)	0.75	1.80	1.10	1.30
Salt (%)	0.20	0.20	0.20	0.20
Mineral/vitamin premix[2] (%)	0.25	0.25	0.25	0.25
Nutrient composition				
ME, kcal/kg	30.18	27.30	30.74	28.54
CP (%)	14.03	14.03	14.03	14.03
P (%)	0.79	0.75	0.84	0.74
Ca (%)	0.99	0.90	1.00	0.94
Lys (%)	0.56	0.76	0.62	0.42
Analyzed composition				
N (%)	1.86	2.33	2.15	2.27
P (%)	0.60	0.86	0.73	0.74
NDF (%)	10.50	2.73	10.15	2.34
ADF (%)	4.94	2.85	4.22	2.83
Ash (%)	5.63	5.70	5.88	4.81

[1]Treatments: CSM = Corn/Soybean Meal; RSM = brewers Rice/Soybean Meal; CBY = Corn/dried distillers Brewers Yeast; RBY = brewers Rice/dried distillers Brewers Yeast

[2]Mineral/vitamin premix provided per kilogram: Iron, 180 ppm; Zinc, 180 ppm; Manganese, 37 ppm; Copper, 75 ppm; Iodine, 2.5 ppm; Selenium, 1.5 ppm; Vitamin A, 15,000 IU; Vitamin D3, 2,500 IU; Vitamin E, 60 IU; Vitamin B12, 62 µg; Menadione, 2.5 mg^{-1}; Riboflriboflavin, 13.7 mg; D-pantothenic Acid, 102.5 mg^{-1}

Table 2. Average daily gain, fecal output, apparent total tract digestibility and feed efficiency ofgrowing-finishing pigs

	Treatment[1]					
Item	CSM[1]	RSM	CBY	RBY	SEM	P value
BW at start (kg)	70.259	71.989	73.722	74.006	5.710	>0.100
BW at end (kg)	90.795	97.045	94.034	97.557	5.204	<0.010
DM intake (kg)	2.889	2.886	2.870	2.899	0.000	
ADG (kg)	0.734^{b}	0.895^{a}	0.725^{b}	0.841^{a}	0.041	<0.010
FO[2] (kg)	0.639^{a}	0.352^{c}	0.575^{b}	0.245^{d}	0.093	<0.001
ATTD (%)	77.896^{d}	87.794^{b}	79.956^{c}	91.518^{a}	3.217	<0.001
G:F(kg/kg)	0.254^{b}	0.310^{a}	0.253^{b}	0.290^{a}	0.014	<0.010

[1]Treatments: CSM = Corn/Soybean Meal; RSM = brewers Rice/Soybean Meal; CBY = Corn/dried distillers Brewers Yeast; RBY = brewers Rice/dried distillers Brewers Yeast

[2]FO = Fecal Output (dry matter)

[3]ATTD = Apparent Total Tract Digestibility

Table 3. Intake and digestibility of N and P in growing-finishing pigs

	Treatment[1]					
Item	CSM[1]	RSM	CBY	RBY	SEM	P value
Intake N (kg)	0.054^{d}	0.067^{a}	0.062^{c}	0.066^{b}	0.003	<0.001
Intake P (kg)	0.017^{d}	0.025^{a}	0.021^{b}	0.018^{c}	0.001	<0.001
Fecal N (kg)	0.021^{a}	0.013^{b}	0.019^{a}	0.010^{c}	0.003	<0.001
Fecal P (kg)	0.016^{b}	0.014^{c}	0.019^{a}	0.010^{d}	0.002	<0.001
Digest N (%)	60.442^{d}	79.943^{b}	69.420^{c}	84.443^{a}	5.388	<0.001
Digest P (%)	8.971^{b}	45.167^{a}	11.630^{b}	43.678^{a}	9.870	<0.001

[1]Treatments: CSM = Corn/Soybean Meal; RSM = brewers Rice/Soybean Meal; CBY = Corn/dried distillers Brewers Yeast; RBY = brewers Rice/dried distillers Brewer's Yeast a-d; Means within a row with different superscripts differ ($p<0.05$)

A better gain to feed ratio for pigs fed BR based diets compared with corn can be attributed to greater ADG since feed intake was the same across diets. Although intake of N and P was greater for pigs fed BR based diets, pigs fed corn based diets excreted more N and P in the feces. Diet modification BR and replaced corn and SBM, respectively, may have resulted in greater N and P digestibility and reduced excretion in the feces.

3.1. Implications

Results of this study further confirm that diet modification to include highly digestible plant based feedstuffs remains a viable option that can reduce excessive excretion of feed nutrients, notably N and P. Furthermore, significant reduction in fecal N and P is a boon and adds value to efforts aimed at reducing environmental pollution caused by manure generated through intensive swine and poultry operations.

4. CONCLUSION

Brewers rice and dried distillers brewers yeast can replace all corn and soybean meal, respectively, in diets for growing-finishing pigs and reduce fecal DM output and fecal loss of N and P with no negative effects on animal growth and productivity. In this study, brewers rice/dried distillers brewers yeast based diets may have provided animals with highly digestible nutrients and less manure, contributing to reduced environmental pollution. However, the superior performance of brewers rice and dried distillers brewers yeast over corn and soybean meal, respectively, may need further investigation to determine the effect of diet on carcass quality and other characteristics including eating attributes.

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