MISSISSIPPI STATE UNIVERSITY™

Animal and Dairy SCIENCES

2014 ANNUAL DEPARTMENTAL REPORT

J. Parish, J. M. Graves, and S. H. Ward
ANIMAL AND DAIRY SCIENCES | MISSISSIPPI STATE UNIVERSITY

Table of Contents

EXTENSION AND OUTREACH

From the Department Head

To: Livestock Producers, Industry Leaders, Alumni, and Friends of the Department:

The Department of Animal and Dairy Sciences would like to thank all of our stakeholders and partners for their support during 2013/2014. This has been a great year for us as the faculty and students in Animal and Dairy Sciences continues to grow with the addition of two new faculty and record enrollment of more than 300 undergraduate students and 15 graduate students.

Last year, the Department incurred over $1 million in externally funded research expenditures that resulted in 30 refereed journal publications, 15 presentations at national and international meetings, publication of 3 book chapters and 33 extension reports. I am very proud of the Department's research and extension programs and the economic impact that they have on the state of Mississippi. Included in this report are summaries of some of these efforts, for your information. Additionally, you will see the outcomes of our research and extension activities at many statewide, regional, and national events in the coming months. We want our programs to continue to support the growth of the animal agriculture industry in the state of Mississippi and the Southeast region, therefore, we look forward to receiving input from you on the future direction of these programs.

To ensure that our students receive the highest quality education and that we conduct meaningful research, the Department welcomed two new faculty members. Dr. Thu Dinh, a meat scientist, originally from Vietnam who brings a great deal of experience in flavor and food chemistry to the department. In his first year, Dr. Dinh has been successful at obtaining national and international recognition. In fact, one of his first graduate students, April McCain, received a Borlaug Scholarship to complete her thesis research on quality of meat products in Vietnam markets. April is spending this academic year in Vietnam completing her research and you can follow her experiences on our Animal and Dairy Sciences blog. Just before the end of 2014, Dr. Clay Cavinder also accepted the Equine Extension Specialist position in our department. Dr. Cavinder has more than a decade of experience in the equine industry and brings a wealth of knowledge about stock and performance horses to this position. Dr. Cavinder is not a stranger to our equine clientele in the state and we look forward to the programs and relationships he will build and strengthen in the Mississippi equine industry.

Again, the Department of Animal and Dairy Sciences appreciates all of the support we have received from you throughout the year and we look forward to future opportunities to serve you. Feel free to contact any of us if you have questions or desire additional information. We value your interest and support and welcome you to visit the department anytime.

John Blanton, Jr.
Professor and Head
Animal and Dairy Sciences

New Faces in Animal and Dairy Sciences

Dr. Thu Dinh joined Mississippi State University as an Assistant Professor of Meat Science at the Department of Animal and Dairy Sciences in January 2014. His interest in meat science was generated from an internship at a meat processing company in Vietnam, where he performed duties of a food engineer. He received an M.S. in Food Technology in 2006 and a Ph.D. in Animal Science in 2010, both with an emphasis in Meat Science, from Texas Tech University. His research at Texas Tech University involved many aspects of meat science from shelf life and sensory evaluation of fresh meat products to the nutritional composition of meat and poultry. He undertook a major role as an analytical chemist and a meat scientist in the beef flavor precursor projects at Texas Tech University, funded by the National Cattlemen's Beef Association from 2011 to 2013. At Mississippi State University, Dr. Dinh's research focuses will be the oxidation of lipid and protein in meat and various effects of oxidation on meat flavor, tenderness, and nutritional composition. He is also interested in developing and validating analytical methods for meat science research. He will be teaching various courses in meat science, including the Introduction to Meat Science and the Advanced Science of Muscle Foods.

Dr. Clay Cavinder is an Associate Professor in the Department of Animal and Dairy Sciences. As of January 2015 he is the State Extension Equine Specialist for Mississippi and also holds a teaching appointment. From 2006-2014, he was on faculty at Texas A&M University in College Station where he held an appointment with teaching and research. At A&M he taught numerous undergraduate courses, was the Horse Judging Team coach, and was a member of the graduate faculty, focusing on how nutrition and exercise affect reproductive efficiency of both the stallion and mare.

Clay grew up on a horse and cattle ranch in southeast Oklahoma where his family raised and bred halter and performance horses while also running a small cow/calf operation. As an undergraduate, he was a competitive member of the horse judging teams at Northeastern Oklahoma A&M College and Oklahoma State University. After completing his intercollegiate eligibility, he coached the horse judging team at NEO A&M from 2000-2003 and Texas A&M from 2003-2014.

Clay also judges professionally holding breed cards with the AQHA, APHA, PHBA, NRHA, ApHC and NSBA. He has had the pleasure of judging throughout the United States, Canada, Europe and Australia. Major shows that he has judged include the APHA World Show, PHBA World Show, the ApHC Nationals, ApHC Youth World and the Reichert Celebration.

Clay enjoys training 2 and 3 year old horses for events in Reining, Cowhorse, and Ranch Horse Pleasure. He has been active in teaching riding clinics in the U.S. and Europe.

Departmental Scholarships

J. E. Larson
Department of Animal and Dairy Sciences, Mississippi State University, MS

Introduction

The Department of Animal and Dairy Sciences has always had a rich tradition of presenting scholarships to a large number of worthy students. Scholarships awarded for the 2014-2015 academic year were no exception due to generous alumni and former faculty members. Incoming and current students submitted applications which were reviewed and scholarships were awarded at the Animal and Dairy Sciences' Spring Banquet.

Scholarship applicants answered a variety of questions about interests, activities, goals and academic performance. The various scholarships the department offered have a variety of specifications, so the scholarship committee worked hard to match the scholarship with the most deserving student. The majority of scholarships were awarded to current undergraduate students, but several were presented to incoming students.

Outcomes

Both incoming students and current students were eligible to apply for departmental scholarships. Application forms, located on the departmental website, were completed by students and submitted either electronically or by hard copy to the scholarship chairperson. Scholarship applications were due February 1, after that date the scholarship committee, composed of departmental faculty, reviewed and evaluated the applications. Recipients were announced at the Animal and Dairy Sciences' Spring Banquet.

The department awarded approximately $22,000 in scholarship money. Twenty-six undergraduate scholarships were awarded. The following list is the scholarships awarded and recipients:

- *ADS Judging Team Scholarship* – Michael Buckley
- *Bryan and Nona Baker Endowed Scholarship* – Emily Beaty and Blair Fleming
- R*ev. and Mrs. William Page Brown Memorial Scholarship* – Ayla O'Neal
- *Miles Carpenter /Bill McGee-Higgins Endowed Scholarship* – Kaitlyn Junkin
- *Mark Crenshaw Scholarship* – Katie Cagle
- *Billy Gene Diggs Memorial Scholarship* – Elizabeth Orr
- *Janice McCool Durff and Alma McCool Liles Scholarship* – Courtney Fancer, Erin Doll, Rebecca Hilderbrand, Samantha Eder, Parker Adams, Moriah Lorge, and Andrea Seitz
- *Fuquay Endowed Scholarship* – Hailey McGuire
- *Henry H. Leveck Memorial Scholarship* – Ethan Sutherland and Thomas Waldrip

- *Glenn McCullough Scholarship* – Rachel Wilson
- *Mississippi State Equine Association Scholarship* – Trusten Moore
- *Rodney Moore Scholarship* – Destiny Winkler
- *Enoch Norton Endowed Scholarship* – Jessica Cowley and Carrie Abel
- *Dero and Adelaide Ramsey Scholarship* – Sydney McConnell
- *W. L. Buddy Richmond* – Nancy Davis
- *Linda "Big Lou" Schuerer Scholarship* – Olivia Cesnik
- *O.W. Scott Memorial Scholarship* – Emerald Ford

Implications

Scholarships provide deserving students the funds necessary to pay tuition, purchase books and help defray living expenses. As the cost of education continues to rise, scholarships play a critical role in paying for higher education. Also, scholarships offer a way to compensate students for their hard work in the classroom and their involvement on campus. If you are considering making a donation to the scholarship fund, please contact the department for more information.

ADS Curriculum Update

J.M. Graves
Department of Animal and Dairy Sciences, Mississippi State University, MS

Introduction

As the world's population continues to grow, the global demand for quality food and fiber products also continues to increase. The Department of Animal and Dairy Sciences at Mississippi State University recognizes the need to provide the agriculture workforce with individuals who can positively contribute to meet the needs of the agriculture industry. Our undergraduate curriculum has recently been reviewed and modified to better foster a learning environment where students not only gain discipline knowledge, but also experiences that will more adequately prepare them to be positive leaders in agriculture. The revised curriculum is designed to provide students with academic and experiential learning while also allowing them the flexibility to tailor their academic program by taking courses that best prepare and support their professional goals.

Outcomes

In a recent survey, students and employers identified the educational needs that would better prepare those entering the workforce. Among the critical educational needs were communication (written and oral), soft skills (critical thinking, teamwork, and leadership) and experience/hands-on skills. Students in the Department of Animal and Dairy Sciences are challenged to think critically and exercise knowledge of discipline content through scientific writing, presentation and practical application. One of the most significant changes to the new curriculum is the requirement of all students to complete 3 credit hours of

"Experiential Learning". Examples of how a student may fulfill this requirement include: an internship, undergraduate research, study abroad, or national student exchange.

ADS student participating in the Kentucky Equine Management Internship (KEMI) program.

Students may also choose to get experience in more than one of these areas. It is anticipated that during a student's participation in an experiential learning activity, they will also strengthen the soft skills needed to be successful. In addition to learning opportunities outside the classroom, the Department is incorporating more communication and soft skills training in the classroom through the use of group projects, oral presentations and various writing assignments which all challenge the students to articulate their thoughts clearly and concisely. Furthermore, the Department will adopt a service-learning component in courses where appropriate. This would provide students with the chance to work closely with community (industry) partners where they learn business and production management strategies from those in the livestock industries. Additionally, service-learning partnerships allow the Department to develop and strengthen

relationships with those in the livestock industries.

There are 300+ students majoring in Animal and Dairy Sciences (ADS) and approximately 79% follow the Science/Veterinary Science concentration. The majority of these students have ambitions of one day becoming veterinarians, thus the curriculum is designed to provide these students with an educational experience that will equip them with a sound knowledge in the sciences along with animal handling skills needed to be successful if they are afforded the opportunity to pursue their dream of becoming veterinarians. The Department's hands-on teaching approach allows students with limited experience to become more familiar with animal handling techniques and management practices for various livestock species.

Many of the Pre-Vet students change their career goals as they progress through their academic career. Therefore, the Science/Veterinary Science option is designed to enable students to be competitive for careers in the pharmaceutical, feed and chemical industries, qualify for medical, dental, nursing or pharmacy school or continue on for a graduate degree. The remaining students in the Department are more production focused individuals who have a desire to pursue careers in industry or continue in a graduate education program. During the curriculum review, the Department saw a need to increase flexibility for students in their academic program. Each student's background and personality are equally as different as their career aspirations, thus we believe that allowing students to tailor their academic program with coursework that relates to their specific career goals, will create a learning environment in which students are motivated to excel. Students will now have the option to choose from one of the following concentrations: Business & Industry, Production Management, and Science/Veterinary Science.

ADS students working in nutrition laboratory.

Implications

As the global population continues to increase, the agricultural community also has to advance in order to meet the consumer demands for quality food and fiber products. The Department of Animal and Dairy Sciences has many young faculty investigating new ideas and technologies in the areas of reproduction, nutrition, genetics, muscle growth and meat science in an effort to help livestock producers maximize their profitability. Students who choose the Department of Animal and Dairy Sciences as their major, will surely find a place that will prepare them to be the next generation of leaders in agriculture.

For those interested in providing internship opportunities for ADS students or for additional information about our educational programs, please contact Ms. Jessica Graves, Undergraduate Coordinator, at jessica.graves@msstate.edu.

Re-establishment of Livestock Judging Team

B. Crow
Department of Animal and Dairy Sciences, Mississippi State University, MS

Introduction

Mississippi State University is in the process of re-establishing a livestock judging team. In January 2013, Brett Crow joined the MSU faculty as the new livestock judging team coach and began the process of building a judging program. Fund-raising, recruiting and practicing is underway with the team having competed in its first contests during the spring 2014 season.

The MSU livestock judging team is open to students from any department or college on campus but is already shaping up to be heavily comprised of Animal and Dairy Science majors. The livestock judging team is a competitive team that travels the scope of the U.S. to practices and contests. Students have the opportunity to attend the country's most prestigious livestock shows and judging contests and visit premier farms and ranches thus developing a network with the nation's leaders in livestock production. Life-long friendships and the ability to work extensively with others are among many skills that come from being a part of a competitive livestock judging team. Students develop the ability to make quick decisions and defend them with logic and also polish their public speaking skills. Clearly, team-members gain an in-depth understanding of the livestock industry and hone skills that prepare them to make a positive impact on its efficiency. However, many of the traits developed through being a part of the team improve their lives on a personal level and serve them well in a variety of occupations.

An "interest meeting" was held in September 2013 as a way of gathering students who wanted to learn more about the new judging program. The meeting was promoted campus-wide. During the meeting, the coach's expectations of team regarding time commitments, grades and dedication was discussed along with other generalities about contest and team dynamics for those students less familiar with collegiate judging. Mr. Crow visited other club meetings within the Department of Animal and Dairy Sciences in an effort to promote participation in the livestock judging program. The students who committed to be on the judging team began practicing locally during the fall semester to get familiar with the program and to begin preparing for competitive season. In October 2013, the team also volunteered to help with the Town Creek Farms Bull and Female Sale in West Point, MS in exchange for a donation to support team travel. The team also assisted with the Tanner Farms Bull Sale in Shuqualak, MS and received a donation for their efforts. The MSU livestock judging team travel season began in December 2013. The team traveled to Griswold Cattle Company in Stillwater, OK and Express Ranches in Yukon, OK for practices. In January 2014 the team traveled to contests in Lincoln, NE as well as the National Western Stock Show in Denver, CO. February was a busy month as the MSU team being responsible for hosting the Dixie National Judging Contest in Jackson, MS.

February also included a trip to the Intercollegiate Livestock Judging Contest at the San Antonio Livestock Exposition in San Antonio, TX. In March 2014, the team traveled to Houston, TX to compete at the Houston Livestock Show and Rodeo. The spring season of competition ended at the "All East" contest which was hosted in April in West Lafayette, IN. Throughout the summer 2014, Mr. Crow traveled to livestock shows throughout Mississippi, Alabama, Georgia and Tennessee promoting the judging program. In a recruiting effort, he also attended the State 4-H Livestock Judging Contest in Alabama as well as the State FFA Convention in Mississippi and Mississippi 4-H Club Congress serving as a judge in various contests. Mr. Crow served as an instructor at the 2014 Northwest Georgia Youth Judging Camp as a means of spreading the word about the resurgence of MSU's livestock judging program. He then hosted a youth livestock judging camp in Auburn, AL which gathered participants from all across Alabama and Georgia. Furthermore, two separate judging camps were hosted on the MSU campus in the summer of 2014 as well. Youth from across Mississippi, Louisiana, Alabama and Georgia participated in a three-day camp that taught advanced livestock evaluation skills. Junior 4-H members as well as coaches and volunteers attended a day camp that developed basic judging skills in youth as well as coaching techniques in adult attendees.

The competition Process

Students interested in being a part of the judging program are eligible regardless of prior livestock judging experience. They are encouraged to enroll in *ADS 4212 Livestock Evaluation* as an introduction to livestock judging and *ADS 4232 Advanced Livestock Evaluation* during the time in which they are actively participating on the judging team. The upcoming team spends the fall semester attending local practices and determining if they wish to begin the competitive season as a member of the team. Those students who decide to become a part of the group begin traveling to contests during the spring semester and return that Fall to complete their final season of eligibility.

Outcomes

Judging Team Contests and Participation

Although initial interest in participation on the livestock judging team was high, several students decided to wait at least one year to be on the "traveling team" while others decided the time commitment of being on a competitive team would not match their schedules. The competitive season began with MSU having an incomplete team, so those individuals competed individually throughout the spring 2014 season. The spring season was rewarding with one student finishing among the top twenty high individuals in placing classes at the National Western Stock Show. Two team members ended the spring season with top ten individual finishes at the "All East" contest. Those students continued to stay engaged in learning and building the judging program during the summer of 2014 by helping host judging camps. Fall enrollment in *ADS 4212 Livestock Evaluation* has doubled when compared to that of the spring 2014 semester, and the number of students who have committed to be on the 2015 team is twice that of current participation.

Summer Camps

The 2014 summer camps were a success. Sixteen participants attended Mr. Crow's judging camp in Auburn, AL. Attendees represented counties from across Alabama and Georgia. Many of the participants have expressed interest in attending MSU. Half of the top-ten high individuals in the 2014 Alabama State 4-H Livestock Judging Contest participated in Mr. Crow's camps. The two camps held on the MSU campus were also a major accomplishment. Eighty-seven participants from across Mississippi, Louisiana, Georgia, and Alabama were present to learn more about livestock evaluation and get a glimpse of what MSU has to offer. Total participation was up 53% from the previous year. State champion teams from all four of the states mentioned above were represented at the camp.

Students at MSU three-day camp learn to judge market lambs

MSU three-day campers

Implications

The resurgence of the MSU livestock judging team is a very important part of adding practical application to many of the concepts taught in the Department of Animal and Dairy Sciences. It serves as a way to promote and develop critical thinking skills, something that employers have recently identified as being vital for those entering the workforce. Livestock judging provides industry networking and professional development which enhances career opportunities for participants. The steps taken in 2014 have already boosted interest in the livestock judging program among current and future students. Generating an interest among the student body as well as effective recruiting efforts will serve as a vital part of building the MSU livestock judging program.

Mississippi State University Equine Club and Teams Annual Update

M.C. Nicodemus
Department of Animal and Dairy Sciences, Mississippi State University, MS

Introduction

An indispensable part of educating students is submersing them in the industry through the equine clubs and teams at Mississippi State University. Students with an equine interest have had a fruitful year of learning and networking. In addition to the 9 different equine courses offered multiple times during the year, Animal and Dairy Sciences students have the opportunity to participate in multiple extracurricular organizations focused exclusively on the equine industry. These include the Horseman's Association, Equestrian Team, and Horse Judging Team. Mississippi State University remains the only college in Mississippi to offer these groups in addition to a Stock Seat Equestrian Team. Furthermore, with the addition of an eventing team this year, MSU will also be the only college in Mississippi competing in the Intercollegiate Eventing League. The Horseman's Association was started in 2002 as an equine club for students to get involved in the statewide equine industry. The club is setup as a parent organization for the MSU Equestrian Team. Since 2002, the club has offered clinics, trail rides, and seminars along with volunteering statewide at various equine events. Club members hold fundraisers to support travel and participation in various equine events for the members including support of the equestrian team. Dr. Molly C. Nicodemus, Associate Professor in the Department of Animal & Dairy Sciences is the advisor for the MSU Horseman's Association.

Horseman's Association 2013-2014 Officers at the ADS Spring Banquet (left to right): Julie Cunningham (Treasurer), Emma Stamps (Vice President), Dina Allen (President), and Emerald Barrett (Secretary).

As the team approaches 15 years of competition, it has a proud history of being the first and longest running Intercollegiate Equestrian Team in Mississippi. It is also the only Mississippi Intercollegiate Equestrian Team with students competing in Stock Seat classes. The team was the first to represent Mississippi at the Intercollegiate Horse Show Association (IHSA) Regionals, Zones, and Semi-Finals. The team's successful history includes multiple high point awards and qualifying multiple riders for IHSA Nationals. During the years of competition, the team has competed against schools from Kentucky, Tennessee, Georgia, and Alabama. Dr. Nicodemus is the MSU Equestrian Team's advisor and coach.

To be a strong rider, the student must also understand the performance of the horse which makes the horse judging team a vital component of developing the horsemanship skills of MSU students. The Mississippi State

University Horse Judging Team is one of only a few intercollegiate horse judging teams that has consistently represented the Southeast at some of the major intercollegiate horse judging contests and is the only horse judging team in Mississippi. The team has successfully represented the Southeast, Mississippi, and Mississippi State University since 2001 at nationally recognized competitions. This rich history includes multiple National and Reserve National Championships, and with the support of the Department and ADS Alumni, the team has competed at the Grand National & World Championship Morgan Horse Show, American Quarter Horse World Championship Show, All American Quarter Horse Congress, U.S. National Arabian & Half-Arabian Championship Horse Show, National Reining Horse Association Futurity & Championship, American Paint Horse Association Intercollegiate Horse Judging Spring Sweepstakes, National Appaloosa Horse Show & World Championship Appaloosa Youth Show, Middle Tennessee State University Intercollegiate Horse Judging Contest, and North American Colleges and Teachers of Agriculture Collegiate Horse Judging Contest. Dr. Nicodemus is the advisor and coach of the Horse Judging Team.

Membership for the Equine Organizations

Membership in any of the Mississippi State University Equine organizations is open to any full-time student at Mississippi State University. Alumni of the Horseman's Association and Equestrian Team are welcome to continue participation in some of the activities and are encouraged to contact the advisor of these organizations for specifics concerning Alumni participation. While students do not have to major in Animal & Dairy Sciences to participate in these equine organizations, students interested in equine scholarships will need to be an ADS major.

While a formal tryout is not a requirement for any of the teams, an assessment of student's skill levels by the coaches is expected at the beginning of the competition season along with practices throughout the season. Experience in competing is not required, but students should have some background in equine, and of course, an interest in learning more about equines. Equine courses offered through the Department can assist a student with limited to no background in equine. Students are encouraged to visit with the coaching staff to determine courses and activities that may strengthen the student's abilities for being competitive on the different teams. Along with equine courses, participation in the Horseman's Association and their respective club activities will also assist in developing equine knowledge and skills needed for team members.

Membership in the Equestrian Team requires students to be active members in the Horseman's Association which includes attending meetings, social and fundraising events and volunteering for equine activities, such as, as the Bulldog Classic Spring Quarter Horse Show at the Mississippi Horse Park in Starkville, Mississippi and the Dixie Nationals Quarter Horse Show at the Mississippi Fairgrounds in Jackson, Mississippi. For both the Horseman's Association and the Equestrian Team, horse ownership is not a requirement. Neither organization requires students to enroll in an equine course, but equestrian team members are encouraged to enroll in an equine riding laboratory course for practices working directly with the coaching staff. These courses include ADS 1132 Introduction to Horsemanship, ADS 2312 Advanced Horsemanship, and ADS 3233 Equine Assisted Therapy.

Stock Seat Team members at Berry College IHSA Stock Seat Show (left to right): Jeneva Seidl (2014-2015 Stock Seat Team Captain and HA Treasurer), Katie Roper, and Emma Stamps (2013-2014 Team Co-Captain and HA Vice President).

While being a member of the Horseman's Association is not a requirement, membership is encouraged for the Horse Judging Team as it gives members access to professionals in the show industry. Team members are also encouraged to enroll in an equine evaluation course. These courses include ADS 2102 Equine Conformation & Performance Evaluation and ADS 2122 Advanced Equine Evaluation. Special topics and Directed Individual Study courses may be offered to students where appropriate. Club and course activities aid the students in the development of their equine knowledge and evaluation skills. Students involved in clubs, courses and teams have the opportunity to travel to various equine shows to practice judging horses.

Callie Cornelison, ADS senior, Horse Judging Team member and 2014-2015 Assistant Horse Judging Team Coach, practicing at All American Quarter Horse Congress.

Competing on the Teams

For members to qualify for competition, they must sign up through their respective coaches and the coaches will determine their eligibility. Although Dr. Nicodemus coaches both the equestrian and horse judging teams, she is assisted by various individuals from the University and the equine industry. The Equestrian Team has captains that assist the coach during the competition season with the 2013-2014 Co-Captains being Ms. Emerald Barrett and Ms. Emma Stamps. Both captains were officers of the Horseman's Association, and thus, assisted in determining whether members met the requirement of active club membership for the team. In addition, local horse trainers and owners assisting with the coaching of the team for 2013-2014 competition season included Ms. Betsy Ball, Mrs. Beverly Jones, Mrs. Pam Cunningham, and Ms. Amanda Youngblood. As for the horse judging team, assistant coach for the horse judging team was undergraduate teaching assistant, Ms. Dina Allen. Ms. Allen is the President of the Horseman's Association and has worked as a show secretary and manager for AQHA and NRHA shows. ADS alumni and horse judging team alumni, Ms. Youngblood, assisted with the team horse judging clinic hosted at C-Bar Stables.

Amanda Dendis, MSU undergraduate student, at the Berry College Hunt Seat IHSA Show riding in her rail class.

Currently, MSU does not host Intercollegiate equestrian and horse judging competitions, thus the teams travel to various competitions outside of Mississippi to compete. These competitions are sponsored by other Universities and/or equine organizations. While no horses or tack are required for the teams, competitors are expected to provide their own show and judging attire. Travel is coordinated by the team coach and those individuals assisting with the team so transportation is also not a requirement for team members. Team members are expected to compete for both individual awards and team awards. Departmental funding is limited for the teams, so the students rely on fundraising activities to support travel and related cost.

Outcomes

Horseman's Association membership consisted of around 25 members that qualified as "active members". Active membership required volunteering for at least 8 hours of equine events and attendance of at least 6 club meetings. Meetings consisted of guest speakers from the equine industry including Dr. Gettinger, Mrs. Pam Cunningham, Mr. Rob Seal, and Mr. Tom McBeath. As for volunteering, club members had a busy year assisting with the Better Barrel Races Southeastern Regional Finale, Mississippi Quarter Horse Association Dixie Nationals Horse Show, and the Mississippi State University Quarter Horse Bulldog Classic. Members finished off the year hosting a basic horsemanship clinic with trainer Mr. Ronald Sullivan. Club officers were President Ms. Dina Allen, Vice President Ms. Emma Stamps, Treasurer Ms. Julie Cunningham, and Secretary Ms. Emerald Barrett.

This year, the winning tradition for the equestrian team continued with the team traveling to Berry College in Rome, Georgia both in the fall and spring semesters to proudly represent their school bringing home multiple ribbons in both Hunt Seat and Stock Seat classes. During the fall competition, the team brought home a 5th and 6th place ribbon in the Western Rail division, 5th place ribbon in the English Rail division, and 2nd place ribbon in the English Over Fences division. As for the spring competition, the team brought home a 2nd place ribbon, two 3rd place ribbons, and a 4th place ribbon in the Western Rail division and a 7th place in the English Over Fences division. The team was represented for the 2013-2014 show season by Emma Stamps, Katie Roper, Kristina McKay, Amanda Dendis, Erin Doll, Jeneva Seidl, and Ashley Palmer.

Jeneva Seidl, 2014-2015 Stock Seat Team Captain and Horseman's Association Treasurer, representing MSU at Berry College Stock Seat IHSA Show.

In October, both the Equestrian Team and MSU Horse Judging Team traveled across state lines to compete against other Universities in intercollegiate competitions. The horse judging team went to All American Quarter Horse Congress in Columbus, Ohio for the first time in the history of the team to compete in the largest intercollegiate horse judging competition in the United States with a total of 158 entries for the collegiate division. Team members represented MSU in both the Limited and Junior Divisions. Individual Top Ten Awards were brought home by Cori Webb placing 5th in the Limited Performance Division and Taylor Poe who tied for 10th Overall in the Limited Division. These individuals placed higher than many students from well-known equine programs. Team Top Ten Awards were brought home by our Junior Team consisting of Lauren Hildebrand, Samantha Miller, Destiny Winkler, and Katherine Cagle. The team won 6th in Halter, Performance, and Reasons, and thus, won 6th Overall in the Junior Division. Special thanks were given to last year's team members: Mr. Tommy Ware, Ms. Chelsey Smith, Ms. Kelsey Hart, and Ms. Karley Parker for listening to oral reasons; ADS alumnus, Mrs. Amanda Youngblood, for assisting with the practice judging clinic; and ADS senior, Ms. Dina Allen, for assisting with coaching during practices and competition.

Horse Judging Team at the All American Quarter Horse Congress practicing before the Intercollegiate Horse Judging Competition.

With the New Year approaching, the goal for the club and teams is to grow and to bring in new experts from the industry to assist with making each organization even stronger. While the President of the Horseman's Association, Ms. Dina Allen, will remain the same, a new group of officers have been voted in and with these new officers comes new speakers, clinics, and other equine activities. Along with Ms. Allen, the 2014-2015 club officers will be Vice President Ms. Courtney Fancher, Secretary Ms. Savannah Reily, and Treasurer Ms. Jeneva Seidl. As for the Equestrian Team, Ms. Allen will be stepping in as Assistant Coach of the Stock Seat Team and new captains include Ms. Ashley Palmer, Hunt Seat Team Captain, and Ms. Jeneva Seidl, Stock Seat Team Captain. The judging team will continue to have Ms. Allen assist with the coaching responsibilities and Ms. Callie Cornelison, ADS senior and former horse judging team member, will be also assisting with coaching the team. A part of the growth of the equine extra-curricular activities includes the development of an eventing team to compete in the Intercollegiate Eventing League making Mississippi State University one of the few schools in the Southeast to offer this type of competitive team. Dr. Nicodemus is the advisor for the team and Ms. Betsy Ball, trainer

of Redbud Farm, is the coach. For students interested in becoming club and/or team members and learning more about equine scholarships, contact Dr. Nicodemus.

Stock seat team members showing off their ribbons at Berry College with 2014-2015 Hunt Seat Team Captain Ashley Palmer (left).

The club and team activities would not be possible without local supporters of the Equine program. A recent donation to the program is a registered Oldenburg mare, from Midway Farms of Alabama, to be used for University riding courses including those courses used for equestrian team practices. Individuals interested in donating to these equine organizations can contact Dr. Nicodemus in the Animal & Dairy Sciences department.

Acknowledgements

The author would like acknowledge the assistance of Ms. Dina Allen and Ms. Emma Stamps in finding photos for this manuscript and supplying information about their respective organizations and their activities. Their leadership in these organizations has been instrumental in the success of the equine program.

Contact Address:

Dr. Molly C. Nicodemus
Department of Animal & Dairy Sciences
Mississippi State University
Box 9815
Mississippi State, MS 39762
662-325-9271
mnicodemus@ads.msstate.edu

Equine Summer Course: ADS 3223 Horse Management

M.C. Nicodemus
Department of Animal and Dairy Sciences, Mississippi State University, MS

Introduction

The Department of Animal & Dairy Sciences offers 5 equine courses in the fall and 6 equine courses in the spring, however, it has never offered a summer equine course for students to take until the 2014 summer semester. *ADS 3223 Horse Management* is usually offered in the spring semester and has traditionally been the equine course with the largest enrollment with the course usually reaching maximum enrollment of 35 students. This course instructor is Dr. Molly C. Nicodemus, Associate Professor in the Department of Animal & Dairy Sciences.

According to the 2013-2014 MSU Undergraduate Bulletin, the course description for *ADS 3223* is "breeding, feeding, management, and training of horses" with the course lectures and laboratories designed to meet these objectives. The course is set up as a two credit hour lecture and a one credit hour laboratory with the lectures meeting in the spring on Thursdays from 8-9:50 am at the Wise Center and laboratories on Tuesdays from 8-9:50 am at the Mississippi Horse Park and MAFES Horse Unit. Topic areas covered in lecture include horse industry and careers, facilities design and management, color genetics, breed identification, horse behavior, gait production and lameness evaluation, health care and management, nutrition, and equine reproduction. Topic areas covered in laboratory include facility assessment, color and breed identification, behavior assessment, use of tack and grooming tools, dental evaluation, lameness assessment, body condition scoring, hoof care, stallion and broodmare care and management, vaccinations and de-worming, and wound care and management.

ADS 3223 Horse Management laboratory at the Horse Unit determining body condition scores.

During 2014 summer, *ADS 3223* was offered for the 10-week term. Course times and days were listed on Banner as TBA so that the class meetings could be set up according to the students' schedules. Lecture topics were similar to what was covered in the spring with the students meeting at the Wise Center. Similar to the spring semester, two exams were required and lecture quizzes were given at each class meeting. Since no additional equine courses were offered during the summer, it allowed for more flexibility in the use of the horses and the facilities, and thus, the laboratory was set up differently than what had been done in the spring semester. Laboratories were individually designed to meet the needs of each student with students giving input on what areas of equine management they needed work on or wanted to expand their knowledge. The instructor and graduate teaching assistants, Ms. Toree Bova and Ms. Lauren Hodge, set up multiple laboratories each week at various locations with students selecting which laboratory they wanted to participate in

depending on the student's schedule and the topic being covered. Although more than 60 hours of laboratories were offered throughout the summer semester, only 30 hours of laboratory were required for the students to complete within the 10 weeks. Students were required to develop a laboratory report for each laboratory and turn in their reports at the midterm and final point of the semester. Along with completion of laboratory hours and the associated reports, students were required to select a topic based on laboratory activities and put together an informational brochure or pamphlet to present to their classmates at the end of the semester.

Outcomes

Student enrollment for *ADS 3223 Horse Management* during the summer was 12 students. The course did not require a prerequisite, and thus, the students enrolled in the summer course included sophomores, juniors, and seniors with the majority being Animal & Dairy Sciences students. Other majors enrolled in the summer course included Agricultural Science and Ag Information Science. Many students chose to enroll in *ADS 3223* while also completing other summer courses. Half of the students enrolled had not previously taken an equine course, however, this particular course was beneficial to all as it allowed each student to fulfill course requirements for his or her academic program.

ADS 3223 Horse Management laboratory at the CVM equine clinic assessing lameness with Dr. Robert Linford.

No prior horse experience was required for the course, and thus, 3 out of the 12 students had less than a year's worth of horse handling experience. Students with prior horse experience had been involved in 4H, FFA, breed associations, Pony Club, and intercollegiate equine teams. Student experience varied when it came to horse breeds with the greatest number of students in the summer course having experience working with English breeds.

As a part of their laboratories, students worked during the summer with Extension agents, veterinarians, University farm staff, researchers, graduate students, and local equine professionals. Students had the opportunity to attend state and nationally recognized horse shows working with equine professionals from all over the United States. Various horse breeds were utilized during the laboratories including miniature horses, pony breeds, gaited horses, European breeds, and stock-type breeds. While the spring semester focused exclusively on handling adult horses, the majority of the summer laboratories concentrated on working with younger horses. Laboratory topics were similar between spring and summer semesters, except for the inclusion of basic riding and training activities and

feeding and daily management activities that were only covered in the summer semester. Students were asked at the beginning of the semester to rate their confidence working with horses finding the average score for the class was a 3.5 out of a 5 point scale, and after the completion of the final laboratory, students were asked to re-evaluate their handling abilities finding an increase in handling abilities in all students by ½ point with the average for the class being a 4 out of a 5 point scale.

ADS Horse Management laboratory at the Horse Unit working on imprinting foals.

Along with laboratory hours, exams, and daily quizzes, students had a final project for the summer semester. Through their laboratory experience, students came up with a topic and put together, with the guidance of the instructor, a brochure or pamphlet informing individuals on various equine topics. These topics included dental care, lunging, gaited horse shoeing, skin conditions, grooming techniques, abnormal behaviors, vaccinations, yearling nutrition, weanling sacking out, imprint training, natural horsemanship, and performance horse nutrition and management concerns. These brochures and pamphlets are intended to be used in the future for equine extension activities.

As for the future *of ADS 3223 Horse Management*, the expectation is to offer this course again in the summer of 2015 for the full 10-week summer session along with continuing to offer the course in the spring. Recent modifications have been made to the Department's curriculum, thus *ADS 3223 Horse Management* is to be a three credit hour lecture course beginning spring 2015 with the laboratory component made into a separate course *called ADS 3221 Practices in Horse Care & Management*. The new laboratory course will remain a one credit hour laboratory that will meet two hours per week. Some of the laboratory activities that were only covered in the 2014 summer semester will be included in the new laboratory course. Both the new lecture and laboratory courses will have new prerequisites that will require the introductory animal science lecture and laboratory courses, ADS 1113 and ADS 1121, respectively. Additional equine laboratory courses will be required prior to taking ADS 3221. Suggestions made by the ADS 3223 summer students will be included in the new lecture and laboratory courses offered this spring.

Acknowledgements

The author would like to thank the graduate teaching assistants, Ms. Toree Bova and Ms. Lauren Hodge, for their assistance with scheduling and coordinating summer laboratories along with the help from the Horse Unit Staff, Mrs. Ryann Campbell and Mrs. Jamie Burkhardt. Additional thanks go to the MSU-CVM veterinarians for their care of the laboratory horses and assistance with the laboratories.

Effect of crude protein levels and metaphylaxis on growth and performance of newly received stocker calves

T.J. Braud[1], B.B. Karisch[1], D.R. Smith[2], C.L. Huston[2], S.G. Genova[2]
[1]Department of Animal and Dairy Sciences, Mississippi State University, MS
[2]Department of Pathobiology and Population Medicine, Mississippi State University, MS

Research Summary

The objectives of this study were to evaluate the effects of: (1) metaphylactic antibiotic administration (none or Excede® on arrival); and (2) receiving diet crude protein levels (12% or 18% CP) on respiratory disease incidence, mortality, and growth performance of beef calves received into a stocker calf system. Steer calves (n=244) were stratified by weight and randomly assigned to 20 pens. Treatments were randomly assigned to pen in a 2x2 factorial study design. Cattle were examined daily for signs of BRD and fed once daily (NEg = 0.94 mcal/kg). Cattle receiving metaphylactic treatment were not treated for BRD during the first 7 days; otherwise BRD was diagnosed at the first clinical signs and body temperature greater than 40 °C. Calves were weighed at arrival and every 14 days through day 55 of the 60 day trial. Days-at-risk for BRD was the number of days from arrival until a calf: (1) was first diagnosed with BRD; (2) died; or (3) finished the trial. Overall, 176 calves were treated for BRD over 6,410 days at risk (BRD incidence density = $27.4/10^3$ calf-days). Cattle receiving metaphylaxis were 60% less likely to be diagnosed with BRD (RR = 0.4, P < 0.0001) and every additional 100 lbs at arrival reduced incidence of BRD 45% (RR =0.54, P = 0.004). Neither diet, nor the interaction between diet and metaphylaxis were significantly associated with BRD incidence. Mortality totaled 32 calves (13%). Neither diet, metaphylaxis, nor incoming BW were significantly associated with risk for mortality. Overall, for the 212 cattle finishing the trial, ADG was 0.72 kg/d. Accounting for metaphylaxis, cattle receiving 18% protein gained an additional 0.19 kg/day (P = 0.008). Metaphylaxis did not affect ADG (P = 0.10). Metaphylactic treatment reduced the incidence of BRD and increasing CP in the receiving ration to 18% resulted in higher ADG.

Introduction

Stocker cattle production is a vital part of the nation's beef industry with the state of Mississippi stockering over 400,000 head annually. Stocker cattle systems add value to recently weaned calves by marketing large groups of uniform sized calves that have received health procedures (e.g. vaccinations, deworming, castration, dehorning) and are better prepared to thrive in confined feeding systems. The stocker phase allows calves to overcome the stresses that are involved with weaning, transportation, and comingling. During this time, calves are at a considerably high risk for bovine respiratory disease (BRD) and other causes of morbidity and mortality.

BRD is the most common and economically detrimental disease of beef cattle post weaning, and there are several management options to consider that aid in controlling this disease. Metaphylactic use of several injectable antibiotics at receiving have decreased the incidence of BRD and improved the overall performance of feedlot cattle (Duff and Galyean, 2007). During this phase, calves

are typically lightweight and stressed from weaning and transportation, which can have negative impacts on the immune system (Sweiger, 2010). In addition, stocker calves are naïve and exposed to a variety of new pathogens. To compound these problems, feed intake is usually low (Cole, 1996). For young, lightweight calves, the combination of stress and reduced intake may potentially increase their susceptibility to infection. Loyd et al. (2011) found that for abruptly weaned heifer calves, first feed consumption did not occur until day 5, and that it took 10.7 days for heifers to consume enough feed to reach their NEm requirement.

Previous investigations of the influence of dietary crude protein (CP) level on BRD morbidity have shown conflicting results. Galyean et al. (1999) pooled the results from 15 trials to investigate and the impacts of receiving diet CP level on BRD morbidity and performance. They found that although morbidity increased with CP concentration, performance was equal to or superior to calves fed lower protein levels. Whitney et al. (2006) concluded that early-weaned steers fed a high level of soybean meal (increased protein level) had an increased febrile response (measured by increased rectal temperature) when challenged with an intra-nasal dose of BHV-1. The combination of these results leads to the question if calves fed higher CP level may be inaccurately diagnosed with BRD, and if the increase in performance is able to offset the treatment costs.

Procedures

All procedures in this study were approved by the Institutional Animal and Use Committee of Mississippi State University (IACUC # 13-070).

This study was a 2 x 2 factorial design with 2 levels of metaphylaxis (none or Excede® on arrival) and 2 levels of dietary protein (12% or 18%). Crossbred steer calves (n=244), purchased through an order buyer, were stratified by weight and randomly assigned to 20 pens with treatment being randomly assigned to each pen. Steers were housed at the Mississippi Agricultural and Forestry Experiment Station H.H. Leveck Animal Research Center located in Starkville, Mississippi. The 60-day trial lasted from September 6, 2013 to November 5, 2013.

Upon arrival at the order buyer's processing facility, the steers were individually identified and vaccinated for IBR, BVD, PI3, and BRSV. Upon arrival at Mississippi State University, calves were weighed, treated, and ear-notched for persistent BVD infection (PI) testing. Steers were blocked by initial body weight and randomly assigned to 1 of 20 pens with 12 steers being housed in each pen. Treatments (metaphylaxis and protein level) were then assigned to each pen. Calves were weighed on arrival and every 14 days through day 55 of the 60-day trial.

Cattle were examined daily on horseback for visual signs of respiratory disease (e.g. nasal discharge, ocular discharge, lethargy, inappetence, coughing, labored breathing). Calves that showed signs of BRD were pulled for further examination. Cattle receiving metaphylactic treatment were not treated for BRD during the first 7 days (post treatment interval); otherwise BRD was diagnosed at the first clinical signs and body temperature greater than 40 °C. Pen riders were blinded to metaphylaxis during the post treatment interval, and BRD was diagnosed and treated by a veterinarian during that time.

Cattle were fed once daily (NEg = 0.94 mcal/kg) at 2.0% of BW of the pen. Diet composition is presented in Table 1. Except for the difference in crude protein, diets were isoenergetic and formulated to meet nutrient requirements based on NRC recommendations.

Feeding levels were recalculated after each weigh day to ensure that each pen was being fed 2.0% of the average weight of the pen. A sample was collected from each new batch of feed and the samples were composited and sent to Cumberland Valley Analytical Services in Maugansville, Maryland for nutritional analysis.

A subset of steers (n=76) were sent to Tri-County Steer Carcass Futurity Cooperative in Lewis, Iowa. Steers were fed to a target backfat of 1 cm and harvested in May and June of 2014. Feedlot and carcass data have been obtained for further analysis.

Statistical Analysis

The effects of metaphylaxis and diet on BRD incidence density were tested by Poisson regression in a generalized linear mixed model. The effects of metaphylaxis, diet, and incoming BW on mortality from all causes were tested in a log-binomial model. The effects of metaphylaxis and diet on ADG were tested in a generalized estimating equations model. All models accounted for clustering by pen and significance was defined at $P \leq 0.05$.

Results

There was no interaction between metaphylaxis and diet ($P > 0.10$), and as such all results are presented separately.

Table 1. Ingredient composition of experimental diets.

Item	Diet 1 (18% CP)	Diet 2 (12% CP)
Ingredient, % of DM		
Corn	43.7	47.3
Cottonseed Hulls	17.7	19.2
Salt	0.4	0.4
Soybean Hulls	7.0	19.2
Limestone	1.3	1.2
Molasses	4.1	4.1
Cottonseed Meal	25.7	8.6

Performance Results

Results for growth and ADG are displayed in Table 2. No difference was seen in initial body weights across all treatments ($p = 0.84$). Final body weight differed ($p = 0.0008$) in regards to diet. Cattle that were fed the 18% CP diet gained an additional 9.2 kg over the 60-day trial. Metaphylaxis did not affect final body weight ($P = 0.10$).

Accounting for metaphylaxis, cattle that received the 18% CP diet gained an additional 0.19 kg/day ($P = 0.008$). Metaphylaxis did not affect ADG ($P = 0.10$). Overall, for the 212 cattle finishing the trial, ADG was 0.72 kg/d. Increasing the level of CP in the receiving ration to 18% resulted in higher final body weight and higher ADG.

Table 2. Effects of metaphylaxis and diet on growth and ADG. *

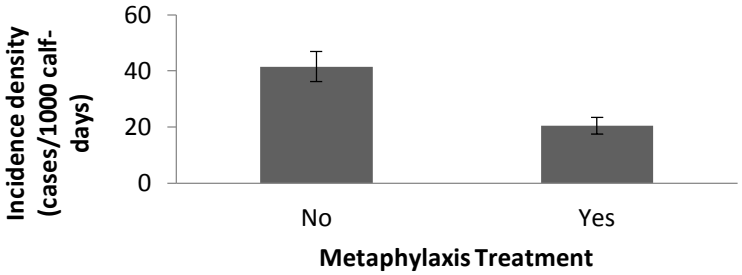
	Treatment					
Item	**12% CP**	**18% CP**	**P-value**	**Excede**	**No Excede**	**P-value**
Initial BW, kg	220.8 ± 17.4	221.1 ± 16.5	0.84	221.3 ± 17.6	220.6 ± 16.2	0.33
Final BW, kg	256.6 ± 30.8	265.8 ± 25.2	0.0008	263.2 ± 28.4	259.1 ± 28.5	0.10
ADG, kg/d	0.62 ± 0.43	0.81 ± 0.36	0.0008	0.74 ± 0.40	0.69 ± 0.41	0.10

***Mean ± standard deviation.**

Health Results

BRD morbidity during the trial totaled 72% with mortality totaling 13%. BRD morbidity was measured as incidence density. Incidence density was calculated as: number of new BRD cases / calf days at risk. Days at risk were defined as the number of days from arrival until a calf: 1) was first diagnosed with BRD; 2) died; or 3) finished the trial. Over the 60 days, 176 calves were treated for BRD over 6,410 days at risk, giving a total incidence density of 27.5 cases of BRD per 1000-calf days. Neither diet, nor the interaction of diet and metaphylaxis were significantly associated with BRD incidence. As shown in Figure 1, accounting for fixed effects of diet, metaphylaxis, and arrival BW, cattle receiving metaphylaxis were 60% less likely to be diagnosed with BRD (RR = 0.4, P < 0.0001).

Figure 1. Effect of metaphylaxis on BRD incidence density.

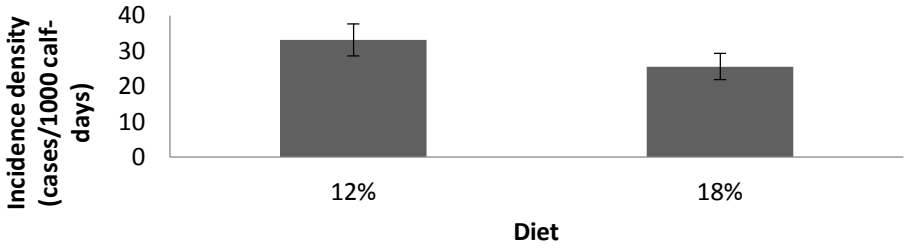


For every additional 45.36 kg at arrival the incidence of BRD was reduced by 45% (RR = 0.54, P = 0.004). Neither diet, nor the interaction between diet and metaphylaxis were significantly associated with BRD incidence (RR = 1.3, P = 0.21), however BRD incidence was 28% greater for those calves fed the 12% diet (Figure 2). Overall, death loss totaled 32 calves. Neither diet, metaphylaxis, nor incoming BW were significantly associated with the risk for mortality.

Implications

As previous research suggested, this study found that metaphylactic treatment reduced the incidence of bovine respiratory disease. Additionally, increasing the level of CP in the receiving ration to 18% resulted in an increase in ADG and an increase in final BW.

Figure 2. Effect of diet on BRD incidence density.



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Effectiveness of Dental-based Beef Cattle Age Estimation

T. F. Best[1], J. A. Parish[1], J. D. Rivera[2], and R. C. Vann[3]

[1]North Mississippi Research and Extension Center, Prairie Research Unit, Prairie, MS
[2]MAFES White Sand Unit, Poplarville, MS
[3]MAFES Brown Loam Branch Experiment Station, Raymond, MS

Research Summary

Despite being a widely used industry practice, there is little information on the effectiveness of dental evaluation for cattle age estimation in modern beef cattle populations in the U.S. This study evaluated 400 crossbred beef cows and heifers at the Prairie Research Unit in August 2014 and 383 of these cattle in September 2013. Age via dental evaluation was estimated in August and September by 3 trained observers along with body condition score (BCS) in August. Cattle were classified by actual age based on birth records as: < 5 yr (YOUNG), 6 to 10 yr (MIDDLE), and > 11 yr (OLD). There was a BCS x age group interaction ($P < 0.01$) in explaining the difference of estimated and actual age. Cattle age overestimation increased as BCS exceeded 6 in YOUNG cattle. Cattle age was overestimated in MIDDLE cattle assigned a BCS of 4 and underestimated at BCS 5 through 9 with underestimation of age increasing beyond a BCS of 7. Underestimation of cattle ages by greater than 1 yr occurred in OLD cattle with BCS 4 or less and 6 or more. Individual animal age was both underestimated and overestimated by as much as 9.5 yr. Across all observers and observation dates, 95.7%, 81.5%, and 62.1%, respectively, of YOUNG, MIDDLE, and OLD cattle age estimates were within 2 yr of actual ages. Decision-making using estimated age should consider the accuracy of this method in the context of age influences on cattle performance and economic valuations of age.

Introduction

It is important to know the age of a beef animal for managing the herd. Many industry-standard cattle performance calculations require knowledge of animal age (Beef Improvement Federation, 2010). Some products applied to cattle, such as growth-promoting implants, have age restrictions listed on their labels. Decisions on when to wean calves (U.S. Department of Agriculture, 2008) and cull cows (Mathews and Short, 2001) typically consider animal age. Past a certain age with advancing age, performance of market cows in feedlots decreases (Pritchard and Burg, 1993; Sawyer et al., 2004), meat quality may decline (Kirton, 1989), and the probability of a cow remaining in production decreases (Mathew and Short, 2001). Cattle age has also been shown to influence market values of animals (Mathews and Short, 2001; Troxel et al., 2002; Sawyer et al., 2004).

Yet documentation of animal age is lacking on many beef cattle in the U.S. (Raines et al., 2008; Parish and Karish, 2013). It has been estimated that less than 5% of the commercial cattle in the U.S. have documentation to prove the actual birth date of the animal (U.S. Department of Agriculture, 2005). In the absence of accurate age records, age is often estimated by looking at the teeth development and wear in cattle (Parish and Karisch, 2013), a practice widely adopted in public cattle auction markets. Information is lacking on the use of dentition for estimating animal age in modern cattle populations within the U.S.

Procedures

The primary objective of this study was to assess the effectiveness of dental evaluation for estimating beef cattle age. This experiment was conducted at the Mississippi Agricultural and Forestry Experiment Station, Prairie Research Unit, located in Prairie, MS. The soil type at the station in acreage utilized for grazing cattle is predominately Houston clay. Primary forages used for grazing cattle in this study were 'Kentucky-31' toxic endophyte-infected tall fescue [*Lolium arundinaceum* (Schreb.)], 'Jesup' MaxQ non-toxic endophyte-infected tall fescue, common bermudagrass (*Cynadon dactylon*), and dallisgrass (*Paspalum dilatatum* Poir.)

Actual birth dates were obtained from calving records retained at the Prairie Research Unit. Other observations were collected and recorded during routine animal processing using proper restraint and handling procedures. Mississippi State University Extension Service Publication 2779, entitled, "Estimating Cattle Age Using Dentition" (Parish and Karisch, 2013), was used as the primary reference observers to study in preparation for assigning ages to cattle using dental evaluation. The observers were allowed to assign 0.5-yr increments of age up to 4.5 yr of age. Ages 5 yr and greater were recorded in whole year increments. A BCS was assigned as the cattle exited the squeeze chute while returning to the holding pens. Body condition score was assessed by using a 9-point scale, with a score of 1 indicating that the animal was emaciated and a score of 9 indicating that the animal was obese (Wagner et al., 1988).

Data collection dates were August 12, 13, 14, 15 and 28, 2014 for the first assessment event (AUG) and September 9, 10, 11 and 12 for the second event (SEPT). At the first observation event, 400 crossbred beef cows and heifers were scored, whereas only 383 cows and heifers, a subset of the initial group, were scored on the second observation event. They were the same heifers and cows with the exception that 17 of the animals used in the first observation event were marketed prior to the second observation event.

Each observer individually recorded each animal's unique identification tag number (ID), body weight, estimated age, and body condition score during the first observation event. At the second observation event, each observer assigned and recorded only animal ID and estimated age via dental examination. The 4-wk interval between observations was intended to prevent observers from recalling initial age assignments that might bias the second assignment of cattle age. The same 3 technicians were used for both observation events.

Incidences of broken-mouth, short and solid, and gummer conditions were recorded. A broken-mouth condition was defined as a bovine mouth in which one or more permanent teeth were missing. A short and solid mouth condition was defined as a state in which all permanent teeth were present but were worn down to approximately half of their original emergence from the gum line. A gummer condition was defined as being present when all of the permanent teeth showed severe wear and barely emerged above the gum line. These teeth appeared peg like in shape and had predominantly only their crowns visible without notable sides showing exterior to the gum surface. For an animal to be recorded as having one of these defined dental conditions, all 3 observers had to agree that the condition was present.

Cattle were classified into age groups based on Beef Improvement Federation guidelines (Beef Improvement Federation, 2010) for age of dam adjustment year classifications and dental development and wear assessment procedures. Cattle age groups were as follows: YOUNG = < 6 yr (< 2069 d); MIDDLE = 6 to 10 yr (2069 to 3926 d); OLD = > 11 yr (> 3926 d). Number of cattle by age group

classifications were as follows for the AUG and SEPT data collection events, respectively, YOUNG: n = 247, n = 235; MIDDLE: n = 121, n = 119; OLD: n = 32, n = 29. There were no instances in which an animal classified in a particular age group in AUG changed to a different age group classification in SEPT.

Actual age, considered the standard in this analysis, was subtracted from estimated age to determine the difference in age evaluated via dental examination versus age determined from known calving dates. A positive value for this difference indicated an overestimation of animal age, i.e., an animal was estimated to be older than it actually was based on dental examination; whereas a negative value for this difference indicated an underestimation of animal age, i.e., an animal was estimated to be younger than it actually was based on dental examination. The GLM and procedure in SAS were used for data analyses with means separated at $P < 0.05$.

Results

Incidence Rates of Various Dental Conditions

Incidence rate of a broken-mouth condition was 3.0% (n = 400) in AUG. One cow that was determined upon examination to not have a broken-mouth condition in AUG was observed to exhibit this condition in SEPT. The incidence rate of the broken-mouth condition in SEPT was therefore, 3.4% (n = 383). Two cows were determined in AUG (incidence rate = 0.50%; n = 400) and SEPT (incidence rate = 0.52%; n = 383) to each have a short and solid mouth condition. One cow was observed in both AUG (incidence rate = 0.25%; n = 400) and SEPT (incidence rate = 0.26%; n = 383) to have a gummer condition.

Accuracy of Dental Evaluation of Cattle Age

Numerically greater percentages of YOUNG cattle were accurately aged via dentition within 1 yr by all 3 observers in SEPT than AUG as shown in Table 1. A possible explanation of this is the additional experience in assigning cattle ages via dentition at the SEPT observation event compared with the AUG observation event. If this is true, then it may be reasonable to expect that increasing observer experience in estimating cattle age by way of dental examination could help to improve accuracy and repeatability of these estimates over time. However, the pattern of numerical improvement in percentage of cattle accurately aged within 1 yr of actual age via dentition from AUG to SEPT was seen for only 2 observers in the MIDDLE age group and 1 observer in the OLD age group.

Table 1. Percentages of cow or heifer ages accurately estimated via dental examination within 1, 2, 3, 4, and 5 yr by age group

Observer[1]	Date[2]	Number of yr age estimate within relative to actual age	Cow or heifer age group[3]		
			YOUNG	MIDDLE	OLD
ONE	AUG	1	84.2%	62.8%	53.1%
		2	97.2%	87.6%	78.1%
		3	99.2%	96.7%	84.4%
		4	100.0%	100.0%	87.5%
		5	100.0%	100.0%	87.5%
	SEPT	1	89.8%	55.5%	55.2%
		2	99.1%	87.4%	86.2%
		3	100.0%	95.8%	86.2%
		4	100.0%	99.2%	93.1%
		5	100.0%	99.2%	96.6%
TWO	AUG	1	84.6%	66.1%	53.1%
		2	98.8%	94.2%	81.3%
		3	99.2%	100.0%	87.5%
		4	100.0%	100.0%	90.6%
		5	100.0%	100.0%	96.9%
	SEPT	1	93.2%	73.9%	51.7%
		2	100.0%	93.3%	82.8%
		3	100.0%	97.5%	89.7%
		4	100.0%	99.2%	93.1%
		5	100.0%	99.2%	93.1%
THREE	AUG	1	81.4%	47.9%	43.8%
		2	96.0%	85.1%	68.8%
		3	99.6%	96.7%	78.1%
		4	100.0%	100.0%	87.5%
		5	100.0%	100.0%	90.6%
	SEPT	1	85.5%	53.8%	34.5%
		2	95.7%	81.5%	62.1%
		3	99.1%	92.4%	86.2%
		4	100.0%	97.5%	89.7%
		5	100.0%	99.2%	89.7%

[1]Observers are denoted as ONE, TWO, and THREE to represent 3 unique individual observers. For both collection dates the same 3 observers were utilized with no change in observer designation between dates.
[2]Observation date: AUG = August 12, 13, 14, 15, or 28, 2014; SEPT = September 9, 10, 11, or 12, 2014.
[3]Cow or heifer ages were divided into 3 groups according to dental eruption and wear evaluation procedures and Beef Improvement Federation standards for classifying cow age in years: YOUNG = < 6 yr (< 2069 d); MIDDLE = 6 to 10 yr (2069 to 3926 d); OLD = $\underline{>}$ 11 yr (> 3926 d).

There was no clear trend amongst observer accuracy rates for either increases or decreases in estimation accuracy from AUG to SEPT (Table 1). Each observer increased in age estimation accuracy within 1 yr of actual age in either MIDDLE or OLD cows but decreased in age estimation accuracy in the other of these 2 age groups going from AUG to SEPT. Across observers and observation dates age estimation accuracy rates within 1 yr of actual age ranged from 47.9 to 73.9% in MIDDLE cattle and from 34.5 to 55.2% in OLD cattle.

Veterinarians are typically the persons at public livestock auctions performing dental evaluations of cattle to estimate age. Veterinary students are often trained that being able to accurately estimate cattle age within 2 yr of actual age is considered effective in performing this service for their clientele (K. Walters, 2014, Mississippi State University College of Veterinary Medicine, Mississippi State, MS, personal communication). Using that standard in the context of the present results, it appears that it is achieving acceptable age estimation results is most readily accomplished within the YOUNG age group. Across observers and observation events a 95.7% or greater rate of accurately estimating YOUNG cattle age within 2 yr was accomplished using dental evaluation. For the MIDDLE and OLD age groups, minimum rates of accurate dental-based estimation of cattle age within 2 yr were 81.5 and 62.1%, respectively.

Perfect, 100%, accuracy of dental-based estimation of cattle age within 2 yr was accomplished in YOUNG cattle by 1 observer in SEPT and across all observers and observation events within 4 yr. In AUG, 1 observer achieved 100% accuracy using dentition to estimate cattle age within 3 yr in MIDDLE cattle, and 99.2% accuracy was attained the within 5 yr in SEPT for all 3 observers. Perfect accuracy of age estimation via dental evaluation within 5 yr was not realized in the OLD cattle by any observer at any observation event. Thus, technicians having a goal of 100% accuracy in matching cattle age estimations using dentition within a specified number of years within actual age are likely to experience greater difficulty in reaching the goal with advancing cattle age.

Relationships with Cattle Age Group and BCS

Cattle age group × BCS was a significant ($P < 0.01$) interaction in the model using the AUG data with age estimated via dental examination minus actual age as the dependent variable, but observer ($P = 0.25$) was not a significant effect (Table 2). This result is consistent with the proposition by Thrift and Thrift (2003) that teeth deterioration associated with advancing cow age affects cattle ability to graze and maintain optimum body condition. The general relationship observed for the interaction was that cattle age overestimation increased as BCS exceeded 6 in YOUNG cattle. Thus, YOUNG cattle displaying advanced permanent incisor development relative to actual age had greater BCS indicating greater percentages of body fat in these cattle. This is logical in that cattle should be better able to harvest forage and consume other feeds with quicker attainment of a “full mouth” of permanent incisors. Inflammation and irritation of the gums is expected during the period of deciduous tooth loss and permanent incisor eruption as cattle transition in dental development to their permanent teeth. The present results suggest that shortening the duration of this transition is associated with improved nutritional status in cattle as indicated by greater BCS. In the YOUNG cattle, a relatively large SE at BCS = 3 meant that the large variation for the observations at this BCS made the numerical difference in the response variable statistically not different from the other BCS levels in that age group.

Table 2. Cow or heifer age estimated via dental examination minus actual age (yr) least squares means and SE for age group by body condition score (BCS)

	Cow or heifer age group[1]		
BCS[2]	YOUNG	MIDDLE	OLD
3	$0.5429^{abcdefghi} \pm 0.6906$	–	$-8.3071^{n} \pm 0.9759$
4	$0.0445^{cdef} \pm 0.1139$	$0.2901^{bcde} \pm 0.1845$	$-1.8507^{m} \pm 0.1993$
5	$0.1291^{cd} \pm 0.0749$	$-0.1657^{ef} \pm 0.1242$	$-0.8598^{ijk} \pm 0.1953$
6	$0.1402^{c} \pm 0.0581$	$-0.0268^{def} \pm 0.0973$	$-1.1917^{kl} \pm 0.1700$
7	$0.3934^{b} \pm 0.0755$	$-0.1917^{fg} \pm 0.1008$	$-1.2205^{jklm} \pm 0.3251$
8	$0.6984^{ab} \pm 0.1623$	$-0.5898^{hij} \pm 0.1182$	$-2.1176^{lm} \pm 0.4883$
9	$1.2656^{a} \pm 0.4381$	$-0.8919^{ghijk} \pm 0.3473$	–

^{a,b,c,d,e,f,g,h,i,j,k,l,m,n}Means with different superscripts within rows and columns differ ($P < 0.05$).

[1]Cow or heifer ages were divided into 3 groups according to dental eruption and wear evaluation procedures and Beef Improvement Federation standards for classifying cow age in years: YOUNG = < 6 yr (< 2069 d); MIDDLE = 6 to 10 yr (2069 to 3926 d); OLD = ≥ 11 yr (> 3926 d).

[2]BCS on a 9-point scale where greater numerical score indicates greater body fat percentage according to Beef Improvement Federation guidelines (Beef Improvement Federation, 2010).

Cattle age was overestimated in MIDDLE cattle assigned a BCS of 4 and underestimated at BCS 5 through 9 with underestimation of age increasing beyond a BCS of 7 (Table 2). Cattle age was underestimated in all OLD cattle but to a greater extent as BCS decreased progressively less than 5. Although there was a relatively large SE at BCS = 3 in the OLD cattle, the numerical difference between that least squares mean and the other ones for OLD cattle was large enough to be statistically different ($P < 0.05$) from the other BCS levels. Underestimation of cattle ages by greater than 1 yr occurred in OLD cattle with BCS 4 or less and 6 or more.

The trends of increasing age underestimation with greater BCS in MIDDLE and OLD cattle were the reverse of the trend noted in the YOUNG cattle. An plausible explanation of this is that MIDDLE and OLD cattle estimated to be younger than their actual ages exhibited less wear and general better dental status than was expected at their ages. Cattle with less dental wear may have been better able to consume adequate amounts of nutrients that then led to greater BCS. Simply put, after development of a full mouth of permanent teeth, cattle that appeared to have less dental wear than would be expected at their true ages were better able to achieve a greater BCS. In that regard, it may be fair for cattle aged 6 yr and older but that are mouthed to be younger than their actual ages to be valued at greater monetary values at market because their dental status signals a greater ability to achieve greater BCS.

Observer, Date, and Age Group Effects

A second model considered the main effects of observer, observation date, and cattle age group and their 2-way and 3-way interactions for explaining the difference between estimated cattle age using dental examination and actual cattle age. Only the 3-way interaction of observer × observation date × cattle age group was significant ($P < 0.01$) (Table 3). The positive least squares means for the response variable for all combinations YOUNG cattle with various observers and observation dates are interpreted as consistent underestimations of age in YOUNG cattle, regardless of observer or observation date. Furthermore, the least square means were not different from one another in YOUNG cattle as observer or observation date varied.

Table 3. Cow or heifer age estimated via dental examination minus actual age (yr) least squares means and SE for age group, observer, and observation date

		Cow or heifer age group[3]		
Observer[1]	Date[2]	YOUNG	MIDDLE	OLD
ONE	AUG	$0.2101^{b} \pm 0.0674$	$-0.1512^{ef} \pm 0.0963$	$-1.4688^{h} \pm 0.1872$
	SEPT	$0.1443^{bcd} \pm 0.0691$	$0.5765^{a} \pm 0.0971$	$0.4069^{ab} \pm 0.1967$
TWO	AUG	$0.1899^{b} \pm 0.0674$	$-0.3496^{fg} \pm 0.0963$	$-1.2187^{h} \pm 0.1872$
	SEPT	$0.0975^{bcd} \pm 0.0691$	$-0.0538^{cde} \pm 0.0971$	$-0.5931^{g} \pm 0.1967$
THREE	AUG	$0.2648^{b} \pm 0.0674$	$-0.0851^{cdef} \pm 0.0963$	$-1.4687^{h} \pm 0.1872$
	SEPT	$0.2166^{b} \pm 0.0691$	$0.5723^{a} \pm 0.0971$	$-0.2138^{defg} \pm 0.1967$

[a,b,c,d,e,f,g,h]Means with different superscripts within rows and columns differ ($P < 0.05$).

[1]Observers are denoted as ONE, TWO, and THREE to represent 3 unique individual observers. For both collection dates the same 3 observers were utilized with no change in observer designation between dates.

[2]Observation date: AUG = August 12, 13, 14, 15, or 28, 2014; SEPT = September 9, 10, 11, or 12, 2014.

[3]Cow or heifer ages were divided into 3 groups according to dental eruption and wear evaluation procedures and Beef Improvement Federation standards for classifying cow age in years: YOUNG = < 6 yr (< 2069 d); MIDDLE = 6 to 10 yr (2069 to 3926 d); OLD = $\geq$ 11 yr (> 3926 d).

Within the MIDDLE cattle, each observer estimated cattle as being older relative to actual age in SEPT than in AUG (Table 3). All 3 observers underestimated cattle age relative to actual age in AUG for MIDDLE cattle, but only observers ONE and THREE overestimated the ages of MIDDLE cattle in SEPT. Like was done for the MIDDLE cattle, each observer estimated the OLD cattle as being older relative to actual age in SEPT compared to AUG. All observer and observation date combinations were underestimations of OLD cattle age except for the overestimation of OLD cattle age by observer ONE in SEPT. The magnitudes of overestimation and underestimations of cattle age for the various combinations of observer, observation date, and cattle age group were all less than 1 yr apart from the underestimations of OLD cattle by less than 1.5 yr by all observers in AUG.

Implications

The effectiveness of estimating cattle age by way of dental examination was shown to be most accurate in cattle aged 5 yr or less. Accuracy of age estimation using this technique was less with advancing cattle age. It is possible to underestimate or overestimate cattle age via dental evaluation as much as 9 or more years, which could bias age-based cattle production and marketing decisions. Future research on possible influences of cattle breed, cattle sex, pasture soil type, and forage nutritive value could provide additional relevant insights to further refine recommendations about using dentition for estimating cattle age. These recommendations would be particularly relevant if coupled with economic valuations of cattle age.

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Temperament alters the metabolic response to glucose and insulin challenges and feed restriction in steers

N. C. Burdick Sanchez[1], J. A. Carroll[1], H. D. Hughes[2], S. L. Roberts[2], J. T. Richeson[2], T. B. Schmidt[3], and R.C. Vann[4]

[1]Livestock Issues Research Unit, USDA-ARS, TX

[2]Department of Agricultural Sciences, West Texas A&M University, TX

[3]Animal Science Department, University of Nebraska-Lincoln, NE

[4]Department of Animal and Dairy Sciences, Mississippi State University, MS

Research Summary

Recently the dramatic metabolic differences between Temperamental and Calm cattle have been elucidated; Temperamental cattle maintain greater circulating concentrations of non-esterified fatty acids (NEFA) when compared to Calm cattle, which may influence other metabolic parameters including glucose and insulin. The objective of this study was to determine whether temperament influences cattle's metabolic responses to a glucose tolerance test (GTT), insulin sensitivity test (IST) and feed restriction (FR). Angus-cross steers (16 Calm and 15 Temperamental; 216±6 kg BW) were selected based on weaning temperament score. On d1 steers were moved into indoor individual stanchions to allow measurement of individual feed intake. On d6 steers were fitted with jugular catheters and were returned to individual stanchions. At 9am on d7 steers received the GTT (0.5 mL/kg BW of a 50% dextrose solution) and at 2pm steers received the IST (2.5 IU bovine insulin/kg BW). Feed was removed for 72h beginning at 8am on d8, and was provided at 25%, 50%, 75%, and 100% of ad libitum on d11, 12, 13, and 14, respectively. Blood samples were collected and serum isolated and stored until analyzed for glucose, insulin, NEFA, and blood urea nitrogen (BUN). All variables changed over time (P<0.01). For the duration of the study, Temperamental steers maintained greater (P<0.01) NEFA and decreased (P≤0.01) BUN and insulin sensitivity (measured using RQUICKI) compared to Calm steers. During the GTT Temperamental steers had greater (P<0.01) glucose, decreased (P=0.03) insulin. During the IST, Temperamental steers had decreased (P=0.04) glucose and greater (P<0.01) insulin. For the duration of the FR challenge, Temperamental steers maintained greater (P=0.001) glucose and decreased (P=0.001) insulin than Calm steers. These data demonstrate that differences exist in the manner that Temperamental steers respond to glucose, insulin, and feed restriction.

Introduction

Stress has been linked to behaviors such as anxiety, fear, and depression (Tyrka et al., 2008). In cattle, changes in behavior, such as fear responses to humans and(or) novel environments, is defined as temperament (Fordyce et al., 1988). More temperamental (or excitable) cattle can increase the risk of injury to themselves and workers and damage to facilities.

Temperamental cattle are behaviorally, physiologically, and immunologically different than Calm cattle. For example, Temperamental cattle display limited or no sickness behavior to an endotoxin challenge and have greater basal body temperature than Calm cattle (Burdick et al., 2011). Additionally, Temperamental cattle have greater basal cortisol and catecholamine (i.e., epinephrine and norepinephrine)

concentrations; yet have a diminished cortisol response to corticotropin-releasing hormone (CRH), adrenocorticotropic hormone (ACTH), or endotoxin challenge (Curley et al., 2008; Burdick et al., 2011). Temperamental cattle also appear to have an altered pro-inflammatory cytokine response to endotoxin challenge and have an reduced vaccine response (Oliphint, 2006). Lastly, performance (ADG, bruise score, marbling) is altered in Temperamental cattle (Fell et al., 1999).

Recently, the dramatic metabolic differences between Temperamental and Calm cattle have been elucidated. First, Temperamental cattle maintain greater circulating NEFA concentrations than Calm cattle while on full feed, yet do not product an increase in glucose concentrations in response to an endotoxin challenge (Burdick Sanchez et al., 2014). Secondly, in an experiment in ad libitum fed dairy steers, administration of a lipid emulsion increased pre-challenge cortisol and decreased the post-challenge cortisol, glucose, and pro-inflammatory cytokine response to an endotoxin challenge (Burdick Sanchez et al., 2013). Therefore, it has been hypothesized that the greater NEFA concentrations observed in Temperamental cattle may influence other metabolic parameters including glucose and insulin. This study was designed to determine whether temperament influences the metabolic responses of cattle to a glucose tolerance test, an insulin sensitivity test, and a feed restriction challenge.

Procedures

Angus-cross steers, 16 Calm and 15 Temperamental, were selected from a herd of 250 steers at the MAFES Brown Loam Experiment Station in Raymond, MS. Steers were selected based on temperament score measured at weaning. Temperament score (King et al., 2006) is an average of exit velocity and pen score (Burdick Sanchez et al., 2014).

On d0, steers were transported from Raymond, MS to Lubbock, TX (approximately 735 mi, 12h). Steers were housed in outdoor pens overnight. The following d steers were moved into individual stanchions to allow for measurement of ad libitum feed intake for 6d. Steers had free access to water throughout the study. On d7, steers were fitted with indwelling jugular catheters and were returned to individual stanchions.

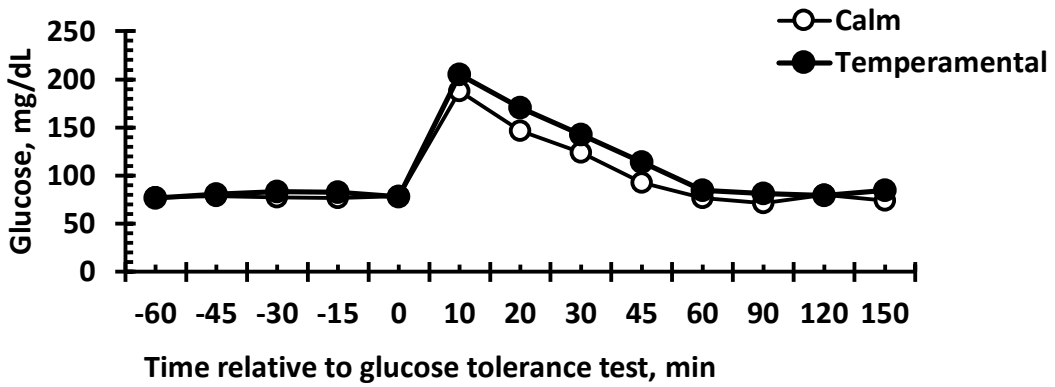
On d7 at 9am steers received the GTT (0.5 mL/kg BW of a 50% dextrose solution) and at 2pm steers received the IST (2.5 IU/kg BW bovine insulin). At 8am on d8 feed was removed for 72h and was provided at 25%, 50%, 75%, and 100% of ad libitum on d11, 12, 13, and 14, respectively. On d7, blood samples were collected and serum isolated at -60, -45, -30, -15, 0, 10, 20, 30, 45, 60, 90, and 150 min relative to the GTT and IST challenges at 0h. Starting at 0h on d8, blood samples were collected and serum isolated at 6h intervals from 0 to 156h relative to feed removal at 0h. Serum was isolated and stored at -80^{o}C until analyzed for glucose, insulin, NEFA, and BUN concentrations. Insulin sensitivity was calculated based on an adaption of the Revised Quantitative Insulin Sensitivity Check Index (RQUICK) method described by Holtenius and Holtenius, 2007. Data were analyzed using the MIXED procedure of SAS specific for repeated measures, with temperament, time and temperament x time included as fixed effects and steer within temperament as the experimental unit. When main effects were different (P>0.05), treatments means were compared utilizing the PDIFF option of SAS.

Results

During all three challenges, serum NEFA concentrations were greater (P<0.001) in Temperamental steers compared to Calm steers. Additionally, serum BUN concentrations were decreased (P≤0.004) in Temperamental

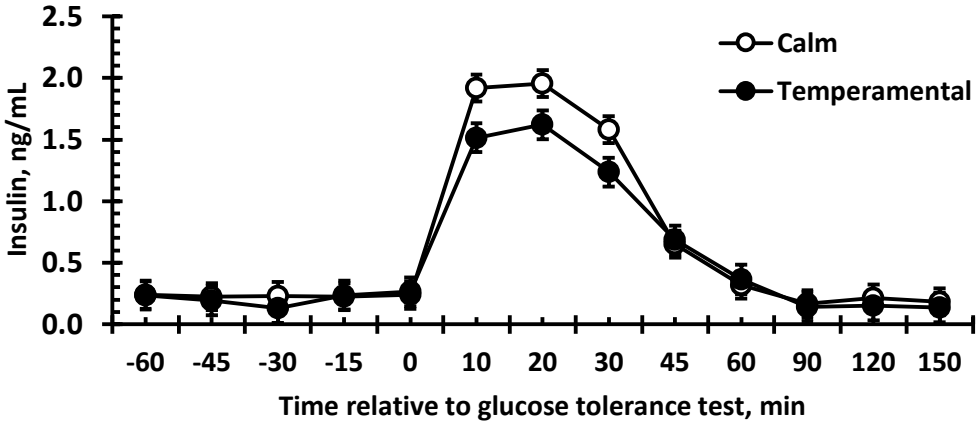
steers when compared to Calm steers. This is similar to what has been previously observed in Temperamental bulls (Burdick Sanchez et al., 2014).

Figure 1. Effect of temperament on the glucose response in Angus-cross steers to a glucose tolerance test.



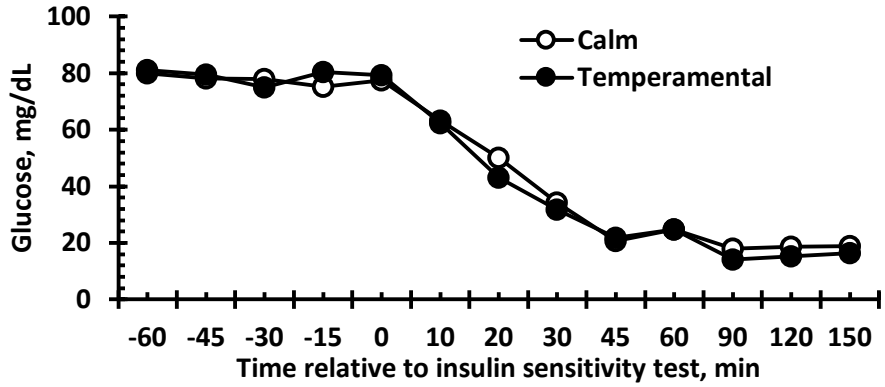
In response to the GTT, glucose concentrations were affected by temperament (P<0.001) and time (P<0.001). Specifically, glucose concentrations increased (P<0.001; 0 min vs. 10 min; Figure 1) within 10 min of the GTT, and remained elevated until 60 min post-GTT (P=0.62; 0 min vs. 60 min). On average, glucose concentrations were greater in Temperamental steers (104.8 ± 1.3 mg/dL) compared to that of the Calm steers (95.6 ± 1.3 mg/dL). Additionally, there was a tendency (P=0.06) for a temperament x time interaction such that glucose concentrations were greater (P≤0.01) in Temperament steers compared to Calm steers from 10 to 45 min relative to the GTT.

Figure 2. Effect of temperament on the insulin response in Angus-cross steers to a glucose tolerance test.



The serum insulin response to the GTT was affected by temperament (P=0.03) and time (P<0.001) but there was no temperament x time interaction (P=0.48). Insulin concentrations increased within 10 min of administration of the GTT (P<0.001; 0 min vs. 10 min; Figure 2) and returned to baseline values within 60 min (P=0.43; 0 min vs. 60 min), similar to glucose concentrations. Average serum insulin concentrations were decreased in Temperamental steers (0.53 ± 0.03 ng/mL) when compared to Calm steers (0.63 ± 0.03 ng/mL).

Figure 3. Effect of temperament on the glucose response in Angus-cross steers to an insulin sensitivity test.



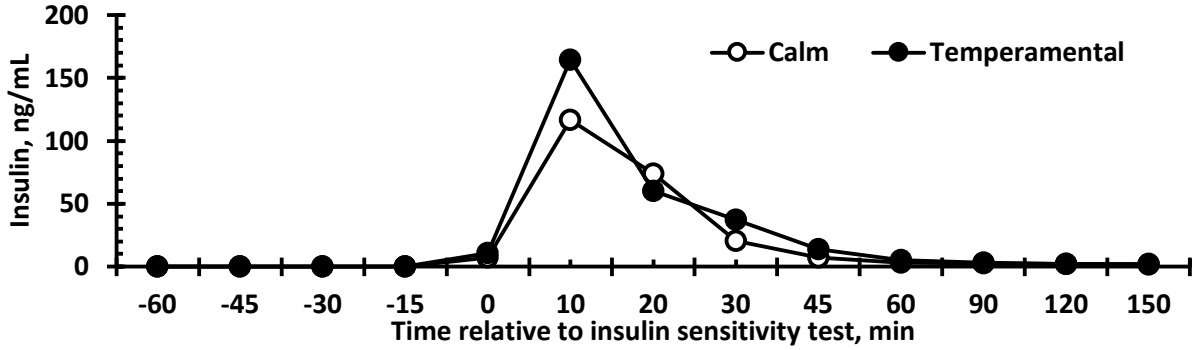
Insulin sensitivity during the GTT, as calculated by RQUICKI, was affected by temperament (P<0.001) and time (P<0.001), but there was no temperament x time interaction (P=0.17). Temperamental steers had decreased insulin sensitivity (0.48 ± 0.01) when compared to Calm steers (0.51± 0.01). Insulin sensitivity decreased in both temperament groups within 10 min (P<0.001; 0min vs. 10min). Insulin sensitivity values did not return to baseline values until 120min post GTT (P=0.54; 0min vs. 120min).

Concentrations of glucose, in response to the IST, were not affected by temperament (P=0.22) or by a temperament x time interaction (P=0.19); however, there was a time effect (P<0.001). Specifically, glucose concentrations decreased 10min post IST challenge (P<0.001; 0min vs. 10min; Figure 3) and remained below baseline values through the duration of the challenge (P<0.001).

There was a temperament x time interaction (P<0.001) for serum insulin concentrations in response to the IST. Specifically, Temperamental steers had greater (P≤0.004; Figure 4) insulin concentrations when compared to Calm steers at 10 and 30min post IST; yet Temperamental steers had decreased insulin (P=0.005) compared to that of Calm steers at 20 min post-IST. Insulin concentrations were also affected by temperament (P<0.001) and time (P<0.001). Serum insulin concentrations increased (P=0.03; -60min vs. 0min) at 0h, with a greater increase 10min post-IST (P<0.001; -60min vs. 10min). Insulin concentrations returned to baseline values within 60min post-challenge (P=0.32; -60min vs. 60min). On average, Temperamental steers had greater

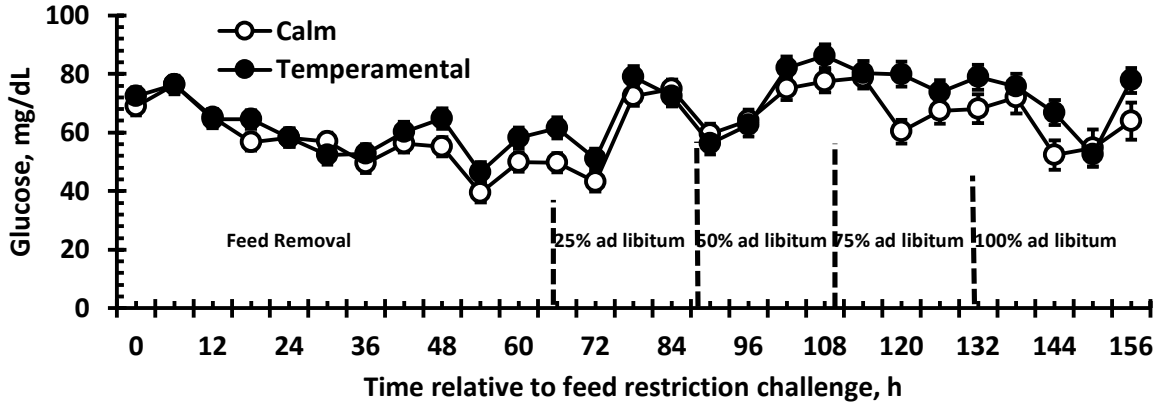
insulin concentrations (23.0 ± 1.2 ng/mL) than Calm steers (15.8 ± 1.1 ng/mL).

Figure 4. Effect of temperament on the insulin response in Angus-cross steers to an insulin sensitivity test.



There was a temperament (P=0.001) and time effect (P<0.001) but not a temperament x time interaction (P=0.90) for insulin sensitivity during the IST. Specifically, insulin sensitivity decreased at 0 min (P<0.001; -60min vs. 0min) and remained below baseline insulin sensitivity values through the duration of the IST (P<0.001). The decreased in sensitivity at 0 min is likely due to the slight increase in insulin concentrations at 0min. On average, Temperamental steers had decreased insulin sensitivity (0.40 ± 0.01) compared to Calm steers (0.43 ± 0.01).

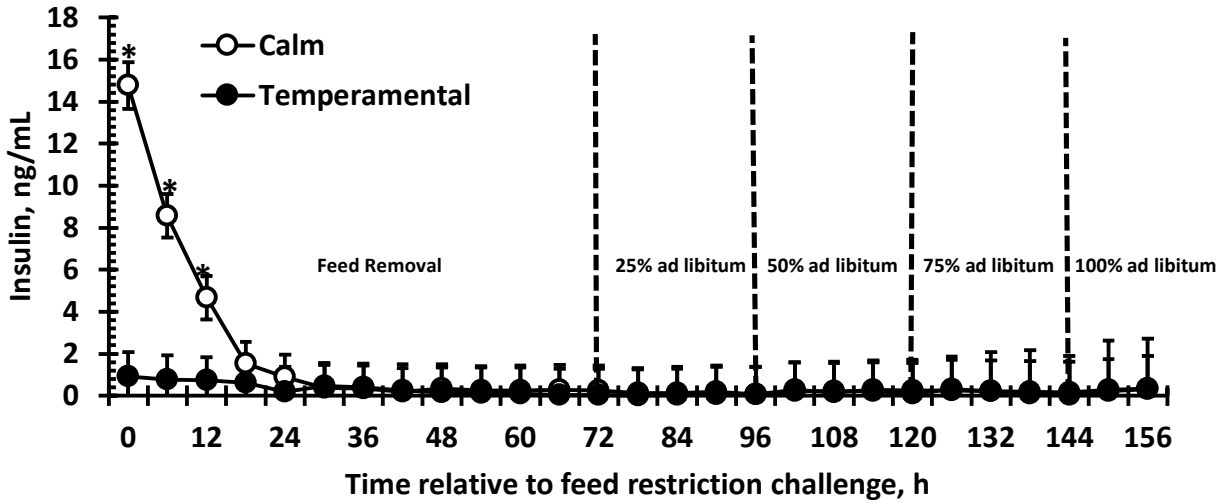
Figure 5. Effect of temperament on the glucose response in Angus-cross steers to a feed restriction challenge.



During the feed restriction challenge, serum glucose concentrations were affected by temperament (P=0.01) and time (P<0.001), but not by a temperament x time interaction (P=0.13). Serum glucose concentrations were greater in Temperamental steers (66.9 ± 1.3 mg/dL) than Calm steers (61.7 ± 1.2 mg/dL) during the feed restriction challenge, with concentrations of glucose fluctuating daily (Figure 5).

There was a temperament x time interaction (P<0.001) for serum insulin concentrations during the feed restriction challenge.

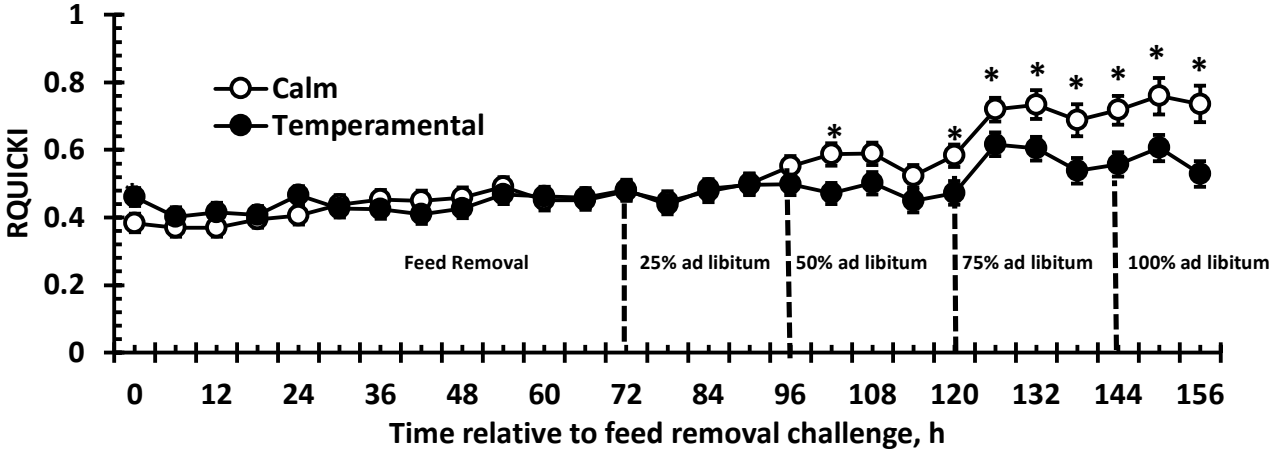
Figure 6. Effect of temperament on the insulin response in Angus-cross steers to a feed restriction challenge[1].



[1]Calm differs from Temperamental (*$P \leq 0.005$)

Specifically, Calm steers had greater insulin concentrations than Temperamental steers at 0, 6, and 12h relative to feed removal (P<0.001; Figure 6). This resulted in a time (P<0.001) and temperament effect (P<0.001), such that Calm steers had greater serum insulin concentrations (1.3 ± 0.3 ng/mL) than Temperamental steers (0.3 ± 0.3 ng/mL). There was also a temperament x time interaction for insulin sensitivity during the feed restriction challenge. Temperamental steers had greater insulin sensitivity at 0h (P=0.04; Figure 7); however, Temperament steers had decreased insulin sensitivity at 102h and from 120 to 156h relative to feed restriction (P≤0.04). This resulted in a time (P<0.001) and a temperament effect (P<0.001) such that Temperamental steers had decreased insulin sensitivity (0.48 ± 001) compared to Calm steers (0.53 ± 0.01).

Figure 7. Effect of temperament on the insulin response in Angus-cross steers to a feed restriction challenge[1,2].



[1]Insulin sensitivity calculated by the Revised Quantitative Insulin Sensitivity Check Index (RQUICKI) as described by Holtenius and Holtenius, 2007

[2]Calm differs from Temperamental (*$P \leq 0.05$)

Implications

These data demonstrate that differences exist in the manner in which Temperamental steers respond to glucose, insulin, and feed restriction. Specifically, Temperamental steers had greater NEFA concentrations, decreased BUN concentrations, altered glucose and insulin kinetics, and reduced insulin sensitivity. These differences exist due to a complex, yet undefined paradigm involving stress, immune, and metabolic parameters, ultimately resulting in greater NEFA concentrations, and insulin sensitivity. The data further implicate metabolic differences as the primary factor associated with the differences observed in immune function and performance traits between Calm and Temperamental cattle, and accentuate the need for different management strategies for feeding Temperamental cattle.

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Hepatic steroid inactivating enzymes, portal blood flow, and corpus luteum blood perfusion in cattle

C.G. Hart, B.E. Voelz, K.E. Brockus, and C.O. Lemley
Department of Animal and Dairy Sciences, Mississippi State University, MS

Research Summary

The objective of this study was to characterize hepatic steroid inactivating enzymes, portal blood flow, and corpus luteum (CL) blood perfusion in pregnant versus open cattle. Twenty early-lactation Holstein cows and 20 commercial beef cows were artificially inseminated on day 0. On day 10 post-insemination, a blood sample and liver biopsy were taken and portal blood flow and CL blood perfusion measurements were taken via color Doppler ultrasonography. Blood samples were analyzed for progesterone (P4) concentrations. Corpus luteum blood perfusion is used as a measure for P4 secretion. The enzymes measured in this study, as well as portal blood flow, are proportional to the level of P4 clearance within the liver. Therefore, increased enzyme activity and/or increased portal blood flow will result in decreased concentrations of P4. On day 30 post-insemination, cows were classified as pregnant or open and data was retrospectively analyzed as such. Cytochrome P450 1A (CYP1A) tended to be increased ($P < 0.10$) in pregnant dairy cows. Uridine diphosphate-glucuronosyltransferase (UGT) activity was increased ($P < 0.005$) in pregnant dairy cows. Portal blood flow tended to be increased ($P < 0.10$) in pregnant dairy cows. Data were also tested for breed differences (beef vs. dairy). Activities of CYP1A, cytochrome P450 3A (CYP3A), aldo-keto reductase (AKR) and UGT were increased ($P < 0.05$) in beef vs. dairy cows. Cytochrome P450 2C (CYP2C) was decreased ($P < 0.05$) in beef vs. dairy cows. Corpus luteum blood perfusion relative to CL volume tended to be increased ($P < 0.10$) in beef vs. dairy cows. Despite these differences, there was no difference ($P > 0.10$) in P4 concentrations between pregnant vs. open or beef vs. dairy cows.

Introduction

Progesterone is required for the maintenance of pregnancy as it blocks uterine contractions from occurring until parturition (Csapo, 1956). In ruminants, a decrease in pregnancy rates may be due to decreased concentrations of P4. It is important to note that both production from the CL and/or liver inactivation impacts peripheral concentrations of P4. Luteal size has long been used as an appropriate estimator for luteal function due to the high positive correlation ($r^2 = 0.85$) between luteal size and progesterone concentrations (Ribadu et al., 1994). However, Herzog et al. (2010) found the use of CL blood perfusion as a more efficient indicator of luteal function over luteal size. Rhinehart et al. (2009) examined the relationship between luteal P4 secretion and liver clearance in lactating dairy cattle, showing that liver inactivation of P4 contributed a major role in modulating peripheral P4 concentrations. Therefore, additional characterization of these liver enzymes throughout gestation will allow researchers to design therapeutic supplements to modify steroid clearance during critical windows of pregnancy.

Cattle with an elevated dry matter intake have increased blood flow to the digestive tract and liver. This in turn leads to an increased delivery rate of steroids to the liver and thus increased metabolism of these substrates (Wiltbank et al., 2006). Excessive steroid inactivation contributes to decreased peripheral concentrations, which can alter reproductive performance. Two potential changes that occur during mid to late gestation are decreased placental nutrient exchange due to decreased concentrations of P4 (Fowden et al., 2006) and decreased uterine blood flow due to decreased concentrations of E2 (Ford, 1995).

Both of these responses could have dramatic consequences to the growth, development, and welfare of the offspring in later life.

Steroids are highly lipophilic and therefore difficult for animals to excrete through the urine and feces. However, several enzymes contribute to steroid inactivation by adding polar groups to the molecule. This makes the molecule more hydrophilic and thus easily excreted in the urine and feces. These enzymes include cytochrome P450 1A (CYP1A), 2C (CYP2C), 3A (CYP3A), aldo-keto reductase 1C (AKR1C), and uridine diphosphate-glucuronosyltransferase (UGT; Lemley and Wilson, 2010). Currently, little is known about how liver enzyme function may contribute to reproductive performance. Hart et al. (2014) found that CYP3A activity was decreased in pregnant beef cows during late-gestation and AKR activity was decreased from mid- to late-gestation whereas P4 concentrations were increased from mid- to late-gestation. However, further characterization of these enzymes is needed throughout gestation. Therefore, our primary objective was to examine liver steroid inactivating enzymes, portal blood flow, and CL blood perfusion during early gestation in pregnant vs. open dairy and beef cows.

Procedures

A total of 20 early lactation Holstein cows and 20 lactating commercial beef cows were utilized for this study. Beef and dairy cows were managed as two separate herds respective of their operation system. After estrus synchronization, cows were artificially inseminated on day 0. On day 10 post-insemination, blood samples and liver biopsies were collected; portal blood flow and CL blood perfusion measurements were taken via color Doppler ultrasonography. On day 30 post-insemination, cows were classified as either pregnant (P; dairy n = 7; beef n= 6) or open (O; dairy n = 12; beef n = 10) and data were retrospectively analyzed as such (P vs. O within dairy or beef). Data were also analyzed for breed differences (dairy vs. beef).

Liver samples were analyzed for protein concentration and assayed for hepatic enzymes Cytochrome P450 1A (CYP1A), cytochrome P450 2C (CYP2C), cytochrome P450 3A (CYP3A), aldo-keto reductase (AKR), and uridine diphosphate-glucuronosyltransferase (UGT). Enzyme activity is expressed relative to mg of protein as well as relative to kg of body weight. Portal blood flow was determined via Doppler ultrasonography and is reported as total portal blood flow and portal blood flow relative to kg of body weight. Corpus luteum volume and blood perfusion were determined using B-mode and Doppler ultrasonography, respectively. Blood perfusion of the CL is reported as total perfusion and perfusion relative to CL volume. Serum concentrations of P4 were measured via radioimmunoassay (Siemens Healthcare Diagnostics, Los Angeles, CA).

The MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) was used to test for differences between P and O within breed and to test for differences between breed. Data found to be non-normally distributed were tested using the Wilcoxon rank sum test. Treatment means were separated using the PDIFF options of the LSMEANS statement. Least square means and SE are reported. Statistical significance was declared at $P < 0.05$.

Table 1. CYP1A, CYP2C, CYP3A, AKR1C, and UGT activity in pregnant vs. open cows at day 10 post-insemination.

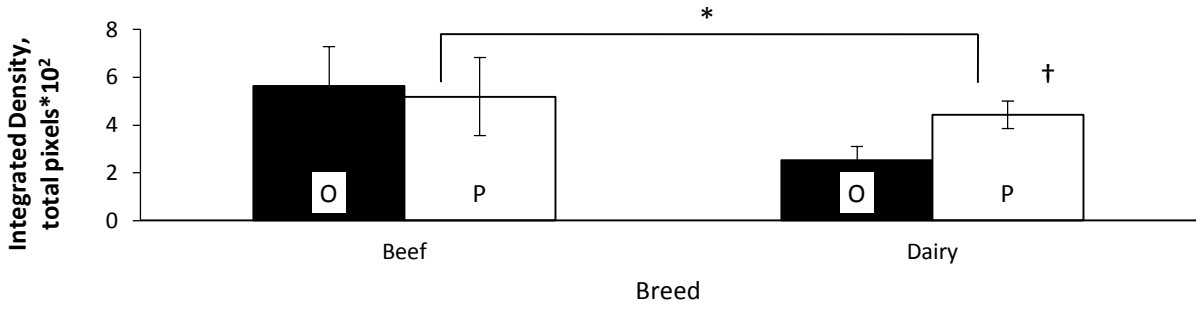
Dependent Variable	Holstein			Beef		
	Pregnant	Open	SE	Pregnant	Open	SE
CYP1A						
RLU/(min × mg protein) × $10^{6‡}$	0.51	0.47	0.04	1.70	0.98	0.25
RLU/(min × kg BW)‡	27.88†	22.62	2.36	65.54	65.52	13.77
CYP2C						
RLU/(min × mg protein) × $10^{3‡}$	4.25	4.62	0.32	3.74	3.15	0.30
RLU/(min × kg BW)‡	0.23	0.22	0.02	0.17	0.19	0.01
CYP3A						
RLU/(min × mg protein) × $10^{6‡}$	1.89	2.03	0.16	2.61	2.47	0.33
RLU/(min × kg BW) ×$10^{2‡}$	0.93	1.03	0.09	1.59	1.12	0.21
AKR						
pmol(min × mg protein)‡	53.10	47.17	2.80	55.29	55.00	2.79
pmol/min × kg of BW × 10^{-3}	8.87	8.09	0.53	10.04	9.49	0.89
UGT						
RLU(min × mg protein) × $10^{6‡}$	1.09	1.27	0.23	1.96	1.65	0.27
RLU(min × kg BW)‡	64.10^{a}	48.27^{b}	3.74	98.37	82.32	14.68

[1]CYP1A = cytochrome P450 1A; CYP2C = cytochrome P450 2C; CYP3A = cytochrome P450 3A; AKR1C = aldo-keto reductase 1C; UGT = uridine diphosphate-glucuronosyltransferase.
[2]Enzyme activity expressed relative to mg of liver protein and relative to kg of body weight.
[3]Mean and SE reported.
‡ Signifies breed differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.
[a,b,c] Least square means with different letter superscripts depict differences $P < 0.05$.

Results

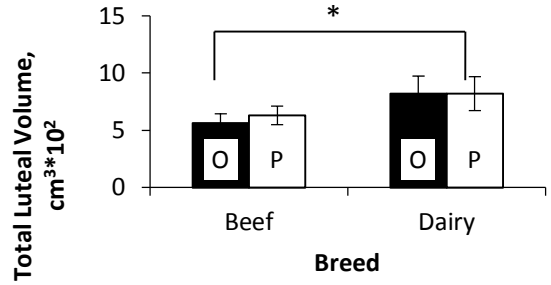
Effects of gestation and breed are illustrated in Table 1. Activities of CYP2C, CYP3A and AKR were not different ($P > 0.11$) between pregnant vs. open cows when expressed per mg of protein and per kg of body weight. Activity of CYP1A per kg of body weight tended to be increased ($P < 0.10$) in pregnant vs. open dairy cows and was increased ($P < 0.05$) in beef vs. dairy cows. Activity of CYP2C was decreased ($P < 0.05$) in beef vs. dairy cows with activity of CYP3A being increased ($P < 0.05$) in beef vs. dairy cows when expressed per mg of protein and per kg of body weight. Activity of AKR was also increased ($P < 0.05$) in beef vs. dairy cows however, this is only when expressed per mg of protein. Activity of UGT per mg of protein was not different ($P > 0.53$) between pregnant vs. open cows but was increased ($P < 0.05$) in beef vs. dairy cows. Activity of UGT per kg of body weight was increased ($P < 0.004$) in pregnant vs. open dairy cows and was increased ($P < 0.05$) in beef vs. dairy cows. Total CL blood perfusion tended to be increased ($P < 0.10$) in pregnant vs. open dairy cows and was increased ($P < 0.05$) in beef vs. dairy cows (Figure 1).

Figure 1. Total corpus luteum blood perfusion in pregnant vs. open cows at day 10 post-insemination.



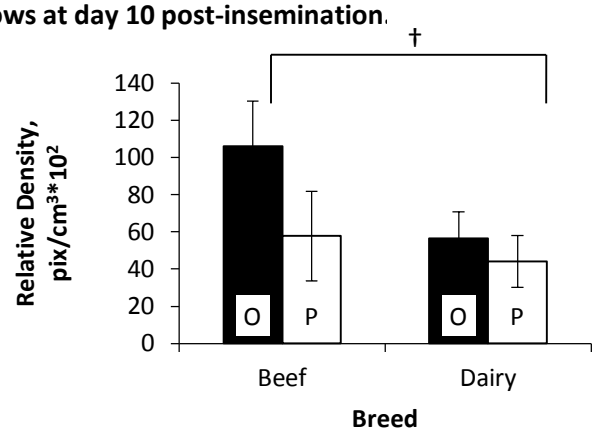
*Signifies differences $P < 0.05$., †Signifies tendencies $P < 0.10$.

Figure 2. Total luteal volume in pregnant vs. open cows at day 10 post-insemination.



*Signifies differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.

Figure 3. Corpus luteum blood perfusion relative to CL volume in pregnant vs. open cows at day 10 post-insemination.



*Signifies differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.

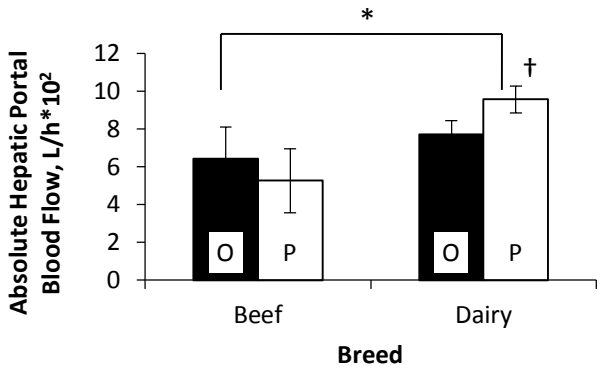
Luteal volume was not different ($P > 0.90$) between pregnant vs. open in cows but was decreased ($P < 0.05$) in beef vs. dairy cows (Figure 2). Blood perfusion relative to CL volume was not different ($P > 0.50$) between pregnant vs. open cows and tended to be increased ($P < 0.10$) in beef vs. dairy cows (Figure 3). Absolute portal blood flow tended to be increased ($P < 0.10$) in pregnant vs. open dairy cows and was decreased ($P < 0.05$) in beef vs. dairy cows (Figure 4). Portal blood flow per kg of body weight tended to be increased ($P < 0.07$) in pregnant vs. open dairy cows and was not different ($P > 0.10$) between dairy vs. beef (Figure 5). Progesterone concentrations were not different ($P > 0.10$) between pregnant vs. open or beef vs. dairy cows (Figure 6).

Implications

Pregnant dairy cows tended to have increased activity of CYP1A, increased activity of UGT, and tended to have increased portal blood flow, yet no difference was found in P4 concentrations between pregnant vs. open dairy cows. However, pregnant dairy cows also tended to

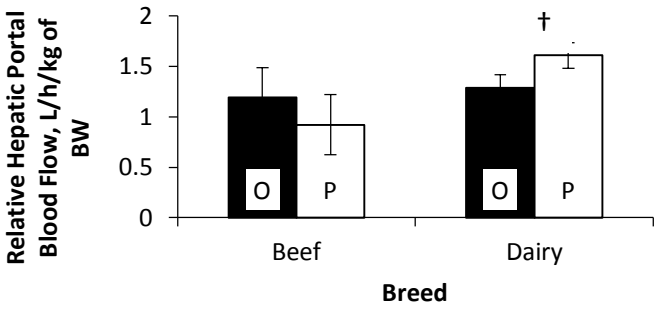
have increased total CL blood perfusion which could account for the lack of difference in P4 concentrations. Interestingly, there were no differences found between pregnant vs. open beef cows in any of the variables measured. Although, many breed differences were observed. Activities of CYP1A, 3A, AKR, and UGT were increased in beef vs. dairy cows. Beef cows also had increased total CL blood perfusion and CL blood perfusion relative to CL volume compared to dairy cows. Despite these differences, there was no difference in P4 concentrations between beef vs. dairy cows perhaps due the increased CL blood perfusion in beef cows. Therefore, the potential increase in luteal P4 synthesis could be negated by an increase in hepatic clearance leading to similar peripheral P4 concentrations. Different management practices, such as nutrition, between these two operations may also have an influence on the variables observed.

Figure 4. Absolute or total hepatic portal blood flow in pregnant vs. open cows at day 10 post-insemination.



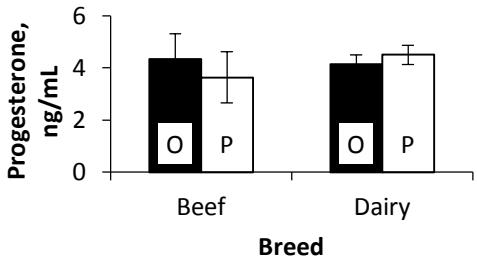
*Signifies differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.

Figure 5. Hepatic portal blood flow per kg of body weight in pregnant vs. open cows at day 10 post-insemination.



*Signifies differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.

Figure 6. Progesterone concentrations in pregnant vs. open cows at day 10 post-insemination.



*Signifies differences $P < 0.05$.
†Signifies tendencies $P < 0.10$.

Although, breed effects have been previously reported (Giantin et al., 2008). The high plane of nutrition in lactating dairy cattle appears to elevate liver blood flow and clearance rate of P4 (Sangsritavong et al., 2002). However, this is not shown in the current data set as there was no difference between beef and dairy P4 concentrations.

While these enzymes have been partially characterized in bovine pregnancy (Hart et al., 2014), further characterization of these enzymes during gestation is needed. Future research may allow for the design of specific therapeutic supplements to modulate steroid metabolism during gestation. The ability to modulate these enzymes in order to increase

peripheral concentrations of progesterone could decrease pregnancy wastage and thus increase reproductive efficiency and production.

The vascular adaptations of the uterus throughout pregnancy may be modulated by estradiol metabolites that remain biologically active after estradiol is altered by CYP1A and CYP3A. These metabolites have been shown to be involved in regulating blood vessel formation during pregnancy. Thus a decrease in these P450s could result in lower concentrations of these biologically active estradiol metabolites and in turn decrease uterine vascular proliferation during pregnancy. Activity of UGT is known to produce P4 metabolites that could also be biologically active. However, the potential effects of these metabolites have yet to be characterized.

Acknowledgements

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Dietary melatonin alters uterine artery hemodynamics in pregnant Holstein heifers

K.E. Brockus, C. G. Hart, B. O. Fleming, and C. O. Lemley
Department of Animal and Dairy Sciences, Mississippi State University, MS

Research Summary

Previous studies have implied that dietary melatonin supplementation serves as a potential therapeutic to improve ovine fetal and placental development, through increased uteroplacental blood flow. Therefore, the objectives of this study were to examine uterine artery hemodynamics and maternal serum profiles in late gestating heifers supplemented with 20 mg of dietary melatonin (MEL; n = 10) or no supplementation (CON; n = 10) from day 190 to day 262 of gestation. Maternal uterine artery blood flow measurements were recorded via Color Doppler ultrasonography and blood samples were collected on days 180 (baseline), 210, 240, and 262 of gestation. Blood samples were analyzed for total serum antioxidant capacity. Total uterine artery blood flow was increased ($P = 0.009$) by 25% in the MEL treated heifers compared to the CON. Total serum antioxidant capacity was increased ($P < 0.0001$) by 39% in MEL treated heifers when compared to CON. The observed increase in total uterine artery blood flow during melatonin supplementation could be related to its antioxidant properties. Compromised pregnancies are typically accompanied by increased oxidative stress; therefore, melatonin could serve as a therapeutic supplementation strategy. Future studies will examine developmental programming, as alterations in uterine blood flow during late gestation could program differences in postnatal offspring growth and development.

Introduction

The uterine environment during late gestation is vital for assuring a continual delivery of sufficient oxygen and nutrients to the exponentially growing fetus (Vonnahme and Lemley 2012; Redmer et al*.,* 2004). Based on average number of lactations in the United States dairy industry, a Holstein cow spends approximately 14% of their life within the uterus, whereby the placenta is their sole source of nourishment. Previous studies have shown that melatonin supplementation during a compromised pregnancy may alter placental functional capacity and uteroplacental blood flow through melatonin receptor-mediated pathways or indirectly by decreasing oxidative stress in the vascular system (Lemley et al., 2012; Lemley et al., 2013).

Melatonin is unique in that it has the ability to protect the body against free radicals via direct or indirect pathways (Reiter et al., 1995). Firstly, melatonin can bind directly to cellular membranes and help stabilize that membrane against possible oxidative damage. Secondly, melatonin has the ability to protect cells indirectly by helping the body up-regulate its own antioxidant defense system. Imbalances between reactive oxygen specie production and antioxidant systems could increase oxidative stress which, in turn, can negatively impact the reproductive process. With these levels being increased during pregnancy, it has been shown that oxidative stress is directly related to several pregnancy disorders, such as spontaneous abortions, embryopathies, preeclampsia, fetal growth restriction, preterm labor, and low birth weight (Kaïs et al., 2010). The links between oxidative stress, the female reproductive system and the development of negative pregnancy outcomes are important concerns in both human and animal reproductive sciences (Kaïs et al., 2010).

Many studies have investigated models of nutrient restriction during pregnancy; however, few studies have examined uteroplacental hemodynamics of improved fetal growth (Lemley et al., 2012). In addition, supplementing dietary melatonin may have the ability of altering fetal organ development and functional capacity (Lemley et al., 2012). Dietary melatonin supplementation increased umbilical artery blood flow in the ewe (Lemley et al*.,* 2012). Moreover, melatonin supplementation increased placental antioxidant enzyme activity in mid-gestating ewes (Lemley et al., 2013). Therefore, we hypothesized that dietary melatonin supplementation would increase uterine artery hemodynamics and total antioxidant capacity in late gestating Holstein heifers.

Procedures

Dairy heifers were artificially inseminated with sex-sorted semen at the Joe Bearden Dairy Research Center. Artificial insemination dates ranged from December 6, 2012 to January 30, 2013. Twenty singleton pregnant Holstein heifers were selected at day 70 to 90 of gestation. The project consisted of a randomized complete block design. The heifers were blocked by both artificial insemination date and body weight. On day 170 of gestation, the heifers were trained to the Calan feeding system to monitor dry matter intake. Dietary melatonin supplementation (MEL; n = 10) or no melatonin supplementation (CON; n = 10) started on day 190 of gestation and ended on day 262. Melatonin (Batch 130307, Health Supplement Wholesalers, Red Lion, PA, USA) was provided by top-dressing grain with 2 mL of 10 mg/mL melatonin dissolved in ethanol (20 mg of melatonin per head per day). The melatonin dosage was based on previous dietary melatonin supplementation studies with cattle (Zinn et al., 1988; Sanchez-Barcelo et al., 1991; Dahl et al., 2000). A total mixed ration of 17 kg/d was provided based on NRC recommendations for a pregnant Holstein heifer during late gestation along with ad libitum access to water. Maternal body weights were recorded every 14 days. Blood samples were collected from the tail via venipuncture of the coccygeal vessels on days 180 (baseline), 210, 240, and 262 of gestation.

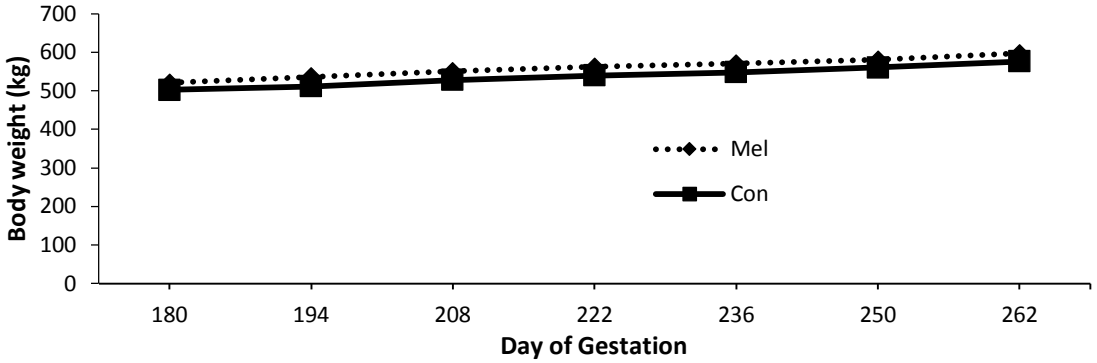
Uterine artery hemodynamics, contralateral and ipsilateral to the conceptus, were determined on days 180 (baseline), 210, 240, and 262 of gestation via color Doppler ultrasonography (MicroMaxx, SonoSite, Inc., Bothell, WA, USA) using a transrectal probe (Sonosite MicroMaxx with a Linear Endorectal L52x probe). Following techniques described by Camacho *et al*. (2014), briefly the uterine artery was identified by following the abdominal aorta towards the origin of the external iliac artery. The internal iliac artery was located by moving the probe caudally. The left and right uterine arteries where identified as a major branch of the iliac arteries. Moreover, the uterine arteries were palpated to assure pliability and pulsatility, which is easily observed during late gestation. The ultrasound transducer was aligned to the uterine artery at an average angle of insonation of 56 ± 2 degrees (mean ± SE). Mean velocity (MnV) was calculated using the equation: (s – d)/PI. Blood flow was calculated using the equation: (MnV*vessel area*60 sec).

Total antioxidant capacity was determined with a colorimetric assay kit (Cayman Chemical Co. Ann Abor, MI, USA). The antioxidant capacity assay was performed following manufactures' instructions except that the serum was diluted with assay buffer to place unknowns within the range of the standard curve. Antioxidant capacity of serum was determined based on the inhibition of ABTS oxidation by metmyoglobin. The ABTS oxidation product was monitored at 405 nm via a Spectra Max Plus plate reader. The kit does not separate aqueous- and lipid-soluble antioxidants; therefore, the combined antioxidant activities of all constituents in maternal serum are reported. The capacity of serum antioxidants in unknown samples to prevent substrate oxidation is compared with

that of a tocopherol analogue (Trolox) and is reported as mM Trolox equivalents. Samples were analyzed against a linear Trolox standard curve (0 – 0.33 mM), with a sensitivity of 0.01 mM and intra- and interassay coefficients of variation were 14.4% and 9.6%, respectively.

Dependent variables were analyzed using repeated-measures ANOVA of the mixed procedure of SAS (SAS software version 9.3, SAS Institute, Cary, NC, USA). Means were separated using the PDIFF option of the LSMEANS statement. The model statement contained dietary treatment, gestational day, and their respective interaction. Main effects of dietary treatment or gestational day are discussed in the absence of significant ($P \leq 0.05$) treatment by day interactions. Least square means and SEM are reported. Statistical significance was declared at $P \leq 0.05$.

Figure 1. Maternal body weight

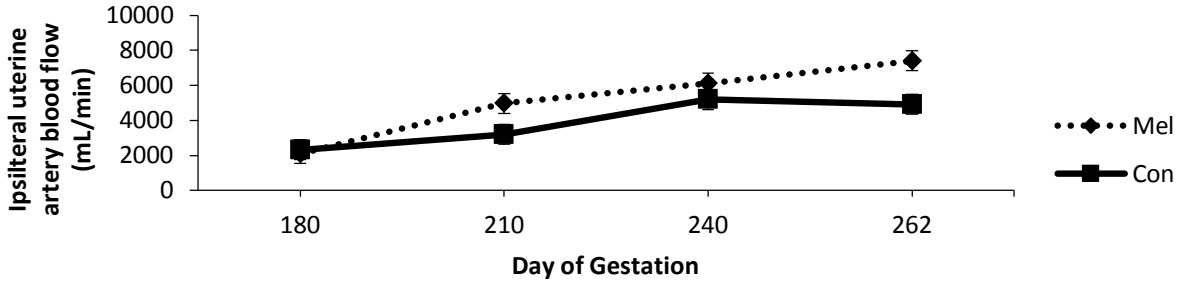


[1] Maternal body weights in heifers treated with or without dietary melatonin from day 190 to 262 of gestation. A main effect of gestational day was observed (P < 0.0001), while melatonin treatment did not influence body weight (P = 0.34).

Results

Heifer body weight increased ($P <$ 0.0001) as gestational day increased (Figure 1); however, melatonin treatment did not influence ($P = 0.34$) heifer body weight. Average daily gain from 180 to 262 of gestation was similar ($P = 0.64$) between MEL (0.92 ± 0.05 kg/d) versus CON (0.87 ± 0.07 kg/d). Body condition score was not different ($P = 0.61$) between MEL and CON heifers and averaged 3.45 ± 0.08. Dry matter intake throughout the supplementation period was not different ($P =$ 0.14) between dietary treatments and averaged 8.95 ± 0.03 kg.

Figure 2. Ipsilateral uterine artery blood flow

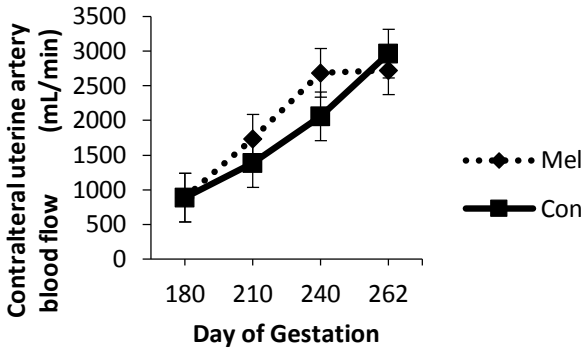


[2] Ipsilateral uterine artery blood flow in heifers treated with or without dietary melatonin from day 190 to 262 of gestation. Main effects of gestational day (P < 0.0001) and melatonin treatment (P = 0.01) were observed for ipsilateral uterine artery blood flow.

Main effects of gestational day (P < 0.0001) and melatonin treatment (P = 0.01) were observed for ipsilateral uterine artery blood flow (Figure 2). On average ipsilateral uterine artery blood flow was increased by 32% in MEL treated heifers compared to CON. A main effect of gestational day (P = 0.02) was observed for ipsilateral RI (data not shown), which decreased at days 210, 240, and 262 versus 180. A main effect of gestational day (P = 0.002) was also observed for ipsilateral PI (data not shown), which was decreased at days 210, 240, and 262 of gestation versus 180. Ipsilateral RI (P = 0.19) and PI (P = 0.29) were not influenced by melatonin supplementation. A main effect of gestational day (P < 0.0001) was observed for ipsilateral diameter of the uterine artery (data not shown), which increased from day 180 to 240 of gestation. Ipsilateral diameter of the uterine artery was not influenced (P = 0.46) by melatonin supplementation.

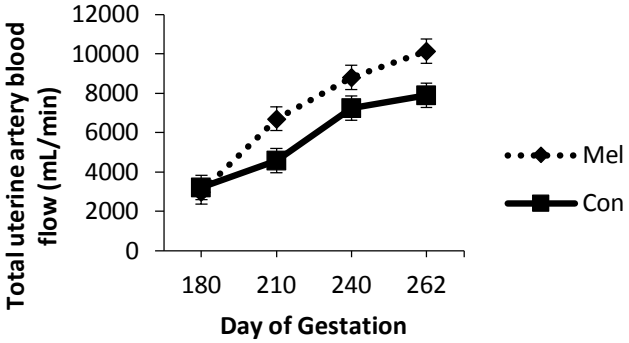
A main effect of gestational day (P < 0.0001) was observed for contralateral uterine artery blood flow, which increased from d 180 to d 240 (Figure 3). Contralateral uterine artery RI and PI (data not shown) were not different across gestational day (P > 0.09) or dietary treatment (P > 0.28). A main effect of gestational day (P < 0.0001) was observed for contralateral diameter of the uterine artery, which increased as gestation proceeded. Dietary treatment did not influence (P = 0.87) contralateral diameter of the uterine artery.

Figure 3. Contralateral uterine artery blood flow



[3] Contralateral uterine artery blood flow in heifers treated with or without dietary melatonin from day 190 to 262 of gestation. A main effect of gestational day (P < 0.0001) was observed for contralateral uterine artery blood flow, with blood flow increasing from d 180 to d 240.

Figure 4. Total uterine artery blood flow



[4] Total uterine artery blood flow in heifers treated with or without dietary melatonin from day 190 to 262 of gestation. Main effects of gestational day (P < 0.0001) and melatonin treatment (P = 0.0091) were observed for total uterine blood flow.

A main effect of gestational day and melatonin treatment was observed for total uterine artery blood flow (Figure 4). Total uterine blood flow was increased (P = 0.009) by 25% in the MEL treated heifers compared to the CON.

Main effects of gestational day (P = 0.002) and dietary treatment (P < 0.0001) were observed for total serum antioxidant capacity (Figure 5). Total serum antioxidant capacity was increased on days 210, 240, and 262 of gestation compared to day 180. There was also a main effect of dietary treatment (P < 0.0001) when examining total serum antioxidant capacity, which was increased by 39% in MEL treated heifers when compared to CON.

Implications

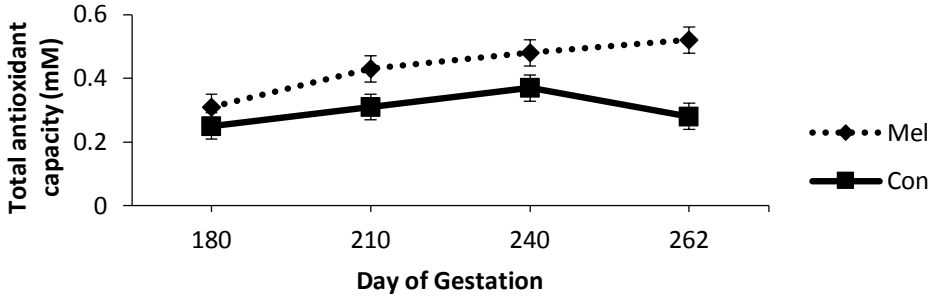
In the present study, ipsilateral uterine artery blood flow, total uterine artery blood

flow, and total antioxidant capacity were increased in pregnant heifers supplemented with dietary melatonin. In addition, no main effects or interactions of melatonin supplementation were observed for heifer body weight, daily feed intake, contralateral blood flow, or gestational length. Melatonin has vasodilation capabilities and could have the potential of increasing blood flow antioxidant capacity in pregnant heifers. Additional studies addressing uteroplacental hemodynamics in models of improved fetal growth are critical, as a paucity of information exists on these stimulatory pathways.

A limited number of studies have utilized Doppler ultrasonography to examine reproductive tract blood flow measurements in cattle. One of the first studies examining uterine artery hemodynamics with Doppler ultrasonography included two Simmental cows and one Brown Swiss cow that were both uniparous and nonlactating (Bollwein et al., 2001). At 7 months of gestation, ipsilateral uterine artery blood flow was approximately 5 L/min, while the contralateral uterine artery was approximately 1.5 L/min (Bollwein et al., 2001). Using surgically implanted electromagnetic flow probes, Ferrell and Ford (1980) observed approximately 3.7 L/min at 7 months of gestation. Reynolds and Ferrell (1987) using the steady-state diffusion method (injection of radioactive substances) observed approximately 7 L/min at 7 months of gestation. The current study observed approximately 5 L/min in the ipsilateral horn with the heifers that were treated with melatonin compared to the controls having approximately 3 L/min at 7 months of gestation. The observations from the current study using ultrasonography are within range of previously recorded methods. In addition, ultrasonography is a less invasive technique and has no withdrawal period.

There are several implications that melatonin supplementation could have on altering uterine artery hemodynamics thus negating the consequences of fetal growth restriction. Compromised pregnancies have been shown to have a decrease in uterine blood flow, which is commonly associated with fetal growth restriction. Increased uterine blood flow has the potential to increase placental transport capacity supporting fetal growth and metabolism. With the observed increase in total uterine artery blood flow, there could be future implications of increased postnatal growth of offspring via in utero developmental programming.

Figure 5. Total antioxidant capacity



[5] Maternal total antioxidant capacity in heifers treated with or without dietary melatonin from day 190 to 262 of gestation. Main effects of gestational day ($P = 0.002$) and dietary treatment ($P < 0.0001$) were observed for total serum antioxidant capacity.

Various melatonin-mediated mechanisms have been proposed for altering vascular function. The current study observed an increase in total antioxidant capacity during melatonin supplementation, which could be leading to the increased uterine artery blood flow. Moreover, melatonin's antioxidant capabilities could result in less stress during pregnancy leading to fewer cases of compromised pregnancies. Future studies will examine various therapeutic supplementation strategies to improve costs and examine potential offspring programming responses.

Acknowledgments

This work was funded through the Mississippi Agriculture and Forestry Experiment Station's Strategic Research Initiative. The authors would like to thank the staff at the Bearden Dairy Research Center, faculty that assisted with BCS measurements (L. Adams and J. Graves), and students that assisted with sample collections (L. Grossner, C. Hardin, and B. Voelz).

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Effect of an induced double ovulation on blood perfusion of corpora lutea, peripheral concentrations of progesterone, and progesterone inactivating enzymes in the liver

B.E. Voelz, G.F. Cline, A.M. Muth-Spurlock, C.G. Hart, C.O. Lemley, J.E. Larson

Department of Animal and Dairy Sciences, Mississippi State University, MS

Research Summary

The objective of this study was to determine if the induction of a second corpus luteum (CL) would alter blood perfusion of CL, circulating concentrations of progesterone, or liver enzymes responsible for the breakdown of progesterone. Twenty eight cows were used for this experiment with 19 responding to the treatments applied. Cows were synchronized using Ovsynch and either received no additional treatment and thus had 1 CL or an injection of human chorionic gonadotropin to induce a second ovulation, and thus had 2 CL. Blood samples were taken daily to determine concentrations of progesterone and a single liver biopsy was collected to measure enzymes which clear progesterone from the blood. Cows that had 2 CL had increased total blood perfusion of those CL compared to cows with just a single CL. Concentration of progesterone was similar between cows with 1 or 2 CL. Furthermore, liver enzyme activity was also similar between treatment groups. Based on results from the current experiment, a double ovulation may not impact progesterone concentrations necessary to maintain pregnancy.

Introduction

Steady declines in reproductive efficiency in dairy cattle have been documented over the past 60 years including decreased pregnancy rates and increased embryonic mortality. Progesterone is the hormone necessary for the maintenance of pregnancy and it is produced by the corpus luteum (CL) in the ovary. Decreased concentrations of progesterone may be partly responsible for increases in pregnancy loss and this could be due to increased break down of progesterone in the liver, decreased secretion from the CL, or both (Inskeep and Dailey, 2005). Suboptimal reproductive efficiency has a large, negative impact on the economics of a dairy operation.

Double ovulation is common in dairy cattle and can lead to the undesirable occurrence of twinning. Silva Del Rio et al. (2006) found that 93% of twins in dairy cattle are non-identical meaning that the majority are the result of a double ovulation. Cows carrying a twin pregnancy are 5.4 times more likely to experience pregnancy loss than singleton pregnancies (Lopez-Gatius et al., 2004). The physiological mechanism for this difference in pregnancy loss still eludes researchers.

Ultrasonography has allowed for the monitoring and quantification of blood perfusion of the CL. The CL is highly vascularized and with the use of power Doppler ultrasonography, blood perfusion can be recorded. Herzog et al. (2010) found a positive correlation between luteal blood perfusion and plasma concentrations of progesterone. Because progesterone is vital to maintaining pregnancy, it is important that sufficient blood perfusion is present to allow progesterone to enter circulation.

Therefore, the objective of this study was to determine if the induction of an accessory CL, via human chorionic gonadotropin (hCG), alters blood perfusion of CL, peripheral concentrations of progesterone, or progesterone inactivating enzymes in the liver.

Procedures

All procedures in this study were approved by the Institutional Animal Care and Use Committee of Mississippi State University.

A total of 28 late lactation, Holstein cows were housed in a free stall barn at the Joe Bearden Dairy Research Center (Starkville, MS). Cows were allowed ad libitum access to a TMR formulated to meet or exceed dietary requirements of lactating cows (NRC, 2001). Average DIM was 289 ± 60 d (range of 163 to 399 d) and average milk production was 71.4 ± 21.3 lb/d. From mid-July to early November, cows had their estrous cycles synchronized using the Ovsynch protocol (Pursley et al., 1995), with d 0 being the day of the second injection of GnRH. Seven days after the completion of Ovsynch (d 7), ovaries were examined using transrectal ultrasonography (10.0 to 5.0-MHz linear-array transducer, MicroMaxx, SonoSite, Inc., Bothell, WA). Cows that responded to Ovsynch and had a single CL remained in the study and either received an injection of hCG (1,000 IU i.m.; Chorulon, Intervet Inc., Millsboro, DE) to induce an accessory CL, or received no additional treatment. Cows that did not respond to Ovsynch or had multiple CL at this time were excluded from the current repetition. Cows that did not respond or were excluded from the previous repetition were re-enrolled using the same procedures previously stated.

On d 10, cows that had received hCG were required to have 2 CL and those that failed to produce 1 accessory CL in response to the hCG were excluded from the study. Cows in the control group were also examined to ensure that the single CL had not regressed. Cows that failed to respond to the initial synchronization or failed to produce 1 accessory CL were re-submitted to Ovsynch and subsequent treatments and evaluations, with a minimum of a 15 d period between repetitions.

From d 10 to 18, ovaries were evaluated using transrectal ultrasonography. Blood perfusion of the CL was evaluated using the power flow option of the ultrasound machine and 2 still images and 1 video were recorded for each CL for later analysis. Blood samples were collected daily from d 10 to 18.

On d 13, a liver biopsy was performed following the previously published methods of Lemley et al. (2010). Body weights were recorded prior to milking on d 12 and after milking on d 13 and averaged. On d 18 after completion of daily measurements and blood sampling, all cows were administered an injection of $PGF_{2\alpha}$ (5 mL i.m.; Lutalyse, Zoetis Inc., Kalamazoo, MI) to regress CL present.

Liver samples collected on d 13 were analyzed for protein concentration and assayed for hepatic enzymes Cytochrome P450 1A, 2C, 3A, AKR, and UGT. Concentrations of progesterone were determined via Radioimmunoassay (Siemens Healthcare Diagnostics Inc., Los Angeles, CA).

Images and videos were uploaded from the ultrasound machine and saved to an external location. Images were then analyzed using ImageJ software (version 1.47, US National Institutes of Health, Bethesda, MD) for quantification of total pixels of blood perfusion. Images and videos were visually scored by two independent and trained technicians using a scale from 0 to 9 (0 = 0% perfusion, 9 = 100% perfusion).

The concentration of progesterone, total luteal volume, and blood perfusion of the CL were analyzed using repeated measurements in the MIXED procedure of SAS (SAS software version 9.3, SAS Institute Inc., Cary, NC) with autoregressive-1 as the covariate structure. The model contained cow which was considered a random variable and milk production, DIM, and body weights which were considered covariates. Treatment effect for hepatic enzymes was analyzed using the MIXED procedure of SAS. Means were separated using the PDIFF option of the LSMEANS statement. Pearson correlation coefficients were determined using the CORR procedure of SAS. Least-square means and pooled standard error are reported. Statistical significance was declared at $P < 0.05$ and a tendency was declared when $P > 0.05$ but ≤ 0.10.

Results

The response rate for cows producing a single CL on d 7 was 63.3% (38 of 60 cows). Cows administered hCG produced an accessory CL 36% (9 of 25 cows) of the time. Peripheral concentrations of progesterone were not different (P = 0.62) between cows with 1 CL (7.19 ± 0.71 ng/mL) or cows with 2 CL (7.73 ± 0.84 ng/mL). There was an interaction (P = 0.02) between treatment and day for total luteal volume (Figure 1). On d 10 to 18, total luteal volumes were not different between treatment groups within a given day.

Figure 1. Total luteal volume between cows receiving control or human chorionic gonadotropin treatment

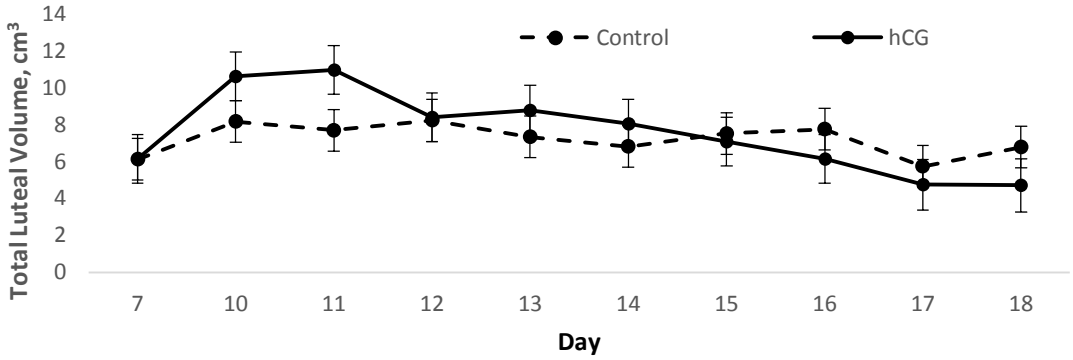
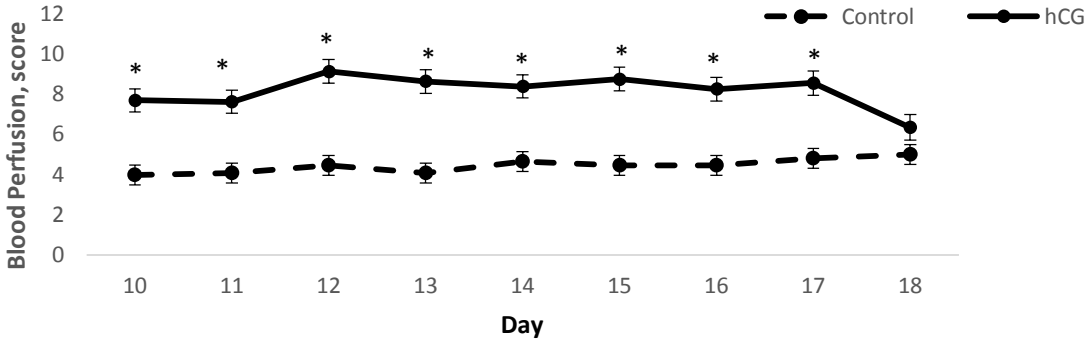


Figure 2. Visual characterization of total perfusion from images on d 10 to 18, between cows receiving control or human chorionic gonadotropin treatment



* Denotes difference (P <0.05) between treatments

Total integrated densities were greater (P = 0.001) in cows with 2 CL (7,781.44 ± 758.06 pixels) than cows with 1 CL (4,399.69 ± 638.95 pixels). Similarly, blood perfusion scores were greater (P < 0.001) in cows with 2 CL (6.96 ± 0.32) than cows with 1 CL (3.82 ± 0.27) for visually scored images. There was a treatment by day interaction (P = 0.02; Figure 2) for videos visually scored for blood perfusion. Blood perfusion measured from videos was different

($P < 0.001$) between treatment groups for d 10 through 17 and tended to be different ($P = 0.10$) on d 18.

There was no significant difference between cows with 1 CL or cows with 2 CL for all liver enzymes responsible for progesterone clearance tested in this study.

Implications

Early embryonic loss continues to be an issue in dairy cattle. Current research continues to investigate the relationship between progesterone and embryo survival. Blood perfusion from the CL is one of the recent advances that can be used as a valuable tool to continue to investigate CL function without invasive procedures. Furthermore, metabolic demand of dairy cattle continues to grow as producers demand for increased milk production per cow also increases. This metabolic increase could have a negative effect on peripheral concentrations of progesterone due to a potential increase in progesterone clearance. Though we did not see a difference in enzymes related to progesterone clearance in this study, more research is required to fully understand the impact that progesterone clearance might have on reproductive performance. Overall, the increased blood perfusion of CL in cows with 2 CL did not correspond to peripheral concentrations of progesterone or clearance as measured by hepatic enzyme activity, perhaps indicating that a double ovulation does not impact progesterone necessary to maintain pregnancy. More research is necessary to determine the underlying cause of decreased fertility and early embryonic mortality in dairy cattle with singleton or twin pregnancies.

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Effects of USDA Beef Quality Grade and Cooking on Fatty Acid Composition of Neutral And Polar Lipid Fractions[1]

J. F. Legako[a], T. T. N. Dinh[b], M. F. Miller[c], and J. C. Brooks[c]
a Department of Nutrition, Dietetics, and Food Sciences, Utah State University, Logan, UT 84322
b Department of Animal and Dairy Sciences, Mississippi State University, Starkville, MS 39762
c Department of Animal and Food Sciences, Texas Tech University, Lubbock, TX 79409
1 Funded by the Beef Checkoff

Research Summary

The effects of USDA beef quality grade (QG; Prime, Low Choice, and Standard; n = 8) and cooking (RC) on fatty acid (FA) concentrations (mg/g dry matter) and percentages of neutral and polar lipid fractions (NL and PL, respectively) from strip steaks were explored. An increase in QG led to an accumulation of most FA, especially in the NL fraction ($P < 0.001$). Common effects on FA percentages were two-way interactions of either QG or RC with LF ($P < 0.05$). Fatty acids were affected differently by QG and RC depending on their originating LF. Monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) percentages of the PL were dependent on QG ($P < 0.05$). Cooking and QG had minimal impact on the FA percentages of the NL, however, greatly influenced PL MUFA and PUFA percentages. There was evidence indicating that dry heat cookery affected not only PUFA as generally thought, but also the MUFA of PL fraction.

Introduction

Oxidation of lipids is commonly believed to occur during storage and cooking. Typically oxidation during storage is believed to produce volatile off-flavors and off-odors. Interestingly, the positive volatile flavors and aromas that are produced during cooking follow the same basic reaction pathways as oxidation during storage (Ladikos and Lougovis, 1990). However, subtle variation in thermal and storage oxidation mechanisms produce differing volatile mixtures (Mottram, 1987). Unlike prolonged storage oxidation of FA, thermal oxidation usually induces the dimerization of lipid degradation products and even the non-oxidative decomposition of SFA at a rapid rate to produce desirable volatile compounds, such as saturated and unsaturated aldehydes and ketones, important components of cooked flavor (Nawar, 1984; Mottram, 1998; Selke, Rohwedder and Dutton, 1977, 1980).

Polyunsaturated fatty acids (PUFA) have lower melting points and are more susceptible to oxidation than monounsaturated and saturated fatty acids (MUFA and SFA, respectively). Intramuscular lipids are composed of the NL primarily consisting of triglycerides and the PL containing mostly phospholipids. The FA composition of the PL fraction contains a large proportion of PUFA. Polar lipids are known to be more susceptible to oxidation (Mottram, 1998) and the PUFA content of PL is the primary substrate of rancidity development (Igene et al., 1980). The PUFA in the PL exhibit similar susceptibility to thermal oxidation where cooking affects the PL to a greater extent than it does the NL (Terrell etal., 1968).

As part of a comprehensive investigation on beef flavor contributing compounds, it was the objective of this study to determine how USDA quality grade and cooking changed FA composition, as potential flavor precursors, and whether the hypothesized effects varied by lipid fractions (LF).

Procedures

Product Selection. Twenty-four beef strip loins (Longissimus lumborum; Institutional Meat

Purchase Specifications # 180, North American Meat Processors Association, 2010) were collected from carcasses of three USDA quality grades (Prime, Low Choice, and Standard; USDA, 1997; n = 8) from "A" maturity animals in the Midwest region of the US. Carcass marbling score was determined by trained individuals through comparison of visual marbling within the *Longissimus* muscle (LM) at the 12th and 13th rib with official USDA marbling photographs (National Cattlemen's Beef Association, Centennial, CO, USA). Marbling scores [Prime (Slightly Abundant^{00} or greater), Low Choice (Small^{00} to Small^{100}), and Standard (Traces^{100} or lower)], lean maturity (A^{00} to A^{100}), skeletal maturity (A^{00} to A^{100}), fat thickness (cm), LM area (cm^2), hot carcass weight (kg), and percentage of kidney pelvic and heart fat were all collected to determine the USDA quality and yield grades (USDA, 1997; Table 1). Strip loin subprimals from the selected carcasses were vacuum-packaged (Barrier shrink bags, Sealed Air Corporation, Elmwood Park, NJ, USA) and transported to the Texas Tech University Gordon W. Davis Meat Laboratory, where they were aged at 2 to 4 °C in the absence of light for 21 days postmortem before fabrication.

Table 1. Carcass characteristics of USDA Prime, Low Choice, and Standard quality grades (n = 8)

Measurement	Prime	Low Choice	Standard	Std.
Hot carcass weight, kg	381.5	374.4	377.2	11.2
LM area[2], cm^2	80.6^b	83.7^b	97.3^a	3.2
12th-rib fat, cm	1.6^a	1.5^a	0.8^b	0.18
KPH[3], %	3.1^a	3.0^a	2.1^b	0.19
Marbling[4]	774.2^a	429.2^b	264.6^c	12.8
Calculated yield grade	3.1^a	1.7^b	1.0^b	0.24
Skeletal maturity	48.3	35.0	42.5	3.9
Lean maturity	48.3	48.3	57.5	3.4
Overall maturity	48.3	41.7	50.0	3.3

[1] Pooled standard error of means.
[2] Area of the *Longissimus* muscle (LM) at the 12th and 13th rib.
[3] Percentage of kidney, pelvic and heart fat of the carcass.
[4] Marbling assessed at LM surface between the 12th and 13th rib by comparison with official USDA marbling photographs (National Cattlemen's Beef Association, Centennial, CO, USA). Marbling score units: 200 = Traces^{00}; 300 = Slight^{00}; 400 = Small^{00}; 500 = Modest^{00}; 600 = Moderate^{00}; 700 = Slightly Abundant^{00}; 800 = Moderately abundant^{00}.
[a,b,c] Means within a row lacking a common superscript differ ($P \leq 0.05$).

Fabrication and Sample Preparation. Strip loins remained in sealed vacuum packaging until fabrication on day 22 postmortem. Strip steaks were cut to 2.54-cm thickness and trimmed to 0-cm external fat thickness. Posterior steaks containing the *Gluteus medius* muscle were excluded. Within each strip loin, four steaks were cut from the anterior end of each strip loin after removal of a "face steak" to straighten the anterior end. Anterior steaks numbering 1 and 3 were taken as raw samples and steaks numbering 2 and 4 were designated for cooking. Cooking was performed on an electric clamshell grill (George Foreman, Original Next Grilleration, model GRP99, George Foreman, Westmont, NJ, USA) to a medium degree of doneness (71 °C; AMSA, 1995), monitored by a Cole Parmer Type J thermocouple (Vernon Hills, IL, USA). Remaining external fat, accessory muscles, and connective tissues were removed from all cooked and raw steaks, leaving only the separable lean tissue of the *Longissimus lumborum* muscle. The trimmed cooked and raw steaks were cubed, frozen in liquid nitrogen, and homogenized to a fine powder. The homogenized samples were stored at -80 °C until subsequent analyses.

Chemical Analysis. Total lipids were extracted from 1-g homogenates of either raw or cooked samples using a modified Folch method (Folch et al., 1957). The extracted lipids were fractionated using a Resprep® silica gel cartridge (Restek Corporation, Bellefonte, PA)

as described by Juaneda and Rocquelin (1982). Both lipid fractions were dried under a gentle nitrogen stream at 40 °C and stored at -80 °C until the subsequent fatty acid derivatization.

Table 2. Abbreviations and common names[1] of fatty acids

Abbreviations	Common Names	Abbreviations	Common Names
10:0	Capric	17:1	Heptadecenoic
12:0	Lauric	18:1 *trans*	Elaidic
14:0	Myristic	18:1 *cis*-9	Oleic
15:0	Pentadecylic	20:1	Eicosenoic
16:0	Palmitic	18:2 n-6 *trans*	Linolelaidic (Internal
17:0	Margaric	18:2 n-6	Linoleic
18:0	Stearic	18:3 n-6	γ-Linolenic
20:0	Arachidic	18:3 n-3	α-Linolenic
21:0	Heneicosanoic	20:2	Eicosadienoic
22:0	Behenic	20:3 n-6	Dihomo-γ-linolenic
14:1	Myristoleic	20:4 n-6	Arachidonic
16:1	Palmitoleic		

[1] Supelco® 37 Component FAME Mix, Sigma-Aldrich, St. Louis, MO, USA

Fatty acids in the NL were saponified and derivatized to fatty acid methyl esters (FAME) using sodium methoxide in methanol (Li and Watkins, 2001), whereas the saponification and derivatization of FA in the PL were performed with methanolic potassium hydroxide (Maxwell and Marmer, 1983). Linolelaidic (18:2 n-6 trans) methyl ester (Cat # FLSA-093, Ultra Scientific, N. Kingstown, RI, USA) was used as the internal standard during the derivatization. Fatty acid methyl esters were analyzed on an Agilent Technologies (Santa Clara, CA, USA) 6890N series gas chromatography system equipped with an HP-88 capillary column (100 m × 0.25 mm i.d.; Agilent Technologies, Santa Clara, CA, USA) and a flame-ionization detector. Fatty acid methyl esters were identified by authentic FAME standards (Supelco® 37 Component FAME Mix, Sigma-Aldrich, St. Louis, MO, USA) and quantified by an internal standard calibration method. Concentrations of individual FA were calculated as milligram per 1 g of dry matter. Total FA concentration (mg/g dry matter) was also calculated for each fraction and for the entire FA composition. Percentages of FA were computed by dividing the individual FA concentration (mg/g dry matter) by the corresponding LF concentration (mg/g dry matter) then multiplying by 100. Percentages of NL and PL fractions were calculated by dividing the LF concentrations (mg/g dry matter) by the total FA concentration (mg/g dry matter). The common names and corresponding abbreviations of individual FA are listed in Table 2.

Statistical Analysis. A split-split-plot design was used with QG, subprimal (strip loin), raw vs. cooked (RC), and lipid fractions (LF) serving as main factor, experimental unit or whole plot, split-factor, and split-split-factor, respectively, for the statistical analysis of percentages and concentrations of individual FA and FA categories. However, a split-plot design was used to analyze the percentages of LF (based on entire FA composition; using QG and RC factors) and the differences in LF concentrations between cooked and raw steaks (mg/g dry matter; using QG and LF factors). The effects of QG, RC, LF, and their interactions on concentrations and percentages of individual FA, FA categories, and LF were statistically analyzed by SAS version 9.3 (Cary, NC, USA). Analysis of variance was based on a generalized linear mixed model, estimated by the GLIMMIX

procedure of SAS. Statistical significance was determined at $P \leq 0.05$. Denominator degrees of freedom were calculated using the Kenward-Rogers approximation.

Figure 1. Percentages of neutral (NL) and polar (PL) lipid fractions (LF) of raw and cooked Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Overall effects of USDA quality grade and cooking were observed ($P < 0.001$)

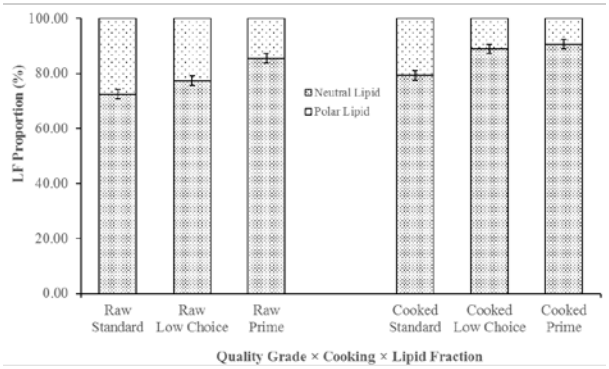
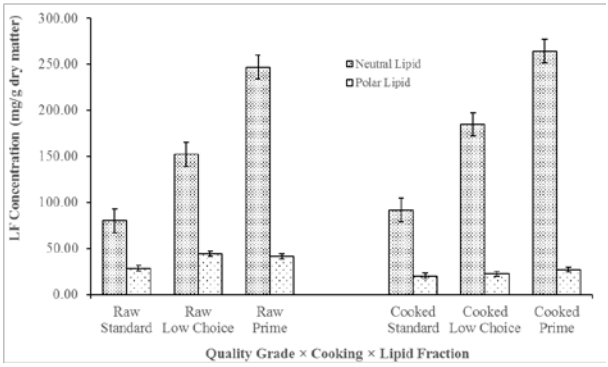


Figure 2. Concentrations (mg/g dry matter) of neutral (NL) and polar (PL) lipid fractions (LF) of raw and cooked Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interactions (quality grade×lipid fraction, $P < 0.001$; raw/cooked×lipid fraction, $P = 0.031$) were observed.



Results

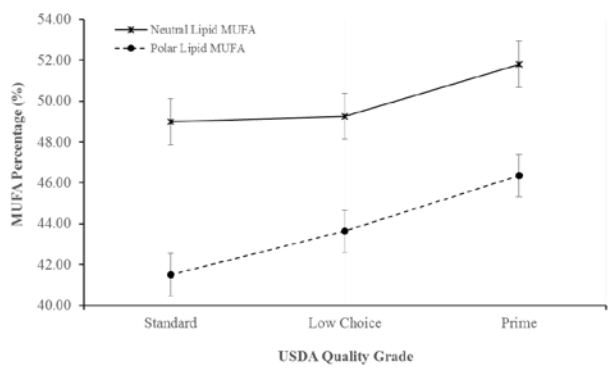
Overall Effects of USDA Quality Grade and Cooking on Entire Lipid Fractions. There were main effects of QG ($P < 0.001$) and RC ($P < 0.001$) on the percentage of LF (Table 3). In raw steaks, Prime steaks had the most NL and the least PL (85.43% and 14.57%, respectively; $P < 0.001$), whereas Low Choice and Standard steaks had similar LF percentages (77.38 and 72.45% NL and 22.62 and 27.55% PL, respectively; $P = 0.054$). In cooked steaks, Prime and Low Choice steaks had similar LF percentages ($P = 0.501$), which were greater in NL and less in PL compared with Standard steaks ($P < 0.001$). Cooking increased the NL and decreased the PL in Prime, Low Choice, and Standard steaks by 5, 11, and 7%, respectively (Figure 1; $P < 0.001$). Regardless of QG and in both raw and cooked steaks, the percentage of the NL was greater than that of the PL (Table 3; $P < 0.001$). However, as reported previously, the magnitude of the difference were not the same among QG ($P < 0.001$) and after cooking ($P < 0.001$).

A significantly lower PL concentration in Standard steaks was unexpected. Warren et al. (2008) reported an approximately 7 mg phospholipids/g wet sample across a wide range of 41 to 96 mg total lipid/g wet sample. However, as reported by Larick and Turner (1989), it was possible for lean beef muscle, e.g., *Pectoralis*, with an estimate of 30 mg total lipid/g wet sample to have only 2.9 mg polar lipids/g wet sample. Markedly lower intramuscular fat possibly resulted in enough differences in tissue structure to alter the composition and distribution of structural components such as phospholipids (Rule et al., 1997), the major lipid class of the PL fraction.

An increase in NL concentration was only significant in Prime and Low Choice steaks ($P < 0.031$). A closer look at the total fatty acid concentration of each LF (mg/g dry matter;

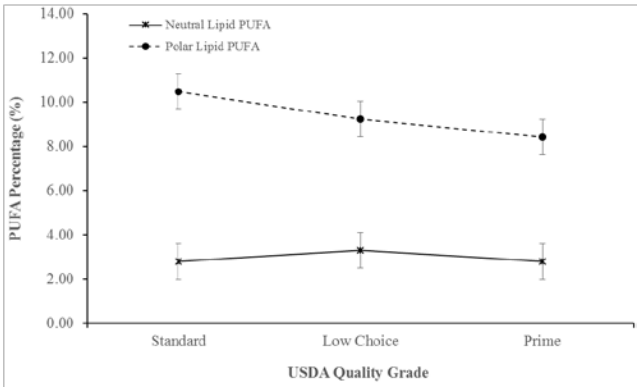
Table 4) revealed that cooking caused more changes ($P < 0.001$) in Low Choice steaks (32 mg/g in NL and 22 mg/g in PL) than Prime (17 mg/g in NL and 14 mg/g in PL) and Standard steaks (11 mg/g in NL and 8 mg/g in PL). The PL concentration was decreased ($P < 0.001$), whereas the NL concentration was increased ($P < 0.001$) after cooking (Figure 2). Prime and Low Choice raw steaks had greater PL concentrations (41.44 mg/g and 44.41 mg/g, respectively; $P < 0.001$) than that of Standard steaks (28.64 mg/g). However, after cooking, PL concentrations of all QG were decreased and

Figure 3. Percentages of monounsaturated fatty acids (MUFA) from the neutral and polar lipid fractions of raw Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interaction (quality grade×lipid fraction, $P \leq 0.001$) was observed.



Varying Effects of USDA Quality Grade on the Fatty Acid Composition of Lipid Fractions. Percentages of MUFA and PUFA in each LF differed by QG ($P \leq 0.014$, Table 3). These differences were caused by the two predominant MUFA and PUFA, 18:1 cis-9 and 18:2 n-6 (Table 3). It can be observed that the percentages of both MUFA and PUFA of the NL in raw steaks remained constant across QG (Figure 3 and 4; $P > 0.05$), although there were clear incremental changes in concentration of NL MUFA and PUFA ($P < 0.05$; Table 4; Figures 5 and 6, respectively) between raw steaks of Prime, Low Choice and Standard QG. As expected, the decreases in FA concentrations of did not differ ($P > 0.089$; Table 3, Figure 2). An increase in NL concentration could be a result of solid loss during cooking. Hydrolysis and migration of PL components during cooking from tissue membrane could provide another FA influx to the NL, which could also explain a significant decrease in the PL concentration. An experiment similar to what Yarmanda and Homayouni (2009) conducted can provide better insights into microstructural and molecular changes of lipid components during cooking.

Figure 4. Percentages of polyunsaturated fatty acids (PUFA) from the neutral and polar lipid fractions of raw Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interaction (quality grade×lipid fraction, $P \leq 0.001$) was observed



the NL mirrored changes in marbling scores from Prime to Standard (Table 1). It is very interesting that such drastic differences in MUFA concentrations (127.73, 74.98 and 40.28 mg/g for Prime, Low Choice and Standard, respectively) did not result in any differences in NL MUFA percentages ($P > 0.05$).

The percentages of MUFA and PUFA of the PL in raw steaks, however, were significantly differentiated by QG ($P = 0.007$ and 0.014, respectively) with Prime having the greatest proportion of MUFA and the least proportion of PUFA (Figure 3 and 4). Although statistically significant, only a 5% decrease in MUFA proportion and a 2% increase in PUFA proportion of the Standard PL (Table 3) were

caused by drastic decreases in PL MUFA and PUFA concentrations in Standard steaks (12.25 and 2.80 mg/g , respectively) compared with Prime (19.30 and 3.39 mg/g) and Low Choice (19.52 and 4.00 mg/g). Such changes were a direct result of the difference in LF concentration among QG (41.45, 44.41, and 28.64 mg/g for Prime, Low Choice and Standard, respectively). This compositional shift in PL percentages was driven by 18:1 cis-9 and 18:2 n-6, the predominant FA in the MUFA and PUFA categories. Oleic acid percentages of the PL fraction were greater (P = 0.001) in Prime than in Low Choice and Standard, whereas 18:2 n-6 percentage of the PL was greater (P < 0.05) in Low Choice and Standard than in Prime (Table 3). No such patterns were found for the percentages of 18:1 cis-9 and 18:2 n-6 of the NL (Table 3). The concentration pattern of PL MUFA as previously mentioned also followed the similar pattern of 18:1 cis-9 which showed 15.32, 15.19 and 10.10 mg/g in Prime, Low Choice and Standard raw steaks (Table 4).

Figure 5. Concentration (mg/g dry matter) of monounsaturated fatty acids (MUFA) from the neutral and polar lipid fractions of raw Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interaction (quality grade×lipid fraction, P < 0.001) was observed.

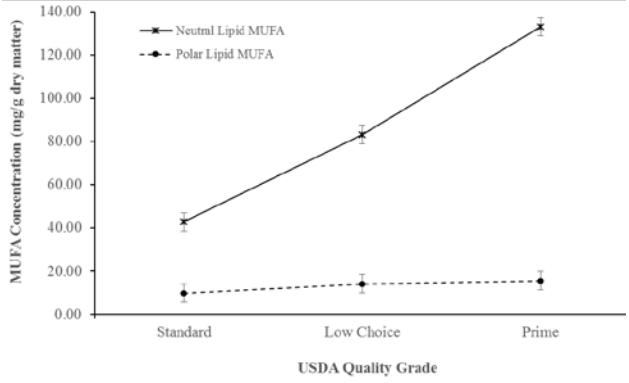
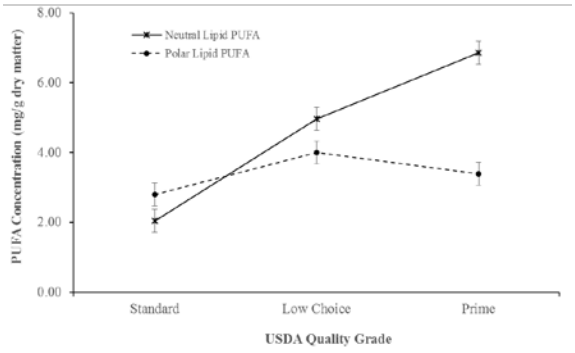


Figure 6. Concentration (mg/g dry matter) of polyunsaturated fatty acids (PUFA) from the neutral and polar lipid fractions of raw Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interaction (quality grade×lipid fraction, P < 0.001) was observed.

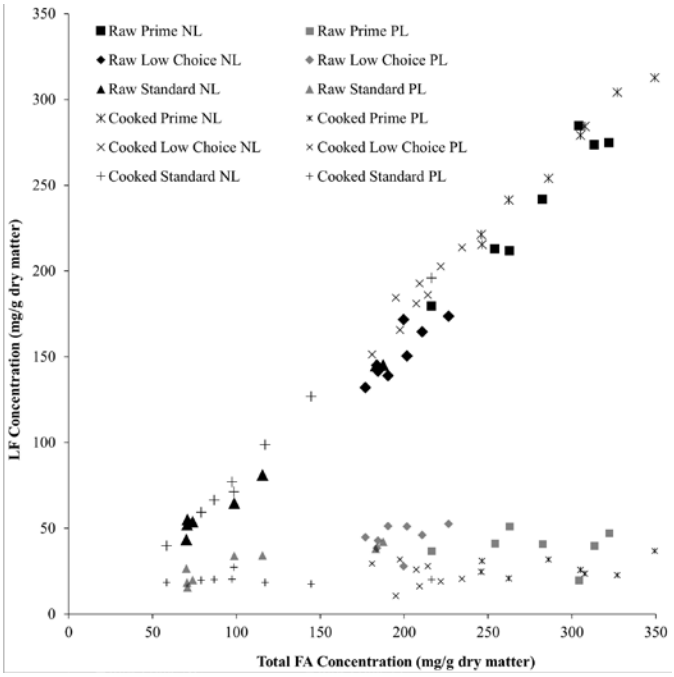


Biological effects of fat content, i.e. QG, on FA concentrations have been reported numerously for the entire FA composition (see reviews by Wood et al., 2008; Scollan et al., 2006), which revealed that as fat content increases, concentrations of all FA increase accordingly. However, MUFA and SFA increase to a much greater extent because of a direct result of triglyceride accumulation (primary component of NL) during animal fattening. However, the data in this study indicated that a drastic difference in fat content, e.g., between Prime and Standard QG, could also alter the concentration of the PL, which in turn could impact the concentration and percentages of PUFA. Regardless of LF, 18:1 cis-9 is the most prominent FA in beef (Wood et al., 2008) because it tends to occupy the primary positions of both triglycerides and phospholipids (deMan, 1999).

In raw steaks across all QG, it was clear that the FA composition of the NL fraction had a much greater concentrations and was more saturated (Table 3 and 4). The NL had more SFA, MUFA, and PUFA simply because it constitutes a much greater proportion of the entire FA composition as previously mentioned. An exception was that concentrations and percentages of 20:3 n-6 and 20:4 n-6 which were greater in PL compared

with NL (Table 3 and 4; $P < 0.001$). As a result of great variation in fat content, the concentration of FA in the steaks and their percentages in each LF were expected to interact with QG. However, percentages of 14:1, the second most prominent MUFA, and 16:0, the most prominent SFA were greater in Prime and Low Choice than in Standard across both LF ($P \leq 0.002$; Table 3). It is important to recognize that 14:1 and 16:0 are two of the primary products of fatty acid de novo synthesis and that percentage calculations eliminate the simple causal effects of greater lipid concentrations, e.g., Prime and Low Choice QG, thereby implicating the possible role of FA de novo synthesis in defining FA composition where fat content is drastically different.

Figure 7. Concentrations of neutral (NL) and polar (PL) lipid fractions (LF) plotted against total fatty acid (FA) concentration (mg/g dry matter) of raw and cooked Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8).



In this study, carcasses from Prime, Low Choice, and Standard QG were separated by visual marbling scores of 774.2, 429.2, and 264.6, respectively ($P < 0.001$; Table 1). The total fatty acid content also differed ($P < 0.001$) among QG (288.59, 196.72, and 108.79 mg/g for Prime. Low Choice, and Standard raw steaks, respectively; calculated from Table 4). Moreover, lipid fractionation data (Table 4, Figure 7) indicated fairly constant concentrations of FA in the PL in the contrary of decreased concentrations of FA in the NL as QG changed from Prime to Standard. As mentioned previously, 14:1 and 16:0 percentages were greater in Prime and Low Choice than in Standard raw steaks ($P \leq 0.002$). Interestingly, as a confirmation of the roles of the NL during lipid accumulation, percentages of 14:1 and SFA were greater in the NL fraction than in the PL fraction ($P \leq 0.033$). Neutral lipids are richer in SFA and MUFA than the PL (Itoh et al., 1999; Scollan et al., 2006). In this study, the increase in MUFA percentages occurred in response to an increase in QG (Table 3), whereas the percentage of PUFA was decreased. A greater proportion of PUFA has previously been attributed to a greater potential of lipid oxidation, which negatively affects flavor (Larick and Turner, 1990).

Varying Effects of Cooking on the Fatty Acid Composition of Lipid Fractions. The effects of cooking on FA composition was most evident in the general FA categories (SFA, MUFA, and PUFA) of NL and PL fractions. Changes in the percentages of MUFA and PUFA by cooking were dependent on LF ($P \leq 0.001$, Table 3). Meanwhile, changes in SFA percentages with cooking were not dependent on LF ($P = 0.178$). The NL possessed a greater ($P < 0.001$) percentage of MUFA, whereas the PL possessed a greater ($P < 0.001$) percentage of PUFA in both raw and cooked steaks. The MUFA and PUFA percentages in the NL did not differ ($P > 0.05$) between raw and cooked steaks (Figure 8 and 9).

Figure 8. Percentages across USDA Prime, Low Choice, and Standard of monounsaturated fatty acids (MUFA) from neutral and polar lipid fractions of raw and cooked *Longissimus lumborum* steaks (n = 8). Two-way interaction (raw/cooked×lipid fraction, $P < 0.001$) was observed

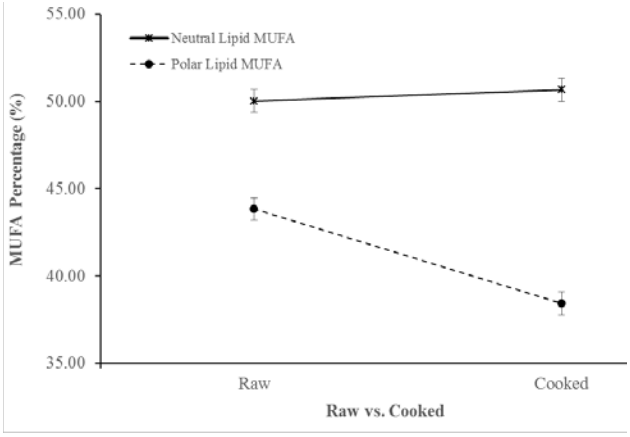
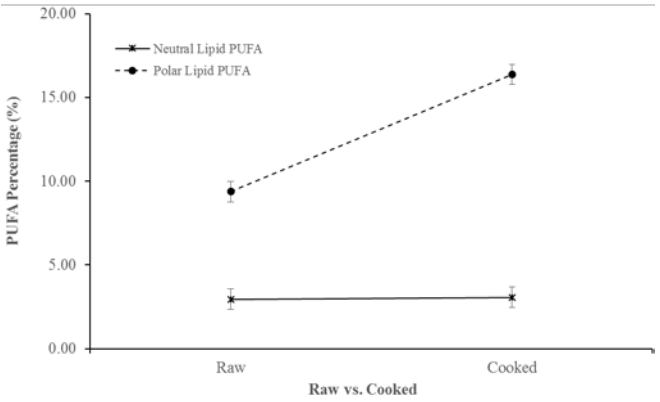


Figure 9. Percentages across USDA Prime. Low Choice, and Standard quality grades of polyunsaturated fatty acids (PUFA) from neutral and polar lipid fractions of raw and cooked Prime, Low Choice, and Standard *Longissimus lumborum* steaks (n = 8). Two-way interaction (raw/cooked×lipid fraction, $P < 0.001$) was observed.



Previous comparisons between raw and cooked beef revealed few proportional differences in FA (Jiang et al., 2010; Harris et al., 1992; Smith et al., 1989). In some cases the general categories SFA and MUFA remained the same between raw and cooked samples, whereas PUFA were affected (Maranesi et al., 2005; Badiani et al., 2002). Still others determined that cooking affected each FA category (Alfaia et al., 2010). Although these results were inconclusive and these authors did not fractionate the lipids, their data support the NL results of this study through numerical similarities or in agreement of statistical significance.

However, previous studies with fractionated lipids from raw and cooked steaks indicated some differences in NL (Duckett and Wagner, 1998), e.g., increases in cooked NL SFA and PUFA percentages and decreases in NL MUFA. As previously stated, in this study, these FA categories were not significantly affected by cooking in the NL. In another study, NL SFA and MUFA were not affected by cooking (Igene et al., 1980). Overall, previously reported data and those in this study have revealed little or no effect on NL FA percentages in response to cooking.

Conversely, PL FA percentages showed a significant response to cooking. The MUFA in the PL were decreased ($P < 0.05$) by 5.4% in cooked steaks compared with raw steaks (Figure 8). The PUFA of PL was increased ($P < 0.05$) in the cooked steaks compared with the raw steaks (Figure 9). The decrease in MUFA and increase in PUFA of the PL is driven by 18:1

cis-9. Within the PL fraction, 18:1 cis-9 was approximately 34.9% of the FA composition in raw steaks and 30.3% in cooked steaks (Table 3), Although PUFA concentrations were decreased during cooking (Table 4), the disappearance of a large amounts (4.6% of PL composition in Table 3, or 6.2 mg/g in Table 4) of PL 18:1 cis-9 dramatically increased the proportion of the remaining PUFA in the PL fraction.

Previously, in contrast with this study, the PL PUFA percentage was found to decrease in response to cooking, whereas MUFA did not differ (Duckett and Wagner, 1998). Interestingly, in a separate study with fresh and frozen raw beef being cooked and compared, MUFA and PUFA of meat, which was frozen, then cooked, followed the similar trends in this study (Igene et al., 1980). Meanwhile, the fresh meat raw and cooked samples were similar to the study of Duckett and Wagner (1998).

These results imply that the PL fraction is more greatly affected by cooking. Mottram and Edwards (1983) reported minimal contributions of NL triglycerides to volatile compound development in response to heating. Their results showed that the PL fraction was the primary contributor to the development of volatile flavor compounds in meat. Thermal oxidation of 18:1 cis-9 leads to aldehydes, such as hexanal, octanal, and nonanal, which impact flavor, odor, and aroma (Cerny, 2007). These results indicate that both MUFA, specifically 18:1 cis-9, and PUFA of the PL are greatly affected by cooking.

The percentages of SFA and 16:0, the predominate SFA, was affected by cooking similarly among the three QG and the two LF, being greater ($P < 0.001$) in raw steaks than in cooked steaks (Table 3). These results are not fully supported by previous work of Duckett and Wagner (1998), who found only a numerical decrease ($P > 0.05$) in 16:0 with cooking and showed an increase in SFA percentage of total FA after cooking, contrary to the decrease observed in this study. However, the NL results of this previous work show a significant decrease in 16:0 with cooking similar to this study.

Changes in percentages of 18:0 and 18:3 n-6 in response to cooking were dependent on QG ($P \leq 0.011$, Table 3). Cooking decreased ($P < 0.011$) the percentages of these two FA in Standard steaks, but not in Low Choice and Prime steaks. Decreases in 18:0 of Standard steaks is contrary to results by Duckett and Wagner (1998), who found the percentage of 18:0 increased after cooking.

Interactions on 18:0 between QG and cooking are noteworthy because of the prominence of this saturated FA (12.9, 14.9, and 18.0 % in Prime, Low Choice, and Standard, respectively; Table 3). Previously, 18:0 was found to be negatively correlated with flavor desirability scores by trained panelists (Westerling and Hedrick, 1979). Negative correlations were also found between 18:0 and cooked beef fat aroma and cooked beef fat flavor (Melton et al., 1982). Additionally, 18:0 was positively correlated with milky-oily flavor, sour flavor, and fishy flavor (Melton et al., 1982). The findings of these studies suggest that quantity of 18:0 could be related to factors decreasing beef sensory quality. When calculating FA on a percentage basis, 18:0 decreased with QG, as previously described (Table 3). However, when quantifying FA on a concentration basis, 18:0 (mg/g) increased with QG (Table 4). Therefore, the cited negative correlations between 18:0 and cooked flavor are most likely a result of concentration changes in response to changes in total intramuscular fat content, rather than a direct causative effect by 18:0, a more stable saturated FA.

Implications

This study revealed that the FA are affected by QG, cooking, and LF. As reported by many studies, QG caused proportionate changes of total FA through a continuous deposit of FA into the NL fraction and to a lesser extent, some key

MUFA and PUFA into the PL fraction. The results in this study indicated that cooking had little impact on FA of the NL, however, caused great changes in the MUFA and PUFA of the PL. Future research on lipid-orginated beef flavor compounds should focus on the PL fraction.

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Table 3. Percentages of fatty acids and fatty acid categories (Saturated fatty acids, SFA; monounsaturated, MUFA; and polyunsaturated fatty acids, PUFA; g/100g of total fatty acids in corresponding lipid fraction) in each lipid fraction (LF) and of each LF in fatty acid composition (g/100g of total fatty acids) from raw and cooked (RC) *Longissimus lumborum* steaks of three USDA quality grades (QG; n=8).

Fatty Acids (%)	Prime				Low Choice				Standard				Std. Error[1]	Significant Effects ($P \leq 0.05$)
	Raw		Cooked		Raw		Cooked		Raw		Cooked			
	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid		
LF	85.43	14.57	90.60	9.40	77.38	22.62	88.91	11.09	72.45	27.55	79.29	20.71	1.99	QG, RC
SFA	45.41	45.21	44.69	45.01	47.45	47.12	46.92	45.04	48.22	48.00	47.18	45.52	0.85	RC, LF
10:0	0.06	0.08	0.06	0.07	0.07	0.09	0.06	0.07	0.05	0.07	0.05	0.06	0.01	QG, LF
12:0	0.07	0.09	0.07	0.08	0.08	0.09	0.08	0.08	0.05	0.07	0.06	0.06	0.01	RC×LF
14:0	3.17	3.47	3.20	3.14	3.21	3.45	3.33	2.88	2.51	2.51	2.56	2.24	0.14	QG×LF,
15:0	0.36	0.37	0.36	0.35	0.39	0.39	0.39	0.34	0.43	0.34	0.43	0.38	0.03	QG×LF
16:0	27.46	27.62	27.15	27.00	27.37	27.76	27.13	24.66	24.86	25.36	24.44	24.45	0.64	QG, RC
17:0	0.97	0.82	0.95	0.82	0.99	0.87	0.99	0.93	1.39	1.06	1.26	0.99	0.07	RC×LF
18:0	13.12	12.52	12.83	13.16	15.19	14.21	14.83	15.62	18.79	18.02	18.27	17.07	0.69	QG×RC,
20:0	0.03	0.15	0.03	0.26	0.09	0.16	0.03	0.31	0.06	0.39	0.05	0.12	0.05	QG×RC×LF
21:0	0.16	0.04	0.03	0.04	0.04	0.04	0.04	0.05	0.06	0.07	0.03	0.04	0.03	
22:0	0.01	0.05	0.01	0.08	0.02	0.06	0.02	0.11	0.02	0.11	0.02	0.12	0.01	QG×LF,
MUFA	51.81	46.37	52.48	42.79	49.26	43.64	49.59	36.42	48.99	41.52	49.91	36.08	1.13	QG×LF,
14:1	1.03	0.69	1.06	0.93	0.75	0.73	0.84	0.64	0.46	0.43	0.50	0.39	0.10	QG, LF
16:1	4.12	4.09	4.30	3.64	3.15	3.11	3.53	2.52	2.72	2.59	2.87	2.23	0.28	RC×LF
17:1	0.77	0.78	0.77	0.69	0.65	0.64	0.67	0.54	0.78	0.78	0.80	0.71	0.07	RC×LF
18:1*trans*	4.56	4.01	4.45	3.70	5.66	5.07	5.44	4.26	4.49	3.59	4.47	3.05	0.58	RC×LF
18:1*cis*-9	41.22	36.69	41.77	33.63	38.95	33.98	38.99	28.16	40.38	33.92	41.11	29.19	1.25	QG×LF,
20:1	0.12	0.09	0.12	0.19	0.12	0.11	0.13	0.31	0.15	0.20	0.16	0.52	0.04	QG×LF,
PUFA	2.78	8.42	2.83	12.20	3.29	9.24	3.49	18.54	2.79	10.49	2.91	18.40	1.06	QG×LF,
18:2n-6	2.08	6.11	2.12	8.87	2.56	7.22	2.71	14.08	2.06	8.02	2.19	13.70	0.81	QG×LF,
18:3n-6	0.08	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.12	0.12	0.10	0.09	0.01	QG×RC
18:3n-3	0.52	0.46	0.53	0.41	0.50	0.45	0.55	0.36	0.41	0.33	0.42	0.28	0.05	RC×LF
20:2	0.03	0.09	0.03	0.12	0.05	0.08	0.05	0.18	0.03	0.10	0.04	0.14	0.01	QG×RC×LF
20:3n-6	0.05	0.41	0.05	0.61	0.05	0.36	0.06	0.85	0.06	0.48	0.06	0.94	0.06	RC×LF
20:4n-6	0.03	1.29	0.03	2.11	0.04	1.04	0.03	2.97	0.11	1.45	0.09	3.26	0.25	RC×LF

[1] Pooled standard error of means (%).

Table 4. Concentrations (mg/g dry matter) of individual fatty acids (FA), FA categories (Saturated fatty acids, SFA; mononusaturated, MUFA; and polyunsaturated fatty acids, PUFA), and lipid fractions (LF) from raw and cooked (RC) *Longissimus lumborum* steak of three USDA quality grades (QG; n=8).

Fatty Acids (mg/g dry matter)	Prime				Low Choice				Standard				Std. Error[1]	Significant Effects ($P \leq 0.05$)
	Raw		Cooked		Raw		Cooked		Raw		Cooked			
	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid	Neutral Lipid	Polar Lipid		
LF	247.14	41.45	264.09	27.14	152.31	44.41	184.75	22.76	80.15	28.64	91.99	20.28	9.3	QG×LF, RC×LF
SFA	112.55	18.76	118.15	12.24	72.36	20.89	86.81	10.46	37.72	13.60	42.53	9.28	4.2	QG×LF, RC×LF
10:0	0.14	0.03	0.14	0.02	0.10	0.04	0.12	0.02	0.04	0.02	0.04	0.01	0.0	QG×LF, RC×LF
12:0	0.18	0.04	0.19	0.02	0.12	0.04	0.15	0.02	0.04	0.02	0.06	0.01	0.0	QG×LF, RC×LF
14:0	7.81	1.42	8.44	0.88	4.93	1.54	6.19	0.69	1.95	0.72	2.32	0.47	0.3	QG×LF, RC×LF
15:0	0.86	0.16	0.93	0.10	0.60	0.18	0.74	0.08	0.34	0.10	0.39	0.08	0.0	QG×LF, RC×LF
16:0	67.98	11.43	71.73	7.40	41.8	12.32	50.25	5.88	19.81	7.30	22.44	4.98	2.5	QG×LF, RC×LF
17:0	2.36	0.35	2.46	0.21	1.52	0.39	1.84	0.20	1.09	0.31	1.18	0.20	0.1	QG×LF, RC×LF
18:0	32.7	5.24	34.09	3.52	23.07	6.28	27.37	3.47	14.35	4.99	16.02	3.47	1.5	QG×LF, RC×LF
20:0	0.07	0.06	0.06	0.07	0.13	0.07	0.05	0.07	0.07	0.09	0.04	0.02	0.0	QG×RC×LF
21:0	0.43	0.02	0.08	0.01	0.07	0.02	0.07	0.01	0.04	0.02	0.02	0.01	0.0	LF
22:0	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.0	QG×LF
MUFA	127.73	19.30	138.49	11.82	74.98	19.52	91.53	8.67	40.28	12.25	46.97	7.34	5.1	QG×LF, RC×LF
14:1	2.50	0.28	2.79	0.26	1.15	0.32	1.57	0.15	0.38	0.12	0.48	0.08	0.1	QG×LF, RC×LF
16:1	10.04	1.64	11.33	1.02	4.84	1.39	6.55	0.60	2.23	0.78	2.77	0.46	0.5	QG×LF, RC×LF
17:1	1.86	0.33	2.00	0.19	0.99	0.29	1.23	0.13	0.67	0.23	0.80	0.14	0.1	QG×LF, RC×LF
18:1*tra*	11.09	1.68	11.63	1.02	8.63	2.28	10.13	1.00	3.28	0.97	3.72	0.60	0.9	QG×LF
18:1*cis*-	101.95	15.32	110.42	9.28	59.2	15.19	71.82	6.72	33.61	10.1	39.07	5.95	4.5	QG×LF, RC×LF
20:1	0.28	0.04	0.32	0.05	0.18	0.05	0.23	0.06	0.11	0.05	0.13	0.10	0.0	QG×LF
PUFA	6.85	3.39	7.45	3.08	4.97	4.00	6.41	3.63	2.15	2.80	2.49	3.67	0.3	QG×RC×LF
18:2n-6	5.12	2.45	5.57	2.24	3.86	3.11	4.96	2.77	1.614	2.12	1.88	2.74	0.3	QG×RC×LF
18:3n-6	0.19	0.03	0.18	0.02	0.12	0.04	0.17	0.02	0.09	0.03	0.09	0.02	0.0	QG×RC×LF
18:3n-3	1.29	0.19	1.40	0.11	0.77	0.21	1.02	0.08	0.31	0.09	0.35	0.06	0.0	QG×LF, RC×LF
20:2	0.07	0.03	0.08	0.03	0.07	0.04	0.10	0.04	0.04	0.03	0.04	0.03	0.0	QG×LF, RC×LF
20:3n-6	0.12	0.16	0.14	0.15	0.08	0.16	0.11	0.16	0.05	0.13	0.05	0.19	0.0	QG×RC×LF
20:4n-6	0.07	0.52	0.08	0.52	0.06	0.46	0.06	0.56	0.08	0.39	0.07	0.64	0.0	RC×LF

[1] Pooled standard error mean (mg/g dry matter).

Factors influencing preweaning ultrasound body composition of Brahman calves

B.P. Littlejohn[1,2,*], D.M. Price[1,2], A.W. Lewis[2], J.P. Banta[2], D.G. Riley[1,4], D.A. Neuendorff[2], J.A. Carroll[3], T.H. Welsh, Jr.[1,4], R.D. Randel[2], R.C. Vann[5]

[1]Animal Science, Texas A&M University, College Station

[2]Texas A&M AgriLife Research, Overton

[3]Livestock Issues Research Unit, USDA-ARS, Lubbock

[4] Texas A&M AgriLife Research, College Station

[5]MAFES- Brown Loam, Mississippi State University, Raymond;

Research Summary

The objective of this experiment was to examine factors influencing preweaning ultrasound body composition of Brahman calves. Cows were assigned to a control group (n=42) or a prenatally stressed group (n=43). The prenatally stressed group was subjected to 2 h of transportation at 60, 80, 100, 120, and 140 ± 5 days of gestation. Calf weight, percent intramuscular fat (IMF), rib eye area (REA), rib eye area per 100 lb of body weight (REA/cwt), rib fat thickness, and rump fat thickness were recorded for each calf on days -112, -84, -56, -28, and 0 relative to weaning. Temperament was assessed at weaning using temperament score [TS; (PS+EV)/2], pen score (PS; 1=Calm and 5=Excitable), and exit velocity (EV; m/s). Temperament scores were converted into classes of calm (TS= < 1.78, n=40), intermediate (TS= 1.78 to 2.89, n=26) and temperamental (TS= > 2.89, n=19). As expected, body weight, IMF, REA, and rump fat thickness increased over time. Males were heavier (P<0.01; 164.12±3.57 kg) than females (148.5±3.55 kg). Calf weight was affected by a temperament by gender interaction (P<0.01) and a treatment by temperament interaction (P<0.01). Percent IMF was affected by a temperament by gender by treatment interaction (P=0.02). The REA was greater (P<0.01) in males (13.97±0.28 cm^2) than females (13.37±0.28 cm^2) and was affected by a treatment by temperament interaction (P<0.01). The REA/cwt was affected by a temperament by gender by treatment interaction (P=0.01). Rib fat thickness was not affected by gender, prenatal stress, or temperament. Rump fat thickness was affected by a temperament by gender interaction (P=0.05) and a gender by day interaction, with females having significantly greater rump fat thickness than males on days -56, -28, and 0. The REA, rib fat thickness, and rump fat thickness were characterized with peaks near days -84 to -56. Gender, temperament, and prenatal stress are among major factors that influence preweaning body composition of Brahman calves.

Introduction

The United States of America has a vast demand for beef derived meat products, with the world trade of animal derived meat products becoming a larger and growing industry (USDA, 2013). Therefore, it is imperative to produce quality beef derived products as efficiently as possible. Furthermore, efficiency at the level of the individual animal is driven by attaining an adequate weight and body composition in a timely manner. Therefore, factors affecting growth and body composition of calves may affect profitability. Gender is known to affect growth and development in calves, as purebred Brahman males have been shown to be heavier than purebred Brahman females prior to weaning (Browning et al., 1995). Adrenal production of the stress hormone cortisol has been shown to be greater in temperamental calves relative to

calmer calves (Curley et al., 2008). Nkrumah et al. (2007) reported that the rate of fat deposition is altered in temperamental cattle relative to calmer cattle. Furthermore, King et al. (2006) reported that meat products derived from temperamental cattle are less tender than meat products derived from calmer cattle. Transportation is a common occurrence in many production operations for pregnant cows, and is known to be a stressor in pregnant Brahman cows (Lay et al., 1996). Specifically, the stress of transportation has been reported to cause increased rectal temperature, as well as circulating concentrations of cortisol and glucose (Price et al., 2012). Stress can be defined as the biologic responses by which animals cope with real or perceived threats to homeostasis (Moberg, 1999; Chrousos, 2009). In many species, prenatal stress is known to affect development of the fetus and lead to adverse health issues later in life (Barker et al., 2002). A prenatal stressor, such as transportation, may affect the progeny of gestationally stressed dams. The objective of this experiment was to examine factors, such as gender, temperament, and prenatal stress, influencing preweaning ultrasound body composition of Brahman calves.

Procedures

Mature Brahman cows were assigned to a control group, which consisted of 42 pregnant cows, or a prenatally stressed group, which consisted of 43 pregnant cows that were subjected to transportation at 60, 80, 100, 120, and 140 days of gestation for 2 hour intervals. Body composition characteristics were evaluated using an Aloka 500V, 3.5 mHz probe and Beef Image Analysis Software from ILIA Cup Lab (Harrison, Arkansas; Figure 1). Calf weight, percent intramuscular fat (IMF), rib eye area (REA), rib eye area per 100 lb of body weight (REA/cwt), rib fat, and rump fat were recorded for each calf on days -112, -84, -56, -28, and 0 relative to weaning (0 = weaning). Temperament was assessed at weaning using pen score (PS), exit velocity (EV), and temperament score (TS). Pen score is a subjective measurement in which calves are confined in a pen of 3-5 calves with a single experienced evaluator; reactions to that evaluator are scored on a scale of 1-5 (1=Calm and 5=Excitable) (Hammond et al., 1996). Exit velocity is an objective measurement that is defined as the rate (m/s) in which an animal traverses 1.83 meters upon exiting a squeeze chute (Curley et al., 2006). Temperament score is the numerical average of PS and EV [TS; (PS+EV)/2] (Curley et al., 2006; King et al., 2006). Temperament scores were converted into classes of calm (TS= < 1.78, n=40), intermediate (TS= 1.78 to 2.89, n=26) and temperamental (TS= > 2.89, n=19). Data were analyzed using Mixed Models procedures of SAS specific for repeated measures. Stepwise regression used treatment, calf sex, temperament classification, and number of days prior to weaning as fixed effects; sire was a random effect.

Figure 1. Ultrasound measurements using the Beef Image Analysis Software from ILIA Cup Lab.

Results

As expected, calves' body weight, percent intramuscular fat, rib eye area, and rump fat thickness increased (P=0.01) over time as the animals grew. As anticipated, gender affected body composition characteristics, as males were heavier (P<0.01; 164.12±3.57 kg) than females (148.5±3.55 kg) for all

temperament classifications. Calf weight was affected by a temperament by gender interaction (P<0.01), as temperamental males (163.15±4.09) were heavier than temperamental females (151.95±3.86) relative to males and females in other temperament groups.

Figure 2. Use of ultrasound to determine body composition in Brahman calves prior to weaning.

Calf weight was also affected by a treatment by temperament interaction (P<0.01), as temperamental and intermediate transported calves were heavier than calm transported calves. Percent IMF was affected by a temperament by gender by treatment interaction (P=0.02). Calm control and temperamental transported females had greater IMF than calm control males. The REA was greater (P<0.01) in males (13.97±0.28 cm^2) than females (13.37±0.28 cm^2). The REA was affected by a treatment by temperament interaction (P<0.01), with intermediate prenatally stressed calves having the greatest REA relative to the other groups (Figure 2). The REA/cwt was affected by a temperament by gender by treatment interaction (P=0.01). Intermediate control and temperamental transported males had the lowest REA/cwt compared to other groups. Rib fat thickness was not affected by gender, prenatal stress, or temperament classification. Rump fat thickness was affected by a temperament by gender interaction (P=0.05). Females had greater rump fat thickness relative to males for the calm and intermediate groups, and there was no difference between gender for the temperamental group. Rump fat thickness was also affected by a gender by day interaction (P<0.01), as females started depositing more rump fat than male calves near day -56 relative to weaning, which continued through weaning. The REA, rib fat, and rump fat were characterized with peaks near days -84 to -56.

Implications

These data indicate that gender, temperament, prenatal stress and the interactions thereof are among major factors associated with altered body composition in preweaning age Brahman calves. This study determined that ultrasound can be used to determine body composition measurements on calves prior to weaning.

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A preliminary assessment of seasonal variations of temperature and relative humidity on semen production of indoor boars

D.S. Dillard, M.A. Crenshaw, C.S. Steadman, S.T. Willard, P.L. Ryan, J.M. Feugang
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, Mississippi

Research Summary

Seasonal variations such as temperature and relative humidity negatively affect livestock performance (e.g., feeding, growth, and fertility). To help mitigate these issues, pork producers build expensive temperature regulated barns. Yet, the impact these barns have on boar fertility is still not well-characterized. To this end, our pilot study aimed at monitoring daily environmental changes in a temperature-controlled boar stud and evaluating semen production and sperm quality of a subset of fertile boars throughout the year. Therefore, sensor devices were placed both inside and outside the boar stud and temperature and relative humidity were logged every thirty minutes. Semen was collected and a Digital Infra-red Thermal Imaging camera was used to capture the scrotal surface temperature of ten proven fertile boars that were randomly selected. Semen collections and images were performed twice a month for each boar and semen was analyzed for volume, sperm concentration, and motility characteristics. Results confirmed the capacity of the barn to maintain efficient thermoregulation despite extreme environmental changes. However, the housing system was not able to control relative humidity changes. Semen production and sperm motility were affected by the environmental variations of temperatures and relative humidity, especially during the coldest months. In conclusion, indoor housed boars still experience the effects of outdoor changes in temperature and relative humidity despite the thermoregulation of barns.

Introduction

Numerous environmental factors such as seasonal variations of temperature, daylight length, and relative humidity negatively affect the productivity and profitability of livestock animals (Fuquay, 1981; Silanikove, 2000). The impacts of such variations on reproductive performance of farm animals are referred to as seasonal infertility, which is characterized with reduced fertility of both females and males (Almond and Bilkei, 2005). This phenomenon usually occurs during or after hot summer months or exposure to increased temperatures, which has been clearly demonstrated with outdoor animals (Auvigne et al., 2010; Kunavongkrit et al., 2005). Farming in pastures (outdoor) is more affordable to producers and therefore, widely used in agriculture around the world. However, this housing system provides minimal control of the environment which frequently leads to seasonal infertility of the herds. Due to the unpredictability of the occurrence of seasonal changes, producers have been forced to adopt different indoor housing systems to mitigate the impacts of seasonal variations on livestock production (Gentry et al., 2002).

Especially in commercial pig operations, sophisticated and expensive temperature-regulated barns are common in boar studs, however the optimal protection of male fertility in such housing systems may still not be reached. Indeed, numerous indoor boars are still subjected to high variations in their semen production outputs (Barranco et al., 2013). From this observation, we hypothesized that despite their housing in environment-controlled buildings, indoor boars may still be experiencing the effects of seasonal variations leading to yearly variations of their field fertility after artificial inseminations. Thus, we tested this hypothesis from December 2013 to May 2014, by: (**1**) monitoring temperature and relative humidity variations of a commercial boar stud,

(**2**) recording the scrotal temperatures, and (**3**) evaluating the semen production and quality of indoor housed boars.

Procedures

All data and semen samples were collected at the artificial insemination center of Prestage Farms, Inc., a commercial hog operation located in West Point, MS.

In *experiment 1*, sensor devices or HOBO data loggers (Onset, Bourne, MA) were used to monitor temperature and relative humidity (RH) variations. Sensors were placed both outside and inside the barn, in the vicinity but out of reach of boars. Both HOBO data loggers were calibrated to log temperature and RH at 30 minute intervals, from December 2013 to May 2014. Recorded data were uploaded every week (after semen collection) to a computer for data processing with the HOBOware Professional 3.4.1 software. Temperature variations at West Point, MS were recorded from the National Weather Service (www.weather.gov) or The Weather Channel (www.weather.com) to validate our recording system.

In *experiment 2*, a Digital Infra-red Thermo-Imaging (DITI) camera (FLIR ThermoCAM S60; FLIR Systems, Inc., Boston, MA) was used to measure the scrotal surface temperature gradient. Ten proven fertile indoor boars were randomly selected and followed throughout the experimental period. The DITI camera was used as an effective tool to evaluate the scrotum of boars, with noncontact means, before or after semen collection. Images were subsequently uploaded to a computer and processed with the ThermaCAM Researcher Professional v2.7 software.

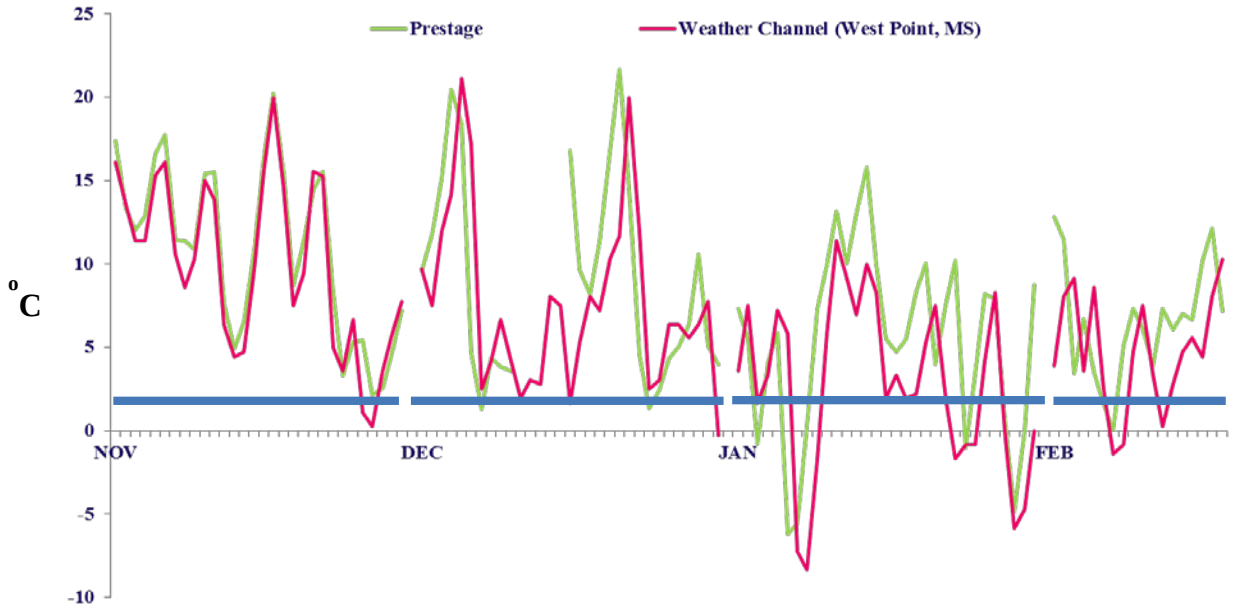
In *experiment 3*, semen of aforementioned boars (n=10) was harvested twice a month at Prestage farms. Semen production outputs (volume, concentrations, and total sperm number) were evaluated and collected semen was extended and aliquoted into commercial doses. Single semen doses of each boar were immediately transported to our laboratory (within 4 hours post-collection) for sperm motility analysis using the Computer-Assisted Sperm Analyzer (CASA; Hamilton-Thorne BioScience, Beverly, MA). Subsets of individual boar semen were frozen for further analyses.

Statistical analysis. All data were analyzed by ANOVA using the General Linear Model of SPSS, version 22 (IBM statistic package). The normality test was performed using the Kolmogorov-Smirnov test. Boars, location (indoor or outdoor), and calendar months were considered as fixed factors to analyze temperature and relative humidity variations, as well as the impacts on scrotal temperatures, semen production outputs, and sperm motility characteristics. Comparisons between months were done using the Fisher's LSD test. The threshold of significance was fixed at $P \leq 0.05$.

Results

External temperature profiles recorded in the current study entirely mirrored those obtained from the National Weather Service reports (Figure 1). Both local (HOBO data Logger, at Prestage Farms) and regional (National Weather Services, at West Point, MS) temperature profiles were not significantly different ($P > 0.05$; ANOVA 1). Therefore, the Hoboware data was used for experiments. Data of ***experiment 1*** are summarized in Table 1.

Figure 1. Representative profiles of Local (Prestage Farms, Inc, MS) and Regional (National Weather Services) temperatures.



Outside temperatures greatly fluctuated from those recorded inside the barn, and the averages were calculated at 12.8 ± 0.3 ˚C outside versus 20.8 ± 0.3 ˚C inside the barn during the experimental period ($P < 0.001$). On the other hand, indoor and outdoor relative humidity fluctuations followed the same pattern, and indoor measurements were generally lower than outdoor records (54.2 ± 0.9 % vs. 68 ± 1 %; $P < 0.0001$). These averages hide the significant increase of temperature and indoor relative humidity that were observed during the last three months of data collection, a time period that corresponds to the spring season.

Table 1. Monthly variation of indoor and outdoor environmental changes.

Months	Environmental parameters			
	Temperatures (°C)		Relative Humidity (%)	
	Inside the barn	Outside the barn	Inside the barn	Outside the barn
December 2013	20.1 ± 0.4 ^{a}	9.1 ± 0.9 ^{a}	52.3 ± 2.1 ^{ac}	79.5 ± 2.7 ^{a}
January 2014	19.7 ± 0.4 ^{a}	5.4 ± 0.9 ^{b}	40.1 ± 2.1 ^{b}	56.2 ± 2.5 ^{b}
February 2014	20.1 ± 0.4 ^{a}	7.7 ± 0.9 ^{ab}	47.5 ± 2.2 ^{ac}	71.3 ± 2.6 ^{c}
March 2014	21.6 ± 0.4 ^{b}	12.3 ± 0.9 ^{c}	43.8 ± 2.1 ^{bc}	64.0 ± 2.5 ^{d}
April 2014	21.3 ± 0.4 ^{b}	19.5 ± 1 ^{d}	63.2 ± 2.1 ^{d}	66.3 ± 2.9 ^{cd}
May 2014	22.1 ± 0.4 ^{b}	22.6 ± 0.9 ^{e}	78.3 ± 2.1 ^{e}	69.2 ± 2.5 ^{cd}

Different letters within the same column indicate significant differences. $P < 0.05$; ANOVA 1. Data are mean ± sem

In experiment 2, scrotal temperatures varied from 30.8 ± 0.3 °C to 32.5 ± 0.3 °C and there were no differences across months ($P > 0.05$). The coldest and warmest values were found during the months of January and May, respectively. These months were observed as

the months of extreme environmental changes in Experiment 1.

Data collected from ***experiment 3*** are summarized in Tables 2 and 3. Monthly variations of temperature and relative humidity did not affect the semen production outputs (volume, sperm concentrations and total number). The total sperm number per ejaculate was numerically, but not significantly decreased in February, one of the coldest months (Table 2). The analysis of the impacts on sperm concentrations indicated a significant interaction between individual boars and months ($P < 0.05$), which led to a tendency of total sperm diminution in ejaculates throughout the experimental period ($P < 0.05$).

Table 2. Impacts of monthly variations on semen production of indoor boars.

Months	Outdoor Temperatures	Semen characteristics		
		Volume	Concentrations	Total sperm
	(◦C)	(ml)	($x10^6$/ml)	($x10^9$)
December 2013	9.1 ± 0.9 [a]	264 ± 10	388 ± 25	101
January 2014	5.4 ± 0.9 [b]	244 ± 10	396 ± 26	96
February 2014	7.7 ± 0.9 [ab]	360 ± 10	360 ± 25	86
March 2014	12.3 ± 0.9 [c]	264 ± 10	369 ± 25	92
April 2014	19.5 ± 1 [d]	246 ± 10	368 ± 25	88
May 2014	22.6 ± 0.9 [e]	241 ± 10	375 ± 25	92
Global effects of the months:		0.68	0.622	0.631
Month x Boar interactions:		0.295	0.003	0.089

Different letters within the same column indicate significant differences. $P < 0.05$; ANOVA 2. Data are mean ± sem

Furthermore, the impacts of monthly environmental changes significantly affected the motility and velocity parameters of spermatozoa (Table 3; $P < 0.05$). Spermatozoa appeared to gain their optimal motility characteristic during the warmer months (April and May), while the lowest proportions of total motile spermatozoa and those moving faster (rapid sperm; ≥ 45 µm/sec) and progressively (straightforward) were found during the cold month of January ($P < 0.05$). Velocity parameters such as the average path (VAP) and straight line (VSL) fluctuated significantly throughout the months, which could possibly influence the fertilizing potential of spermatozoa.

Implications

Indoor housed boars are still experiencing the impacts of environmental temperature and relative humidity variations despite the barns thermoregulation. Day-by-day variations may have detrimental effects on sperm production and quality. The study of semen produced by indoor boars could help to better recognize the plasticity of spermatozoa during seasonal variations. The knowledge gained from such studies will contribute to improve the fertility performance of boars and help with understanding a part of men sub-fertility issues.

Table 3. Impacts of monthly variations on sperm motility characteristics.

Months	Outdoor Temp (◦C)	Motility characteristics				
		Motility parameters (%)			Velocities parameters (μm/s)	
		Total motility	Progressive	Rapid	VAP	VSL
December 2013	9.1 ± 0.9 [a]	76 ± 0.9 [a]	44 ± 0.9 [a]	59 ± 1.1 [a]	69 ± 0.9 [a]	42 ± 0.5 [a]
January 2014	5.4 ± 0.9 [b]	67 ± 1 [b]	36 ± 1 [b]	51 ± 1.2 [b]	68 ± 0.9 [a]	40 ± 0.5 [bc]
February 2014	7.7 ± 0.9 [ab]	76 ± 1 [a]	38 ± 0.9 [bc]	61 ± 1.2 [a]	75 ± 0.9 [b]	40 ± 0.5 [b]
March 2014	12.3 ± 0.9 [c]	74 ± 1.1 [a]	39 ± 1 [c]	58 ± 1.3 [a]	73 ± 0.9 [b]	40 ± 0.6 [bc]
April 2014	19.5 ± 1 [d]	81 ± 1 [c]	43 ± 0.9 [ad]	65 ± 1.2 [c]	75 ± 0.9 [b]	41 ± 0.5 [ac]
May 2014	22.6 ± 0.9 [e]	82 ± 1.1 [c]	42 ± 1 [d]	72 ± 1.3 [c]	85 ± 0.9 [c]	42 ± 0.6 [a]

Different letters within the same column indicate significant differences. $P < 0.05$; ANOVA 2. Data are mean ± sem

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Mississippi Beef Cattle Improvement Association Activities Update

B. B Karisch[1] and J. A. Parish[2], and R. C. Vann[3]
[1]Department of Animal and Dairy Sciences, Mississippi State, MS
[2]North Mississippi Research and Extension Center, Prairie Research Unit, Prairie, MS
[3]MAFES Brown Loam Branch Experiment Station, Raymond, MS

Extension Summary

The Mississippi Beef Cattle Improvement Association (MBCIA) has the purpose of unifying beef cattle breeders and promoting beef cattle improvement within Mississippi. In adherence with this purpose, association activities were added and modified in 2013 and 2014 to better accomplish MBCIA goals. Specifically, MBCIA developed a new logo, and had caps and ink pens printed to promote the association. Secondly, the MBCIA sponsored the Mississippi State University (MSU) Livestock Judging Team. Thirdly, MBCIA supported beef cattle research at MSU looking into the value and benchmark levels of several traits of cattle at auction markets in the state. Finally, MBCIA is scheduled to co-host the Beef Improvement Federation annual convention in Biloxi, Mississippi in June 2015. These activities show that the association continues to evolve to meet the need of genetic improvement education in an ever-changing industry.

Introduction

The Mississippi Beef Cattle Improvement Association (MBCIA) was established in 1968 for the purpose of unifying beef cattle breeders and promoting beef cattle improvement within Mississippi.
The MBCIA is a member of the Beef Improvement Federation, which was formed as a means to standardize beef cattle performance programs and methodology and to create greater awareness, acceptance, and usage of beef cattle performance concepts. Membership includes purebred and commercial beef cattle producers, commodity association representatives, and Mississippi State University Extension Service and Mississippi

Agricultural and Forestry Experiment Station personnel.

In keeping with its purpose, in 1969 MBCIA initiated a bull sale program with the objective of encouraging production and identification of genetically superior bulls by purebred breeders and promoting the purchase and use of these bulls by commercial producers. The MBCIA bull sale program consists of purebred bull consignment sales open to consignments from Mississippi cattle producers. Out-of state cattle producers are also invited to nominate bulls for this sale provided the bulls were performance tested on the Hinds Community College Bull Test, a 112-day grain-based bull performance test established in 1982 in Raymond, MS, or the South Mississippi Gain-on-Forage Bull Test, a 140-day forage-based bull performance test established in 1986 near Tylertown, MS. The MBCIA Fall Bull Sale is hosted annually on the second Thursday in November. Additionally, a MBCIA Spring Bull Sale began in 2008 and is held annually in conjunction with the Hinds Community College Bull Test sale on the first Thursday in March.

Beyond involvement in cattle marketing programs and centralized bull testing, MBCIA conducts other activities that support its goal of promoting beef cattle improvement. An example includes facilitation of centralized ultrasound body composition scanning of cattle. Recent updates and additions to these activities are presented here.

Procedures

The MBCIA operates under the direction of an elected board of directors. These leaders guide the direction of the association and assist in the implementation of its activities. A complete listing of the current board of directors and other information concerning the MBCIA is posted online at *msucares.com/livestock/beef/mbcia*. The activities highlighted in this report include major MBCIA events in 2013 and 2014.

Results

BCIA Promotional Items

The new BCIA logo was presented to the board at the November 2013 Board of Directors meeting. This logo was designed by the nationally recognized agriculture marketing firm Ranch House Design. The logo was also incorporated into several promotional items to promote the association. Caps were printed with the new logo, and were given to each bull and heifer sale buyer and consigner for both the fall 2013 and spring 2014 sales. The caps were very well received. Ink pens were also printed with the new logo to be given out at BCIA functions, and were also well received.

Livestock Judging Team Sponsorship

At the November 2013, BCIA Board of Directors Meeting, the board unanimously voted to sponsor the Mississippi State University Livestock Judging Team with a $5,000 sponsorship to aid in the team's travel costs. Livestock Judging Team Coach, Brett Crow, was introduced to the board and spoke of the value of the Livestock Judging Team for students, and his plans for the future travel and growth of the team.

Beef Cattle Research Support

The major purpose of the Mississippi BCIA is to promote beef cattle improvement in Mississippi. In accordance with that purpose, the MBCIA voted in June 2014 to provide research support for a project led by Dr. Jane Parish located at the Prairie Research Unit investigating the value of and benchmark levels for cattle sold through Mississippi Auction markets. The project involves the benchmarking of 35 traits and their value for cattle sold through several Mississippi Auction Markets.

2015 Beef Improvement Federation Annual Convention

The MBCIA will co-host the 2015 Beef Improvement Federation Annual Convention in Biloxi, Mississippi on June 9-12. The event will showcase the Mississippi Gulf Coast and beef producers in the state. The event is chaired by Dr. Brandi Karisch, and supported by the MBCIA, MSU Extension Service, and Mississippi Cattlemen's Association.

Implications

The MBCIA has a decades-long history of promoting beef cattle improvement and quality genetics through its activities. The association continues to evolve its activities to meet the need of genetic improvement education in an ever-changing industry. Besides the examples outlined in this report, a future activity of great significance for MBCIA is its role in cohosting the Beef Improvement Federation Annual Convention in Biloxi, Mississippi, from June 9 to 12, 2015.

Beef Cattle Boot Camps

B. B Karisch[1], J. A. Parish[2], and R. C. Vann[3]
[1]Department of Animal and Dairy Sciences, Mississippi State University, MS
[2]North Mississippi Research and Extension Center, Prairie Research Unit, Prairie, MS
[3]MAFES Brown Loam Branch Experiment Station, Raymond, MS

Extension Summary

The Mississippi State University Extension Service (MSU-ES) Beef Cattle Boot Camps were initiated in 2010 to provide an interactive, hands-on educational opportunity for beef cattle producers on Mississippi Agricultural and Forestry Experiment Station (MAFES) stations. Based upon positive feedback from producers, the program has become an annual event. Boot Camp topics in 2014 included breeding soundness evaluation, live animal evaluation, using EPDs, Beef Quality Assurance, farm safety, marketing scenarios, forage ID, and fencing techniques. Participants rated the presentations highly and provided suggestions for future Boot Camps. A set of Boot Camps is now scheduled to be held on an annual basis each April at rotating locations.

Introduction

The Mississippi State University Extension Service (MSU-ES) Beef Cattle Boot Camps were initiated in 2010 to provide an interactive, hands-on educational opportunity for beef cattle producers on Mississippi Agricultural and Forestry Experiment Station (MAFES) stations. They were held at the MAFES Prairie Research Unit in Prairie, MS and MAFES Brown Loam Branch Experiment Station near Raymond, MS. Based upon the positive feedback received from these inaugural Boot Camps, it was determined that subsequent Boot Camps be conducted each year. In 2014, the Beef Cattle Boot Camps were conducted at the MAFES Leveck Animal Research Center on the Mississippi State University main campus and the MAFES Brown Loam Branch Experiment Station, near Raymond, MS.

Procedures

Many MSU-ES beef cattle educational programs focus on complex problems or topics, with the target audience being established beef cattle producers with experience in cattle production. Rather than focus on that target audience, the Boot Camps offered a new approach; they focused on novice cattle producers who may not have the experience or knowledge of longer established producers. The goal of the Boot Camps was to provide basic information to producers in a hands-on, applicable manner. Whereas the novice group was the primary target, the Boot Camps also offered the opportunity for established producers to refresh themselves on basic cattle production skills and information.

The Boot Camps were advertised through the *Cattle Business in Mississippi* magazine, on the Internet, and via local Extension offices. The same program was offered at two locations on different dates to allow participants to choose their preference for program location and date.

Boot Camp topics in 2014 included breeding soundness evaluation, live animal evaluation, using EPDs, Beef Quality Assurance, farm safety, marketing scenarios, forage ID, and fencing techniques. Live animal demonstrations and interactive participant exercises were

included in the program. Following the program, each participant was encouraged to complete and submit a course evaluation.

Each Boot Camp program began at 9:00 a.m., included lunch, and concluded at 4:00 p.m. Registration fees covered the cost of lunch, refreshments, Boot Camp notebooks, and other Boot Camp materials.
Both MSU-ES and MAFES personnel were involved in the Boot Camp planning and program implementation.

Results

All participants completing evaluations of the 2014 Boot Camps (n=17) indicated that the information presented would be useful on their operations. They also all indicated that the length was appropriate. On a 1 to 5 scale, with 1 being “poor” and 5 being “excellent”, the average rating for all Boot Camp presentations was 4.7, similar to the previous year. The ratings for individual topics ranged from 4.40 to 4.94. Individual comments were very positive and included useful ideas such as providing more hands on topics out in the pasture or with animals.

The feedback indicated that the selection of topics for 2014 was appropriate. The topics selected for the 2014 Boot Camps were planned in large part from the suggestions on the participant evaluation forms and verbal feedback from the 2013 Boot Camp attendees. Suggestions from the 2014 Boot Camps for future topics included topics such as pasture finishing beef, vaccinations, medications, budgeting, and artificial insemination. These suggestions are also used in planning additional Extension programming efforts beyond the Boot Camps, such as specialized short courses.

Implications

Hands-on learning experiences are considered valuable to beef cattle producers, especially novice producers who may require more hands-on experiences to understand basic practices. The Beef Cattle Boot Camps provide opportunities for these experiences while also highlighting MAFES beef cattle research activities. In addition, they facilitate interaction between MSU-ES/MAFES personnel and beef cattle producers.

Acknowledgements

Appreciation is extended to the MAFES and departmental staff who assisted in Boot Camp preparations and implementation.

Fed Beef Challenge

B. B. Karisch[1]

[1]Department of Animal and Dairy Sciences, Mississippi State University, MS

Extension Summary

The Mississippi Fed Beef Challenge was designed as an educational tool for Mississippi cattle producers who produce freezer beef to evaluate how their cattle performed on the rail. Cattle were harvested at the Mississippi State University (MSU) Meat Lab and producers were provided carcass quality and yield information along with a freezer of beef processed to their specifications. The challenge also gives beef producers the opportunity to see how their beef stacks up compared to other producers.

Introduction

Many Mississippi beef producers often select a calf from their herd to finish to fill their own freezers. However, most producers do not know how their cattle or their feeding practices have performed. The Mississippi Fed Beef Challenge offers producers the opportunity to discover these two things, and also to discover how their cattle and feeding practices compare to other Mississippi producers. The first Fed Beef Challenge was held in the fall of 2011, and was moved to the spring in 2012. The 2014 contest was held in March, with cattle delivered in late March and carcasses ready for viewing and pick up in April.

Procedures

The format of the contest is informal. Producers are responsible for selecting their own animals, and feeding them until the contest. This leaves the responsibility of determining when the cattle are finished in the producer's hands and allows the results to demonstrate to the producer how well their feeding and selection practices performed.

Cattle are delivered to MSU over a designated 2 day period. Cattle are held overnight, and harvested at the meat lab facilities the next morning. After a 48-hour chill, carcasses are graded by experienced MSU faculty and priced based on current market grids. Carcasses are available for viewing by producers, and MSU faculty and staff explain each carcass specification and how feeding may have improved or changed carcass quality. After an aging period, carcasses are fabricated based on each producer's specifications.

The contest is open to Mississippi beef cattle producers of all ages. The most recent contest had entries from both youth and adults from across the state. Most contestants were repeat entries from previous years. Each contestant is only allowed to enter one steer or heifer, and the contest is limited to the first 12 entries due to cooler space limitations. An entry fee of $50 per entry is required, and producers are also responsible for processing fees. The Champion and Reserve Value carcasses received 50 and 30% of the entry fees. Highest Quality and Yield Grade carcasses each received 10% of the entry fees.

One benefit of the contest is that the cattle are also able to be utilized for Animal and Dairy Science classes as well. Steers are evaluated live in Livestock Evaluation. Students are able to view market ready steers and learn to evaluate muscle and fat thickness on the live animal as it relates to the carcass. Students in Meat Science class have the opportunity to witness the harvest, grading, and carcass fabrication process.

Results

Nine steers were harvested in the 2014 contest. The Champion Value entry belonged to Danny Martin, a contest participant since 2011. The Reserve Value carcass belonged to Phillip Good, a new contestant. The Champion carcass also had the highest quality grade, and finished high choice. The carcass with the best yield grade belonged to Emma Grace Rutherford, a junior entry, and finished with a yield grade of 2.1.

Of the 9 carcasses entered in the contest, 6 reached the choice quality grade, 1 high select, 1 low select, and 1 no roll. The 9 carcasses average 0.41 in. of back fat, with an average ribeye area of 12.38 in^2. The average yield grade of 2.7 is exceptional for steers finished to the choice grade. Carcasses were priced based on the current market grid. The average carcass value was $1,663.13, with the most valuable carcass worth $1,969.70.

Implications

The Fed Beef Challenge offers beef producers the opportunity to learn more about the results of their freezer beef selection and feeding program. The unique nature of this program allows not only producers to learn, but it also offers an opportunity for MSU Animal and Dairy Sciences students to learn from these cattle. Feedback and repeat participation in the challenge indicates that the program should be successful in future years. For more information on this contest visit: *msucares.com/livestock/beef.*

27th Annual Dixie National Intercollegiate Livestock Judging Contest

B. B. Karisch[1], K. Brown[1], T. Smith[1], J. M. Riley[2], and T. J. Braud[1]
[1]Department of Animal and Dairy Sciences, Mississippi State University, MS
[2]Department of Agricultural Economics, Mississippi State University, MS

Extension Summary

Livestock judging contests help students develop critical thinking and decision making skills, as well as teach students to defend their decisions in a logical manner. Students who participate in livestock judging programs develop skills that last a lifetime and aid them in their chosen career. The 27th annual Dixie National Intercollegiate Livestock Judging Contest was held on February 8, 2014. The contest saw competitors from across the country including 54 competitors from 7 senior colleges and 55 competitors from 6 junior colleges.

Introduction

Livestock judging contests help students develop critical thinking and decision making skills, as well as teach students to defend their decisions in a logical manner. Students who participate in livestock judging programs develop skills that last a lifetime, and aid them in their chosen career. The Dixie National Contest is unique in that contestants judge only beef cattle, as compared to other intercollegiate contests, which include hogs, sheep, and/or goats as well. This year marked the 27th year of the contest.

Procedures

The judging contest consisted of 12 classes of cattle, divided into 4 different divisions including Market steers, Brahman influenced breeding cattle, English influenced breeding cattle, and Continental influenced breeding cattle. Cattle for the contest were provided by the Mississippi State University Department of Animal and Dairy Sciences, 3P Brahmans, 4N Ranch, Dyess Farms, Andy Braswell, Tanner Farms, Chris Sweat, No Limit Cattle, JRW LLC, Adamdale Farms, 3MS Simmentals, Dickinson Simmental Farm, Express Ranches, J&J Farms, and Rafter 4L. This group included producers from Mississippi, Oklahoma, Arkansas, Louisiana, and Alabama.

Participants were given 12 minutes to evaluate each class of 4 animals before turning in their placing to be scored. Afterwards, contestants were required to defend their placing in 8 of the 12 classes by giving a set of oral reasons.

The contest was made possible with tremendous support from numerous sponsors and volunteers. The sponsors for the 2014 judging contest were Arkansas Cattlemen's Association, Mississippi Cattlemen's Association, Mississippi Cattlemen's Foundation, Mississippi Department of Agriculture and Commerce, Mississippi State University Animal and Dairy Sciences Department, Mississippi State University Collegiate CattleWomen's Association, Mississippi State University Collegiate Cattlemen's Association, High Grade Farm Supply, Kipp Brown, and Judging Pro. Many individuals volunteered their time as officials, card runners, computer experts, group leaders, cattle handlers, and supervisors. The Mississippi State University Collegiate Cattlemen's Club acted as cattle handlers and group leaders for the contest.

Results

The 2014 contest saw 109 contestants from 7 Senior Colleges and 6 Junior Colleges. Contestants came from Oklahoma State

University, the University of Missouri, the University of Tennessee, The Ohio State University, the University of Florida, West Virginia University, Abraham Baldwin Agricultural College, Connors State College, Lake Land College, Houston Community College, Northern Oklahoma College, Hutchinson Community College, and Murray State College.

In the Senior College Division, Oklahoma State University earned top honors as the high point team followed by Ohio State University, the University of Missouri, West Virginia University, the University of Florida, Abraham Baldwin Agricultural College and the University of Tennessee. The high individual was Nolan Hildebrand of Oklahoma State University, followed by Mari Palacio, Blake Boyd, Ashley Judge, and Gary Agar all of Oklahoma State University.

In the Junior College Division, Lake Land College was awarded the high point team, followed by Connors State College, Hutchinson Community College, Northern Oklahoma College, and Murray State College. The high individual was Marie Lock of Lake Land College, followed by Preston Ogden of Connors State College, Lane Mai of Hutchinson Community College, Shelby Peterson of Lake Land College, and Wyatt Smith of Connors State College.

Implications

Skills developed through competing in livestock judging contests stick with students throughout a lifetime. The Dixie National Intercollegiate Livestock Judging Contest brought together college students from across the country to compete in this unique cattle only contest. This competition enabled future leaders in the livestock industry to test their skills against fellow students from many colleges and universities.

Mississippi Feeder Calf Board Sales

B. B. Karisch[1], L. Newman[2], M. Howell[2], M. Keene[2], and T. J. Braud[1]
[1]Department of Animal and Dairy Sciences, Mississippi State University, MS
[2]Mississippi State University Extension Service, MS

Extension Summary

Two Mississippi Feeder Calf Board Sales were held in 2014 where beef cattle producers marketed farm-fresh and assembled stocker cattle. The 6th annual "Cattlemen's Exchange Producer Sale" held on April 1st in Winona produced 18 truck-load lots while the 7th annual "Homeplace Producers Board Sale" held on August 4th at the Southeast Mississippi Livestock Auction in Hattiesburg generated 10 truck-load lots.

These sales were a collaborative effort among producers, livestock marketers, Mississippi State University (MSU) Extension Service, Mississippi Farm Bureau Federation, Mississippi Beef Cattle Improvement Association, and the Mississippi Cattlemen's Association. With this type of auction format, cattle were not present at the sale facility. Video clips and descriptions of each load were posted prior to the sale on the MSU Beef Cattle YouTube page and broadcast during the sale for prospective buyers. This type of auction offered both the buyer and the seller flexibility in arranging future delivery dates, and offered the sellers the opportunity to market cattle in load lots and command premium prices. The 2014 Homeplace Producers sale saw 700-799 lb. steers bring $19.13/cwt over average Mississippi sale barn prices that same week.

Introduction

Since mid-July of 2007, beef cattle producers and commodity support groups have been working to provide a new marketing option for Mississippi feeder cattle. This is a collaborative effort of the Mississippi Cattlemen's Association, Mississippi Farm Bureau Federation, MSU Extension Service, and Mississippi Beef Cattle Improvement Association. After many meetings and input from interested parties, the group developed the annual Mississippi Homeplace Producers Sale in Hattiesburg and the Cattlemen's Exchange Sale in Winona where beef cattle producers could market their feeder cattle.

Procedures

Auctions were managed as board sales by marketing cattle that were not on site. Each lot was represented by video or pictures of the cattle posted on the MSU Beef Cattle YouTube page. Detailed descriptions of cattle type, weight, and management were also posted on the website and distributed to prospective buyers prior to the sale. The same videos and pictures were presented during the auction for buyers in the audience. Arrangements for delivery from the farm of origin to the buyer's location were made after the sale.

Several organizations work closely together to assure that these sales are well organized and presented. The MSU Extension Service played a large role in planning and organizing the sale. Along with Mississippi Farm Bureau representatives, MSU Extension Agents and Beef Specialists gathered consignments and obtained information on cattle lots. The Center for Distance Education was responsible for filming and editing film on all loads of cattle, which were then posted to the MSU Beef Cattle YouTube page. Representatives of the MSU Extension Service, Mississippi Farm Bureau, and the host sale barn were responsible for

contacting prospective buyers and providing information on all cattle.

These sales accommodated a large number of feeder calves with the flexibility to arrange for future delivery. Cattle were offered in load-lots made up of single or multiple consignments of uniform calves. Consignments were received from across the state and loads were assembled with regard to region and type of cattle. Other advantages include reduced shrink, handling, and comingling prior to shipping. The sales also enabled producers to establish reputations that could attract the same buyers, year after year, willing to pay more for calves from producers whose cattle performed well in the past.

It was extremely important for the integrity of these sales that all cattle were represented truthfully and accurately. It was also essential that each consigner remained committed to the sale after completing a consignment form. This commitment was not only to the management and buyers but, more importantly, to the other beef cattle producers marketing cattle in this sale. The sales were open to various breed types, cattle weights, and management systems. Implementation of quality breeding programs and best management practices were strongly encouraged for all consignors to help enhance sales results and the reputation of Mississippi feeder calves.

Health management and preconditioning were primary concerns with these types of sales. Consignors were encouraged to complete Mississippi Beef Quality Assurance training. These sales did not require a single preconditioning and vaccination protocol. However, calves that have been managed similarly were grouped in the same load. For example, consigners who vaccinated their cattle with the same products and preconditioned calves for a similar amount of time were grouped together and represented as such.

The first annual Mississippi Homeplace Producers Sale was held in 2008, and continues to be held on the first Monday in August each year. The first annual Cattlemen's Exchange Producer Sale was held in 2009, and continues to be held on the first Tuesday in April each year. Several different livestock markets have represented cattle in these sales over the years, and future sales are open to any interested Mississippi livestock markets and cattle producers.

Results

The 6th annual Cattlemen's Exchange Board Sale was held on Tuesday, April 1, 2014 in Winona, MS, and hosted by the Winona Stockyard. The total receipts from the sales approached $1.5 million and averaged well above market value for the week of the sale. Eighteen pot-loads of cattle sold (all prices quoted $ per cwt) and all loads sold with a 2 percent shrink and a $4-5 per cwt slide. Mixed loads quote steer weight first, followed by the heifer weight. Steer price is quoted on the mixed loads, while heifer price was $6 per cwt less than the steers.

Feeder Steers:
Bulk Medium and Large 1 and 2:
8 pot-loads 800-875 lbs 164.50 to 169.90;

Feeder Heifers:
Bulk Medium and Large 1 and 2:
6 pot-loads 725-770 lbs 157.25 to 162.75;
2 pot-loads 800 lbs 158.50;

Mixed Feeder Steers and Heifers:
Bulk Medium and Large 1 and 2:
1 pot-load 775 lbs/750 lbs 165.00;
1 pot-load 600 lbs/550 lbs 181.50.

The 7th annual Mississippi Homeplace Producers Feeder Cattle Board Sale was held at Southeast Mississippi Livestock Exchange in Hattiesburg, MS on Monday, August 4, 2014. The sale generated approximately $1.17 million in total receipts. Eleven pot-loads of cattle sold (all prices quoted $ per cwt) and all loads sold

with a 2 percent shrink and a $5 per cwt slide. Mixed loads quote steer weight first, followed by the heifer weight. Steer price is quoted on the mixed loads, while heifer price was $8 per cwt less than the steers.

Feeder Steers: Bulk Medium and Large 1 and 2:
1 pot-load 600-699 lbs 239.00;
3 pot-loads 700-799 lbs 216.75 to 223.50;
2 pot-loads 800-899 lbs 211.75 to 214.00

Mixed Feeder Steers and Heifers (steer prices listed): Bulk Medium and Large 1 and 2:
4 pot-loads 600-699 lbs 223.25 to 233.50;
1 pot-loads 700-799 lbs 223.25.

Implications

The Mississippi Feeder Calf Board Sales have been successful in bringing together cattle producers and livestock marketers to improve the profitability of both sectors of the beef production chain. Since 2008, more than 24,440 head of cattle in 334 loads have been marketed in these board sales. Together, the receipts from these sales have exceeded $19 million. For more information on these sales visit: *msucares.com/livestock/beef/feedercalf.html*.

Mississippi Master Cattle Producer Self-Study Program

B. B. Karisch[1], J. A. Parish[2], and T. J. Braud[1]
[1]Department of Animal and Dairy Sciences, Mississippi State University, MS
[2]North Mississippi Research and Extension Center, Prairie Research Unit, Prairie, MS

Extension Summary

The Mississippi Master Cattle Producer Program began in 2006 as a comprehensive training offered by the Mississippi State University Extension Service in major beef cattle production topic areas. The 8-session interactive course is designed for persons interested in learning more about improving beef cattle production and marketing practices. Training focuses on improving overall management and decision-making skills and developing a broad beef cattle production knowledge base. The Master Cattle Producer Program was first updated in 2009 with new course materials and an online format to meet the needs of persons wanting to complete the training at their own pace and schedule. Each online module consists of an Adobe Acrobat file with approximately 75 to 80 slides with associated scripts. The examination for each training topic is an interactive form containing 15 multiple-choice questions derived from the training materials. A real-time webinar version of the training was offered in 2010. Course materials were again updated in 2013, and future updates are planned as needed. Most self-study program participants have elected to pursue the free online-only version of the program. Program participation continues to grow, with participants widely dispersed across the nation and throughout the world.

Introduction

Master Cattleman-type educational programs are offered by state Extension Services to beef cattle producers in numerous U.S. states. These highly visible programs typically consist of a series of instructional sessions on a variety of general beef production topics. Many of the Master Cattleman programs certify participants as "Master Cattlemen", upon completion of a particular curriculum and set of basic requirements.

The Mississippi Master Cattle Producer Program is a comprehensive training offered by the Mississippi State University Extension Service in major beef cattle production subject areas. The 8-session interactive course is designed for persons interested in learning more about improving beef cattle production and marketing practices. This training approach complements in-depth subject matter training programs such as short courses. Training focuses on improving overall management and decision-making skills and developing a broad beef cattle production knowledge base.

Procedures

The Mississippi Master Cattle Producer Program was first launched in Mississippi in January 2006 as a collaborative effort with the Auburn Cooperative Extension System taught over the Extension interactive video system. At that time, the training program consisted of eight 3-hour sessions on the following topics: 1) beef cattle nutrition, 2) forage systems, 3) reproductive management, 4) selection for optimum genetics, 5) management and marketing, 6) herd health and handling practices, 7) the product: Yield and Quality Grades, and 8) Beef Quality Assurance (BQA). From course initiation in 2006 through 2008, course participants were required to complete at least 6 of the 8 sessions and become BQA certified to graduate as a Mississippi Master Cattle Producer.

This training opportunity was offered at 10 distance education sites in each state, including Attala, Clarke, Forrest, George, Hinds, Lafayette, Lee, Oktibbeha, Pike, and Winston counties in Mississippi. Nearly 400 beef cattle producers in Mississippi and Alabama completed the comprehensive Master Cattle Producer Training Program via interactive video from January to March 2006. This initial training was videotaped and made available as a self-study course on digital video disc as a 4-disc set with printed course handouts after March 2006. The self-study course was designed for persons interested in learning more about Mississippi beef cattle production at their own pace.

The Master Cattle Producer Program was updated in 2009 with a new format, course materials, and topic areas. Training currently consists of 8 modules in beef cattle production subject areas. However, producers must now successfully review all course materials and complete the exams for all 8 training topics to be eligible for Master Cattle Producer certification. Beef cattle producers enrolled in the Master Cattle Producer program complete approximately 24 hours of training which now includes the following: 1) beef cattle nutrition, 2) forage systems, 3) beef cattle reproduction, 4) breeding and genetics, 5) economics and marketing, 6) herd health and handling, 7) beef end product, and 8) BQA.

The Mississippi Master Cattle Producer Program Internet-based training modules, first made available in 2009, are online at *msucares.com/livestock/beef/mcp*. Popular press, newsletter, and radio advertisements announcing program availability and details were launched in Autumn 2009 to promote the program. A brochure was developed in 2010 to help further market the program.

Course participants can view online training modules and download training materials free of charge. Alternately, participants completing the program can receive printed course materials, a metal farm sign, Master Cattle Producer cap, and certificate of completion for a course fee of $75. The online version of the Mississippi Master Cattle Producer Program is also made available to Mississippi State University Extension Service agents for up to 24 hours of in-service training credit.

Each online module consists of an Adobe Acrobat file with approximately 75 to 80 slides with associated scripts. The training materials cite current Mississippi State University Extension Service publications as supporting references and contain information on how to access those publications on the Internet at *msucares.com/livestock/beef/beefpubs.html*. These reference materials contain detailed information beyond what is covered in the Master Cattle Producer training slides. Contact information for the Extension Beef Cattle Specialists is also included in the training materials to encourage course participants to seek answers to any questions they may have when reviewing training materials.

The examination for each training topic is an interactive Adobe Acrobat form containing 15 multiple-choice questions derived from the training materials. The examinations can be e-mailed directly to the Extension Beef Cattle Specialist administering the program by clicking the “E-mail form” button on the form. These forms can also be saved and then e-mailed or printed and then faxed or mailed to the program administrator. Participants must answer a minimum of 12 out of 15 (80 percent) questions correctly to successfully complete a particular examination and receive credit for the associated training module. Examinations may be taken multiple times if needed to pass them.

The BQA training module is additionally offered as a video-based training via MediaSite. The BQA video training consists of 5 MediaSite presentations including: Mississippi BQA Program introduction, targeted breeding,

responsible culling, proper management, and Mississippi BQA Program conclusions. These video presentations include a speaker addressing Mississippi BQA Program topics utilizing the BQA program display booths. A Microsoft PowerPoint slide show runs simultaneously on the computer screen and corresponds to the video presentation.

A live Internet-based Master Cattle Producer training was conducted in January 2010. A real-time chat feature between presenters and program participants was used during these sessions. In 2013, the course materials were updated to reflect new information. As of 2013, participants were also provided with links and/or copies of new publications referenced in the updated materials for further reading on specific topics covered in the training.

Results

Though the majority of past and present participants in the Mississippi Master Cattle Producer Program are Mississippi beef cattle producers, Mississippians from other segments of the beef cattle industry, such as feed retailers, as well as out-of-state beef cattle producers participate in the program. In addition, program participants have included persons residing in 17 different states and 5 foreign countries. Course participation has increased over time.

The online version of the program already has had greater than 100 participants actively enrolled, with many of these participants already successfully graduating from the program. Approximately two-thirds of self-study participants have completed the course in the free online-only format, whereas, the remaining one-third of these participants have elected to do the paid hard-copy version of the program.

In 2014, the Mississippi Master Cattle Producer Program had a total of 20 participants from 10 different states. Participants were from various geographic locations throughout the United States with the largest number of producers that participated residing in Mississippi.

Implications

The Mississippi Master Cattle Producer Program provides interested participants with a comprehensive training opportunity in 8 major beef cattle production topic areas. The program is offered via the Internet as a self-study training to meet the needs of persons wanting to complete the training at their own pace and schedule. Program materials will continue to be updated as needed to provide current and relevant educational information.

2014 Mississippi 4-H Congress

F. D. Jousan
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS

Extension Summary

Mississippi 4-H Congress is an annual event where senior 4-H youth are given opportunities to compete in educational contests involving livestock. Over the course of a 3-day period, youth compete in visual presentation contests, judging contests, quiz bowl competitions and poster contests. Winning teams in the Meats Judging Contest and Dairy Quiz Bowl advance to represent Mississippi in national competition. While youth enjoy their time during 4-H Congress, they are very competitive and display knowledge and abilities in a variety of contests.

Introduction

Mississippi 4-H Congress is an annual state event designed to supplement county 4-H programs. This event provides positive leadership and educational opportunities for senior 4-H members from across the state in an effort to develop these young people to their full potential, allowing them to become productive citizens and catalysts for positive change and ready to meet the needs of a diverse and changing society. In late May, on the campus of Mississippi State University, senior 4-H members (age 14 to 18 yrs.) are given opportunities to compete in a variety of livestock-related contests. Senior 4-H members give Visual Presentations related to Beef, Sheep, Swine, Goats, Dairy Animals, and Dairy Foods. There are Meats and Dairy Products Judging Contests in addition to Meats and Dairy Quiz Bowls. State Congress provides 4-H members with friendly competition and opportunities to meet 4-H'ers from across the state, attend educational workshops, and have a lot of fun during their visit to the campus. Therefore, the objective of the Mississippi 4-H Congress is to improve youth's knowledge and skills through experiential learning, life skills training, and leadership development opportunities. In addition, the winners in state competitions are selected.

Procedures

At 4-H Congress, a variety of competitions are offered to senior youth. The Visual Presentation contest is divided into several areas, including Beef, Sheep/Swine/Meat Goat, Dairy Foods, and Dairy Animals Visual Presentations. Youth present on a topic of their choice, using posters or Microsoft PowerPoint to supplement their presentation. In Meats Judging, individuals and teams judge 4 classes of meat product, identify 30 retail cuts of beef, pork and lamb and present 2 sets of oral reasons on 2 placing classes. The winning senior Meats Judging team advances to national competition in Denver, CO. Dairy Products Judging includes scoring samples of milk, cottage cheese, cheddar cheese, and ice cream, rating each sample for overall impression and scoring any taste defects. Two quiz bowls are offered, a Dairy Quiz Bowl and Livestock Quiz Bowl. Dairy Quiz Bowl involves a multi-phase event with a scored quiz and rounds of questions given to each team. The winning senior Dairy Quiz Bowl team advances to national competition in Louisville, KY. The Livestock Quiz Bowl is a Jeopardy-style contest with questions written from source

books about cattle, sheep, swine, meat goats, and dairy goats. The final competition available to youth is a Dairy Poster Contest where youth, ages 8 to 18 yrs., design a poster based on the national dairy motto for that year.

Results

There was quality participation in the educational contests held during 4-H Congress this past year. In the visual presentations, there were a total of 18 participants (6 in Sheep/Swine/Meat Goat; 6 in Beef; 3 in Dairy Foods; and 3 in Dairy Animals). In Meats Judging, there were 3 teams and 12 youth that competed in the contest. Dairy Products Judging had 9 teams and 35 total youth judging the dairy product samples. In the quiz bowl competitions, Dairy Bowl had 4 teams and 17 youth while Livestock Bowl had 4 teams and 17 youth. A total of 28 youth submitted posters in the Dairy Poster Contest using the theme "Dairy Packs Power". In this contest, there were 10 participants in the 8 to 10 yr. old division, 9 participants in the 11 to 13 yr. old division and 9 participants in the 14 to 18 yr. old division. Altogether, 127 youth competed in livestock-related educational contests during 4-H Congress.

Implications

Many people think of livestock shows when the 4-H Livestock Program is mentioned. It is important to emphasize the valuable characteristics youth can learn by giving presentations, judging meats and dairy products and justifying their decisions with oral reasons, and using their knowledge of livestock in quiz bowl competitions. These are productive contests that allow youth to exercise their true capabilities and apply what they have learned with their own animals. Participation is always encouraged to allow youth to develop the self-confidence to speak to a group of people about a livestock topic of their interest. It should be noted that for the past 3 years, the Mississippi 4-H State Presidents' main project interests have been the livestock program. These livestock-related educational contests held during 4-H Congress are critical to the 4-H Livestock Program as they allow youth to gain needed experience in communication and decision-making that lead to life-long success.

2014 Dixie National Junior Round-Up

F. D. Jousan
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS

Extension Summary

In early February, 4-H youth brought their livestock projects to Jackson for the Dixie National Junior Round-Up Livestock Shows. This show is the showcase for Mississippi 4-H Livestock Programs and site of the largest junior market livestock show in Mississippi. Those animals that received a blue ribbon at their District Livestock Show qualified for the Dixie National Junior Round-Up. This was the largest Dixie National Junior Round-Up livestock show in the past two decades, as 2,417 animals were exhibited by 1,705 youth. This data supports the strength of Mississippians and the dedication and interest that still existed in showing livestock even when economic times were challenging for many.

Introduction

The Dixie National Junior Round-Up is the largest junior livestock show held in Mississippi. Youth and their families begin preparing for this show many months in advance. Much thought and decision goes into selecting the animal for show, and then the process starts to provide the animal with proper nutrition, care, and training in preparation for show. Through this process, youth learn about aspects of nutrition, reproduction, genetics, selection, and exhibition with their livestock. This enables youth to be competitive in education contests held in conjunction with the Dixie National Junior Round-Up, where they can receive scholarships to help with their college education. Therefore, the objective of the Dixie National Junior Round-Up livestock shows is to offer youth the opportunity to showcase their progress with their livestock projects in the show ring while providing them with opportunities to obtain monies, through education contests, to aid them in pursuing postsecondary instruction.

Procedures

Qualification for Dixie National Junior Round-Up

In order to show livestock at the Dixie National Junior Round-Up, youth compete with their animals at 1 of 5 district shows, depending on their county of residence. At these shows, all animals receiving a blue ribbon qualified for the Junior Round-Up. In the market shows at the district competition, youth were allowed to show up to 6 market hogs, 6 market goats, 6 market lambs, and 3 market steers. From these animals that qualified, youth were allowed to weigh-in and show 2 market animals in those species at the Dixie National Junior Round-Up. If one of their market animals was Mississippi bred, youth were allowed to weigh-in and show 3 market animals. For breeding animals, youth were allowed to enter and show up to 6 beef cattle, 6 dairy cattle, 6 dairy goats, and 6 commercial meat goat does at the Dixie National Junior Round-Up. For the education contests, youth entered competition by submitting applications that were scored prior to on-site competition. In addition, their performance in the remaining aspects of the contests held during the livestock shows contribute to overall rankings.

Results

One thousand, seven-hundred and five 4-H and FFA youth exhibited 2,417 animals at the 2014 Dixie National Junior Round-Up, which was the largest show held as compared to the past two decades. The following is a breakdown of the number of entries in 2014 along with the change in number of animals shown from 2013 to 2014 shown in parentheses: 901 beef cattle (+110); 144 dairy cattle (-16); 761 market hogs (+77); 167 market lambs (+6); 172 market goats (-14); 205 commercial meat goat does (+18); and 67 dairy goats (-14). Exhibitors of market animals were able to show 3 market animals, as long as 1 of the 3 market animals was Mississippi Bred. This change was made for Mississippi producers to be better able to market their animals for shows.

The education contests at the 2014 Dixie National Junior Round-Up had good participation. At the Premier Exhibitor contests, there were 27 participants in the beef division, 6 in the dairy division, 6 in the lamb division, 17 in the swine division, 14 in the goat division and 6 in the dairy goat division, totaling 76 youth who participated in these contests. The winner of each Premier Exhibitor contest received a $2,000 scholarship from the Sale of Junior Champion Promotion Committee.

In addition, the committee awarded 25 Academic Scholarships from the 45 applications it received with each scholarship valued at $1,500 each. Finally, the Sale of Junior Champion Promotion Committee awarded four $1,500 scholarships to the exhibitors of supreme animals at the Junior Round-Up. In addition, the Dixie National Booster Club awarded 6 $1,000 scholarships to the highest placing graduating senior for each species in showmanship.

Implications

The Dixie National Junior Round-Up was a successful event on a number of levels. Several of the species had increased numbers shown compared to 2013. The valuable information that youth learn about their livestock project enables them to be competitive in the education contests and scholarship programs, and the growing number of participants is encouraging. These data show that Mississippi youth are resilient, hard-working individuals who enjoy the challenges associated with showing livestock and competing for scholarship monies.

2014 Dixie National Sale of Junior Champions

F. D. Jousan
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS

Extension Summary

The Dixie National Junior Round-Up Livestock Show is the site of the largest junior market livestock show in Mississippi. Each year, the champions and reserve champions in the junior market shows are selected to participate in the Sale of Junior Champions. Of the 1,424 market animals exhibited at 1 of 5 District Livestock Shows, 44 market animals qualified for the 45th Sale of Champions auction in 2014. These animals sold for $369,125, with 80% of the money going to the exhibitor and 20% into a scholarship fund and to pay expenses of the sale. In addition, 35 youth were recognized for their academic accomplishments and successes with breeding animals, and $55,500 was awarded to these individuals. Even though this was a difficult year from a financial standpoint for many buyers and contributors, the hard work of the promotion committee paid off with the monies raised for Mississippi youth.

Introduction

The Dixie National Junior Round-Up is the largest junior livestock show held in Mississippi. This show culminates each year with the Sale of Junior Champions, where the champion and reserve champion exhibitors in the market shows earn the privilege to sell their animal in a live auction. Youth and their families begin preparing for this show many months in advance in hopes of qualifying an animal for the sale. Much thought and decision go into selecting the animal for show, and then the process starts to provide the animal with proper nutrition, care, and training of the animal in preparation for show.

Members of the Sale of Champions Promotion Committee include adults, businesspeople, and the Extension 4-H Livestock Specialist who are interested in promoting the junior livestock program in Mississippi. These members work diligently to bring potential buyers and contributors to the sale each year to invest in the future of Mississippi youth. The committee seeks to 1) promote the 4-H and FFA livestock programs in Mississippi; 2) promote economic, educational and personal development opportunities for youth; and 3) to motivate and increase interest in the junior livestock program. Not only are youth recognized for qualifying their animal for the sale, but other youth exhibitors are rewarded for their achievements in education contests and with their breeding animals.

Procedures

The Sale of Junior Champions Promotion Committee met several times in the latter part of 2013 and early 2014 to discuss potential buyer and contributor lists. Each committee member was charged with contacting these businesses and individuals to encourage them to participate in the upcoming sale. The number of animals qualifying for the sale varies each year, with approximately 41-44 animals being sold annually. Youth receive 80% of the sale of the animal, while 15% of the money goes into the scholarship fund and 5% covers the expense of the sale. Money in the scholarship fund was used to recognize youth winning education contests (Premier Exhibitor

contests), being a graduating senior without qualifying an animal for the sale (Academic Scholarships), and for exhibiting animals that won supreme awards (Supreme Animal Scholarships).

Results

One thousand, four-hundred twenty-four market animals were exhibited at one of five District Livestock Shows in an attempt to qualify for the Dixie National Junior Round-Up. Of these market animals, 1,231 animals were exhibited at the Junior Round-Up from which 44 market animals qualified for the Sale of Junior Champions. The sale included 9 market steers, 13 market hogs, 13 market lambs and 9 market goats. These 44 animals sold for a record total of $369,125, making it the 20th consecutive year the sale grossed over $100,000. To date, the 45 combined sales have grossed a very impressive $5.49 million dollars.

Although the exhibitor is allowed to keep 80% of the money from the proceeds of the animal, 15% of that money is used in the scholarship program. Twenty-five Academic Scholarships (each worth $1,500) were awarded to graduating seniors who did not have an animal that qualified for the sale (totaled $37,500). Forty-five applications were received for the Academic Scholarships in 2014.

In addition, the Premier Exhibitor contest recognized the winner of each of the 6 species shown (beef, 27 entries; dairy, 6 entries; sheep, 6 entries; swine, 17 entries; goat, 14 entries; and dairy goat, 6 entries) with $2,000 scholarships, totaling $12,000. Finally, the exhibitor of the Supreme Beef Bull, Supreme Beef Female, Supreme Dairy Cattle Female and Supreme Dairy Goat Female received a $1,500 Supreme Animal Scholarship, totaling $6,000. Altogether, $55,500 in scholarships was awarded to 35 youth by the Sale of Champions Promotion Committee. The scholarship program was initiated in 1993, and to date, 502 scholarships have been awarded for a total of $602,700.

Implications

Committee members worked diligently in preparing for the 2014 Sale of Junior Champions and were pleased with its outcome and for recognizing the large number of animals that qualified for the sale. Despite difficult economic times, buyers and contributors gave generously and the number of youth served in this program was substantial. The data demonstrates the generosity of Mississippians when it comes to helping put youth in a position to be successful later in life. That is the goal of the Sale of Champions, to work toward the personal development of youth who participate in livestock programs.

2014 4-H/FFA Replacement Beef Heifer Contest

F. D. Jousan
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS

Extension Summary

4-H and FFA livestock projects have been successful at teaching youth and their families about responsibility and care for their livestock. The Replacement Beef Heifer Development Contest is a 10 month event where the contestant is personally responsible for the daily management of their heifers. During the contest, youth maintain records about their project to justify management decisions. At the end of the contest, they turn in a record book (30% of the contest), have their heifers evaluated (20% of the contest), and make a presentation about their project during an interview (50% of the contest). In the sixth year of competition, 12 entries were received in November and the contest will be completed in August. It is anticipated that youth in this contest will be able to educate adult beef cattle producers about management practices and become good stewards of their cattle.

Introduction

Livestock shows have always been popular among Mississippi youth. Showing livestock provides youth with a variety of avenues to learn about their animals, including aspects of nutrition, reproduction, genetics, selection and exhibition. As youth grow in the program, they are better able to utilize and understand this information to make enhanced decisions regarding their livestock projects. A common misconception about livestock shows is that the most successful youth are those who have unlimited resources from which high-quality livestock and equipment can be obtained for shows. This has been known to discourage some youth and families from participating in livestock shows. Some youth, regardless of whether they show cattle, are integral parts of family cattle operations and have obtained experiences that will enable them to make sound heifer management decisions. Therefore, the objective of the Replacement Beef Heifer Development Contest is to recognize those youth that have a true passion for raising beef cattle. In doing so, youth will learn about proper heifer development practices and procedures and can be a positive influence on adult producers involved in raising cattle.

Procedures

Contest Design

The 4-H and FFA Heifer Development Contest is a 10 month project that started on November 1, 2013, and concluded August 8 to 9, 2014. Contestants must be 4-H or FFA members who compete as individuals unless 2 or more brothers or sisters (each at least 14 yrs. of age but not over 18 yrs. of age as of January 1 of the year in which the contest begins) of a family constitute a joint entry. If the entrant is in college, he/she must personally manage and care for their heifers on a daily basis by commuting to and from home and school. It is not permissible to have someone else care for contest heifers while away at school.

The heifer development project must consist of 3 heifers (purebred or commercial)

that are either autumn born from the previous year or spring born of the year in which the contest begins. While not mandatory, the heifers can be exhibited in junior shows. Heifers can be purchased from a purebred or commercial producer or be selected from operations of an immediate family member (parent, stepparent, brother, sister, half-brother, half-sister, grandparent, or legal guardian). This contest is designed to evaluate the youth producer's ability to manage the heifers rather than the genetic makeup of the heifers. Therefore, participants using purebred and commercial heifers will be judged together without preference given for breed or breed type. Contestants will be judged on all managerial aspects of their heifer development project. Participants were encouraged to take advantage of Extension agents, advisors, and experienced producers in selecting quality heifers and discussing production costs.

Evaluation System

Youth submitted entry forms with a description of the 3 heifers they entered in the contest by November 1, 2013, to the Extension 4-H Livestock Specialist. Initial criteria to be included on the entry form included each animal's age, weight, breed, and starting value (purchase price). In addition, each entrant submitted their goals for the project. If registered heifers were used, the entry included a photocopy of that animal's registration paper.

Heifers chosen for the contest must have been born in the autumn of 2013 or the spring of 2014. Any heifer with a sign of 3-yr-old teeth were eliminated at the contest site, regardless of a registered or printed birth date for that heifer. Upon arrival to the contest site, all entered heifers were checked to confirm that the heifer was entered in the contest.

The 4-H and FFA Heifer Development Contest consists of 3 components: a visual appraisal of the heifers, a record keeping system, and an interview process.

- **Visual Evaluation:** A committee of judges evaluated each group of 3 heifers managed by youth. Criteria evaluated included weight, frame score, growth, body condition score, health, structural/skeletal soundness, and reproductive ultrasound evaluation. In addition, each entrant was judged on their salesmanship skills and overall knowledge of phenotypic characteristics of their heifers. *This component of the contest was worth 20%.*

- **Records:** Youth were required to submit records kept throughout the project by August 1, 2014. At the start of the project, contestants were asked to list short- and long-term goals for their heifer project. During each month of the project, contestants should have recorded management practices performed on his/her heifers. Examples include recording the amount of feed, hay or other nutritional supplements purchased or fed, veterinarian expenses and other health-related costs, breeding decisions, rotational grazing of pastures, a complete budget/expense sheets and any other management issue in which the youth made a decision for the continued development of his/her heifers. At the conclusion of the project, youth should have addressed whether they achieved their goals set at the start of the project. These records were judged on their completeness and exactness during the contest year. *This component of the contest was worth 30%.*

- **Interview:** A committee of judges interviewed the exhibitor on their individual production practices.

Exhibitors gave a 10 to 15 minute presentation (Microsoft PowerPoint slides or other visual aids) to summarize his/her heifer development project. This presentation included anything relevant to the contestant's project (goals for project and if they were accomplished, pictures to illustrate the project, etc.). Each exhibitor then answered questions from the committee in regard to their project, such as the process used to select the heifers, record keeping system used, nutrition program, bull used for breeding purposes, health records and any production practices utilized by the exhibitor during this contest. *This component of the contest was worth 50%.*

Judges for this contest were chosen from Extension area livestock agents, cattle producers, Extension specialists, and cattle association members. All ties were to be broken using the interview score followed by the record book.

Results

In the sixth year of this contest, 12 entries were received and 5 youth completed the contest. Throughout the year, several educational opportunities were made available to youth to assist them with their heifer project.

This contest was a big endeavor for youth, and it was important to reward them justly. While the education and knowledge learned about heifer development will benefit youth long-term, it was important to provide valuable prizes for winning.

To date, prizes to be awarded for the 4-H/FFA Replacement Beef Heifer Development Contest include a bumper-pull livestock trailer, laptop, truck/trailer hitches, cash prizes, and complimentary artificial insemination school registrations for all participants, courtesy of the Mississippi State University Extension Service. The announcement of winners and awarding of prizes will take place during the Mississippi State Fair and the winner will present what they learned about heifer development at the 2015 Mississippi Cattlemen's Association Annual Convention.

Implications

The Replacement Beef Heifer Development Contest provides an authentic experience for youth that choose to participate. Not only do youth learn valuable information that they can use for a lifetime, but the cattle industry benefits as young cattlemen and cattlewomen will be educated producers in the future. These youth can be a positive influence on their own family's cattle production system and share their insights with other cattle producers around the state, prompting adults to think more about their own management decisions.

2014 Mississippi 4-H Horse Championship

F. D. Jousan
Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS

Extension Summary

The highlight of the year for youth interested in the 4-H Horse Program is the Mississippi 4-H Horse Championship. Many of these youth had to qualify for this show by placing well at 1 of 4 district horse shows held across the state. In 2014, 600 youth competed at district shows on 1,026 horses, with a total of 2,205 total entries participating in these shows. Overall, 64 counties had youth represented at the district shows. At the state horse show, 388 youth (representing 61 counties) competed on 603 horses, with a total of 1,189 entries being shown. The district and state shows offered numerous opportunities for junior and senior youth to compete in education contests. Altogether, 355 youth competed in these education contests. In our creative contests, Horse Art, Horse Photography and County T-shirt Design, there were 233 youth entered and 15 counties that submitted entries. The Mississippi 4-H Horse Program was well represented by youth at national contests, attesting to the quality of the youth involved in this program.

Introduction

The State 4-H Horse Championship is the largest 4-H horse show held in Mississippi. Youth and their families begin preparing for this show many months in advance. Much time and effort goes into training and working with the horse and rider to make them best suited for competition. During this process, youth gain valuable insight regarding proper nutrition for their horse and preparation for the district and state horse shows. In addition to an understanding of nutrition, youth learn about aspects of reproduction, genetics, selection, and exhibition with their horses, thereby enabling them to be competitive in education contests held in conjunction with the State 4-H Horse Championships, where senior winning individuals and teams are selected to represent Mississippi in national contests. Therefore, the objective of the Mississippi 4-H Horse Championship is to offer youth the opportunity to showcase the progress they have made with their horses in competition while providing opportunities to use their knowledge and training about horses in educational contests.

Procedures

There are 2 types of classes offered through the Mississippi 4-H Horse Program: **District Only** classes where youth must qualify their horses to advance to state competition and **State Only** classes where youth compete on their horses at the state show without having to qualify for that class. **State Only** classes require some equipment that all district shows are not able to obtain, such as jumps and fences for Over Fences classes.

At the district horse shows (Northeast: Verona, MS; Northwest: Tunica, MS; Southeast: Meridian, MS; Southwest: Jackson, MS), all junior (age 8 to 13) educational contests are held, with the top 3 teams and/or individuals (depending on the contest) advancing to compete at the state show against other winning juniors. Senior 4-H youth compete at the state competition held during the state horse show. During the state horse show, all

education contests are held prior to the horse classes. Education contests offered at these shows include Horse Public Speaking, Horse Individual Demonstration, Horse Team Demonstration, Horse Bowl, Horse Judging, and Hippology (senior-only event). In addition, creative contests are offered for youth to compete in as individuals and as a county, including Horse Art, Horse Photography, County T-shirt Design Contest, and County Stall Decoration/Display Contest.

Winners are announced at the Opening Ceremony. Of the classes offered during the state horse show, 50 horses were chosen to advance to the Southern Regional 4-H Horse Championship. Winners of the senior educational contests received some travel support to compete at the Western National 4-H Roundup in the Horse Classic in Denver, Colorado.

Results

At the District 4-H Horse Shows held in 2014, 600 youth rode 1,026 horses with a total of 2,205 entries. Overall, 64 counties had youth represented at the 4 district shows. At the state horse show, 388 youth (representing 61 counties) competed on 603 horses, with a total of 1,189 entries being shown. Altogether, 355 youth competed in these educational contests at the district and state horse shows. In our creative contests, 119 youth had exhibits in Horse Art, 114 youth had exhibits in Horse Photography, 15 counties entered the County T-shirt Design Contest and 2 counties entered the County Stall Decoration/Display Contest.

Implications

It is important for youth to learn communication skills in 4-H. The Mississippi 4-H Horse Program provides many opportunities for youth to gain valuable experiences in educational contests that will help them as they progress towards college. Competition in these events is friendly, but fierce, similar to what is seen in our classes. Mississippi youth performed well at regional and national contests, demonstrating the depth of the quality of youth at these district and state shows.

Beef Cattle Extension Social Media and Apps

B. B. Karisch
Department of Animal and Dairy Sciences, Mississippi State University, MS

Extension Summary

The Mississippi State University Beef Cattle Extension team is constantly exploring new ways to share information with beef cattle producers. In December 2012, the Mississippi State University Extension Service (MSU-ES) launched the YouTube channel, MSUBeefCattle, which is accessible online at *www.youtube.com/user/MSUBeefCattle*. Since inception through September 2014, 116 videos were uploaded to MSUBeefCattle with a total of 30,641 views. A Twitter account (@MSUBeefCattle) was started in February 2013 to share up-to-date beef cattle news via social media. The account has garnered 210 followers. In December 2013, the first beef cattle app was launched by the MSU-ES beef team, titled MSU-ES Cattle Calculator. The app has been downloaded 2,670 times by users around the world. The Beef Extension team is committed to keeping beef producers up to date with knowledge through new sources.

Introduction

Social media has continued to increase in popularity as a news source. Apps such as Twitter, Facebook, and YouTube, which link to these popular websites, offer beef producers a way to stay in touch with current news while on the go. Most major beef industry groups maintain a presence on each of these sites. Twitter is simply an online social networking service that limits the length of messages users can share to 140 characters. These short messages are known as “tweets”, and have quickly become the source for late breaking news. The Mississippi State Beef Extension Team provides news and information on Twitter which can be found by following @MSUBeefCattle. Facebook is similar to Twitter, but without the character limit on messages. Often beef industry groups will provide news and information on these pages. YouTube is a popular video sharing site that can also be viewed through a smartphone app. It is best used as a source of educational information or quick how-to videos. The Mississippi State Beef Extension Team (www.youtube.com/user/MSUBeefCattle) provides educational clips that are approximately 4 to 5 minutes long on a wide variety of topics such as Freeze Branding and Transporting, with new videos added on a regular basis.

There is an amazing variety of applications, better known as “apps,” available for beef producers on mobile devices. There are apps for monitoring weather conditions, market conditions, herd management, record keeping, functional apps such as flashlights, and even apps that allows for keeping track of employee work hours. The Mississippi State University Extension Service has recently entered the world of app development and released its first beef cattle app in December 2013 called MSU-ES Cattle Calculator.

Procedures

YouTube

The MSUBeefCattle YouTube channel was launched with its first video posting on December 7, 2012. Since then a total of 116 videos were posted on the website through September 15, 2014. Videos were produced by an extension beef cattle specialist using Camtasia Studio® 8 software (TechSmith® Corporation, Okemos, MI) and included a common introduction and ending branding them with the Mississippi State University Extension Service and MSUcares logos and including the tag line “Education for the Beef

Cattle Industry – On Demand". The only exceptions to this common production and branding approach were the feeder calf board sale lot videos, which were produced by the Mississippi State University Extension Service Center for Technology Outreach.

The YouTube Analytics feature of the channel manager dashboard was used to access video view and engagement information. This information was assessed over the lifetime of the channel through September 15, 2014. Highlights of this evaluation are presented in this report.

Twitter

The MSUBeefCattle Twitter account was launched in February 2013, with posts continuously shared by the page manager. The Twitter Analytics feature was used to track follower rates and demographics through September 15, 2014. Highlights are presented in the results section.

Table 1. MSUBeefCattle YouTube channel top 10 videos for views and their estimated minutes watched through September 15, 2014**.**

Video Title	Views	Estimated Minutes Watched
Freeze Branding Beef Cattle	7,197	19,076
Bull Semen Storage and Handling	5,400	15,851
Estimating Cattle Age by Dentition	4,707	12,015
Beef Cattle Crossbreeding Systems	2,071	5,485
Body Condition Scoring Beef Cattle	1,766	4,660
Mineral and Vitamin Feeding Management	1,732	4,011
Beef Cattle Handling Facilities Basic Components	1,067	3,359
Beef Cattle Handling Facilities Optional Features	680	2,027
Heifer Reproductive Tract Scores and Pelvic Area	534	1,847
Beef Calf Weaning Management	447	1,281

MSU-ES Cattle Calculator app

The MSU-ES Cattle Calculator app was launched in December 2013, and is available through iTunes. The app was promoted through several news articles, as well as print and social media. Cattle Calculator allows beef cattle producers to make quick everyday calculations important for their operations. Calculations related to reproductive management, animal performance, and management decisions are available. Reproductive calculations include: calving date based on a known breeding date, breeding date based on a known calving date, number of days pregnant based on today's date and a breeding date, and a breeding season calculator which provides calving and breeding dates based on a set breeding season. Animal performance calculations include: Adjusted birth weight, weaning weight, and yearling weight, average daily gain and required gain. Management calculations include: dosage calculations for dewormers and medicines given an animal weight and manufacturer's recommended dosage, frame score calculations, trailer stocking density, and yield grade.

Results

YouTube

As of September 15, 2014, theMSUBeefCattle YouTube channel had amassed 30,641 video views; 77,314 minutes watched; 33 subscribers; 20 likes; 8 shares; and 6 favorites added.

The top 10 videos in descending order of views and their estimated minutes watched are listed in Table 1. The two most popular

videos in terms of number of views were "Freeze Branding Beef Cattle" and "Bull Semen Storage and Handling", with 7,197 and 5,400 views, respectively. Both of these videos also topped the rankings for estimated minutes watched. Three videos tied for the most "Likes" on the page: "Bull Semen Storage and Handling," "Freeze Branding Beef Cattle and "Estimating Cattle Age by Dentition." Of the top 10 videos for estimated minutes watched, the top 3 videos for average percentage of videos viewed were: 1) Mineral and Vitamin Feeding Management, 65%; 2) Freeze Branding Beef Cattle, 61%; and 3) Beef Cattle Crossbreeding Systems, 60%.

Channel viewer demographics were as follows. Male viewers accounted for 75.8% of MSUBeefCattle YouTube channel viewership. By geography, the United States was the leading viewer location with 59% of the views and 63% of the estimated minutes watched. Rounding out the top 5 viewer locations in descending order of percentage of views were Canada, the United Kingdom, India, and Australia. A total of 170 countries were represented in the channel viewership, but the countries not specifically mentioned here each accounted for less than 2% of the views. Within the United States' viewership, the majority of the views came from Mississippi (15%) followed by Texas (9.8%), California (6.4%), Georgia (3.8%), and Tennessee (3.6%).

Twitter

As of September 13, 2014, the MSUBeefCattle Twitter account had 209 followers and 288 tweets, of which 77 were photos or videos. Follower demographics were as follows. Approximately 180 followers were from the United States, 10 followers from Canada, and approximately 20 from other countries. Within the United States, the majority of followers were from MS (36%) followed by Kansas (11%), Texas (7%), Alabama (4%), and Georgia (3%). Followers of the account were approximately 70% male and 30% female.

MSU-ES Cattle Calculator app

The MSU-ES Cattle Calculator app was launched in December 2013. Since that time there have been 2,670 downloads of the app. It has been very well received by producers with a rating of 4+ out of 5, and positive comments.

Implications

Initial interest in and response to social media use to disseminate beef cattle related information has been encouraging. YouTube Channel viewership is steadily increasing, making this a promising means of disseminating educational information relating to beef cattle production and marketing.

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