

W4177: Enhancing the Competitiveness and Value of U.S. Beef

Annual report

1. Accomplishments

California - Scott Fausti

Efforts in CA (Dr. Fausti) have been focused on achieving the milestones outlined in objective 2 of the W-4177 project proposal, through (a) investigating the economic and socioeconomic factors contributing to the decline of small and medium sized feedlots in the U.S., (b) identifying the economic factors influencing the current evolution of alternative marketing arrangements in the fed cattle industry, and (c) how structural change in the marketing behavior of both packers and feedlots is affecting the competitive nature of the fed cattle market. Accomplishments include the South Dakota feedlot survey project being in its final stage with data from the stratified random sample of South Dakota feedlots for 2015 being complete. Initial quantitative and statistical analysis has been completed. Survey findings has been published through South Dakota Agricultural Experiment Station. The survey report provides the first comprehensive survey of the State feedlot industry in over 20 years.

Colorado - Dale Woerner and Keith Belk

Colorado State University (CSU; Dr. Woerner and Dr. Belk) has been actively engaged in research during the past year with a particular focus on palatability, processing, and marketing of beef, prevention of food-borne illness, and consumer preferences for beef. The PIs are intensely investigating the incidence and causes for antimicrobial resistance of bacterial pathogens in livestock production using metagenomics. Furthermore, Woerner and Belk are working extensively in the area of red meat flavor chemistry and the development of instrumentation for segregation of flavor intensities and off-flavors. In that regard, research has been performed on beef flavor variations as it relates to production practices, animal breed, postmortem aging, grade level, and muscle-specificity. Research at CSU has also focused on the use of growth promotants on beef production, techniques for detection of growth promotants in meat, and the impact of these on global trade. CSU also took an active role in conducting the National Beef Quality audit in 2016, and the results were published as peer-reviewed journal articles in 2017. Nutritional information of red meat and the effect of broad and inconsistent classification of muscle food on dietary guidelines also has been undertaken as research topics in the past year.

Kansas – Glynn Tonsor

Collaborating faculty completed projects with the U.S. beef industry examining the feasibility of new beef demand indices and identifying current determinants of U.S. beef demand. Each project was part of the annual cattle industry conference signaling linkage with industry and real-world relevance.

Kentucky - Surendranath Suman

Ractopamine is a beta-adrenergic agonist approved for use in beef cattle and pigs as a repartitioning agent to increase lean muscle deposition and to decrease lipogenesis. Although

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the effects of dietary ractopamine on proteome profile of postmortem pork muscles have been examined, its influence on beef muscle proteome has not been studied. Therefore, the objective of this study was to examine the effect of ractopamine on the proteome profile of postmortem beef longissimus lumborum (LL) muscle. LL muscle samples were obtained from the carcasses of nine (n = 6) steers fed ractopamine (RAC; 400 mg ractopamine hydrochloride for 28 days) and steers fed no ractopamine (CON). The whole-muscle proteome was analyzed using two-dimensional gel electrophoresis and tandem mass spectrometry. Five differentially abundant spots were identified, and all the spots were over-abundant in RAC. The identified proteins were involved in muscle structure development (F-actin-capping protein subunit beta-2; PDZ and LIM domain protein-3), chaperone activity (heat shock protein beta-1), oxygen transport (myoglobin), and glycolysis (L-lactate dehydrogenase A chain). These results suggested that dietary ractopamine influences the abundance of enzymes associated with muscle development and muscle fiber type shift in beef LL muscle.

Michigan – David Ortega

Dr. Ortega is currently working on evaluating emerging markets for US meat products in China. This includes beef and substitute product, namely pork. Special attention is given to the role of e-commerce in promoting US products as well as Chinese consumer acceptance of novel traceability systems in beef products.

Mississippi – Thu Dinh and Kalyn Coatney

Thu Dinh of Mississippi State has been conducting two beef quality and safety projects: (1) the effects of endophyte-infected tall fescue seeds on beef quality and the use of pre-rigor beef for sausage production. In addition to data of ergovaline concentration and the hepatic enzyme activity, we found that endophyte-infected tall fescue seeds did not affect beef quality attributes during retail display although retail display decreased beef color stability and metmyoglobin reductase activity and increased lipid oxidation and off-flavors. It is possible that long breakout period and vitamin E in alfalfa supplementation allow the cattle to develop resistance to the effects of endophyte-infected tall fescue. In the other study, we found that pre-rigor beef not only did not impact safety of cooked beef sausage but also improved sensory attributes, especially flavor, of the sausage and had a greater demand, which could lead to a more profitable processing model.

Currently, Kalyn Coatney is developing a testable theory to analyze the potential competitive effects of multiproduct mergers, as well as an antitrust decision rule regarding the required economies of scope to evaluate the likelihood these types of mergers are anticompetitive, specifically related to the meat processing sector, laboratory testing of the competitive implications of linking forward contract base prices to cash market prices and empirically analyzing the effectiveness of auctioneer strategies to enhance competition among bidders.

Montana - Carl Yeoman

In recently published manuscripts, we have: i) defined a core microbiome across globally-distributed wild and domestic ruminant animals; ii) shown that the feed efficiency of

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ruminant livestock involves microbes in the rumen, small intestine, and hind gut and include microbial taxa associated with health; iii) revealed that more than 45 % of gut microbes, including many species known to be important to nutrition and health are acquired from maternal reservoirs including the vagina, colostrum and teat. Further, we are in the process of preparing a manuscript for submission showing that the succession of the ruminant gut microbiota corresponds with the animal's immunological development. We have identified several microbial taxa that show strong correlative relationships to animal productivity and immunological development and are currently working to experimentally interrogate these relationships.

Nebraska – Gary Sullivan and Chris Calkins

With the growth of the ethanol industry, distillers grains are utilized as a component in cattle diets. As a result of the manufacturing processes, the fat content of distillers grains is greater than corn and increases the polyunsaturated fatty acid (PUFA) content of beef when cattle fed distillers grains. There is an increased PUFA and phosphatidylcholine contents in muscle organelle membranes when distillers grains are fed which could cause membrane instability, decreased control of calcium, and increased proteolytic activity early postmortem. Feeding vitamin E along with distillers can counteract changes in discoloration and oxidation in raw and cooked beef quality. Natural plant extracts can help to maintain color in raw ground beef and reduce lipid oxidation in raw and cooked ground beef.

The food industry has trended toward the use of simple ingredients. Research has been conducted on manufacturing cured beef products with alternative sources of nitrite. These data can be used by processors to manufacture cured beef products to meet consumer demands. Another trend is toward reduced sodium content (salt) in processed meats. Reducing salt in sliced deli-roast beef did not change the microbial population but increased spoilage bacteria growth rates.

Anitmicrobial food safety interventions are necessary to provide safe beef but can impact product quality characteristics. The organic acid treatment of beef subprimals can reduce *E. coli* O157:H7 but extended treatment times can reduce shelf life by increasing discoloration and oxidation in ground beef. High pressure processing is a non-thermal process to reduce *E. coli* O157:H7 but can cause color changes in raw ground beef and resulted in steaks intended for sous vide cooking, caused increased toughness.

Nevada – Amilton de Mello

Nevada has been conducting research to improve safety, nutritional values, and sensory attributes of beef.

The beef industry heavily relies on interventions based on organic acids, predominantly PAA and LA. Research performed by Nevada demonstrated that both acids do not reduce STEC and Salmonella loads when directly applied on beef. Combined applications of bacteriophages S16 and FO1a and UV light reduced about 2 log of *Salmonella* in fresh beef. Applications of a cocktail containing 7 T4-like phages (MelloShebs1-157H7, MelloShebs1-145, MelloShebs1-121, MelloShebs1-111, MelloShebs1-103, MelloShebs1-45, and MelloShebs1-26) reduced about 1 log of a cocktail of adulterant STEC strains.

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Projects studying the effects of finishing diets based on legume and grass pasture in comparison with corn-based diets showed that it is possible to obtain beef carcasses with similar weights. Beef from steers fed legume and grass had improved lipid stability and lower off-flavor intensity due to higher tocopherol concentrations in the lean and lower concentrations of volatiles associated with lipid oxidation, respectively.

Currently, dry aging beef is a process used by meat purveyors and upscale restaurants to increase value of beef. A common claim of dry-aged beef is that the product has superior tenderness and flavor. Nevada has showed that dry-aging beef inhibits bacteria growth but does not affect objective tenderness parameters including desmin degradation, lipid oxidation of the lean and flavor.

Regarding nutrition values, preliminary studies were conducted to understand epigenetics and aging effects on microRNAs in beef. MicroRNAs (miR) are small non-coding RNA molecules that are directly involved in gene expression and consequently, possible interactions with human gastric and intestinal cells during digestion and absorption of meat proteins. Nevada has shown that expressions of miRs (17, 19, 20, 23, 24, and 206) are elevated during the first 14 days post mortem but significantly decrease as aging time extends. Future studies to understand regulation of proteases and interactions of miR with gastric and intestinal human cells are planned.

North Dakota - Robert Maddock

Projects investigating forage level and corn processing and delayed entry into feedlots by utilizing extended grazing of native pastures and utilizing forage corn on beef quality were completed. Our objectives are to maintain beef quality while reducing input costs. For one project, steers (n = 106) were fed either twenty or forty percent forage, with whole or dry-rolled corn. There were no differences in fat thickness, longissimus area, KPH, marbling, or USDA quality grade ($P \geq 0.11$). Cattle fed high forage and whole corn tended to have lighter hot carcass weights ($P = 0.07$). Additionally, the forty percent forage treatment tended to have lower USDA yield grades, ($P \leq 0.06$) and had darker colored steaks ($P \leq 0.0001$). We found no difference in Warner-Bratzler shear force or cook loss ($P \geq 0.174$). Additionally, steaks from the dry-rolled corn treatment had steaks that were redder and more yellow ($P \leq 0.0003$). A second project found that delayed entry into a feedlot by utilizing annual forages or native range grazing to increase weights did not affect tenderness, juiciness, or flavor ($p > 0.05$) of steaks from beef steers.

2. Short-term Outcomes

California - Scott Fausti

Research has generated several key understandings of feedlot operation in the U.S., including:

- Minimal distinct patterns were found among structural characteristics and finishing or backgrounding features. The size of a cow herd and placement activity in a feedlot were positively correlated, suggesting that a feeding enterprise may complement a cow-calf enterprise. The larger the placement activity, the larger the number of hired workers.

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- At different feedlot sizes (less than 1,000 head and 1,000+ capacity), there are differences in the use of backgrounding. Smaller feedlots have a greater portion of cattle on feed that were raised on the operation. These cattle are placed at a lighter weights than would be typical of larger feedlots.
- Smaller feedlots have greater reliance on public information, such as local auction reports (not necessarily from the Agricultural Marketing Service), whereas larger feedlots are more likely use futures prices and packer bids to inform selling decisions. Smaller feedlots are more likely to use auctions, whereas larger feedlots are more likely to use direct sales to packers, and to use a variety of different pricing methods.
- Use of crop insurance and contracting non-feed inputs are common across feedlot sizes. Larger feedlots are more likely to use forward contracts, futures contracts and options contracts than are smaller feedlots. The use by larger lots is consistent with selective hedging.
- There was a high percent of feedlots that use a nutritionist, a veterinarian, a hospital pen, medical records and visual sorting of cattle. There was a low percent of feedlots that use Beta Agonists and ultrasound. The shares were more pronounced for larger versus smaller feedlots.
- Feedlots, especially larger feedlots, are not risk seeking, but have to bear a large amount of risk. In other words, larger feedlots have to take risks feeding cattle, but do not necessarily seek it out in the traditional sense.
- Survey respondents indicated, on average, feedlot capacity is going to be expanded over the next five years, as responded consistently across feedlot capacity categories (Table 1).

Table 1. Firms size distribution effect on future capacity decisions (Next Five Years).			
Capacity/Firm Size	Firm<1000	Firm>1000	All Firms
Increase	81 (23.5%)	11 (29.7%)	92
Constant	223 (64.8%)	21 (56.7%)	244
Decrease	40 (11.6%)	5 (13.5%)	45
Totals	344 (100%)	37 (100%)	381

Colorado - Dale Woerner and Keith Belk

The Pls served as members of advisory boards for major processing companies and research foundations, integrated research findings into university courses and curriculum, and have been invited and serve as a member of closed research groups for targeted research dollars for industry associations.

Kansas – Glynn Tonsor

A better, deeper understanding of U.S. beef demand.

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Kentucky - Surendranath Suman

The results of the present study suggested that dietary ractopamine influenced the abundance of proteins related to muscle structure development, chaperone activity, oxygen transport, and glycolysis in postmortem beef longissimus lumborum muscle.

Michigan – David Ortega

The work on emerging markets for US beef products is producing timely information that can be used by US meat industries when developing marketing strategies for their products in China.

Mississippi – Thu Dinh and Kalyn Coatney

The results provide the beef industry with a better understanding of the effects of tall fescue on beef quality and how to mitigate the negative impacts. Moreover, pre-rigor processing can be a promising processing model for cooked beef sausage. It is also more financially sustainable. This processing method improve the quality of cooked beef sausage.

The model developed by Kalyn Coatney may change the decision-making process of how to send cattle for slaughter to maximize profit.

Nebraska – Gary Sullivan and Chris Calkins

Research on alternative meat curing systems in has generated much discussion with meat industry professionals as more meat processors are entering this area.

The research on feeding distillers grains to cattle has provided confidence that distillers grains can be feed with limited detrimental effects to beef quality when appropriate precautions are taken.

Nevada – Amilton de Mello

Alternative food safety interventions are needed to improve control of STEC and *Salmonella* in beef. Research demonstrated that bacteriophages and UV light provide better bacterial reduction when applied onto beef when compared to common interventions based on organic acids.

Finishing beef on grass and legume pastures leads to higher tocopherol deposition improving lipid stability. In addition, it is possible to obtain similar hot carcass weight than corn-feeding when finishing steers on pasture containing rye grass and clover.

Dry aging does not affect flavor and tenderness of beef. Although it was initially hypothesized that possible effects on flavor due minimal oxidation would be found, dried surfaces possibly inhibit propagation of radicals throughout the lean.

Expression of some microRNAs in beef decrease during aging. Impacts on muscle proteolysis related to meat quality and on human digestive cells related to nutritional impact must be studied to understand cell response pathways when beef is consumed.

North Dakota - Robert Maddock

Information from research that indicated forage levels and corn processing did not affect carcass traits and delayed feedlot entry did not affect meat quality was relayed to beef

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cattle producers via Extension meetings, field day events and NDSU Beef Report. We are not aware if changes in diet formulation were adopted based on this project. Extension agents have been in contact for additional information that may be implemented by livestock producers.

3. Outputs

California - Scott Fausti

Fausti: Fausti, S.W., and M.A. Diersen (August 2017). Economic Factors Influencing the Sustainability of Feedlots in South Dakota: AFRI Seed Grant. Presentation prepared for the NIFA Post Conference Workshop held in conjunction with Agriculture and Applied Economics Association held in Boston MA.

Matthew Diersen and Scott Fausti (2017). "Small- and Medium-Sized Feedlots: Management and Marketing Survey Results", Economics Research Report 2017-1, Department of Economics, South Dakota State University, Brookings South Dakota (December 21, 2017).

Colorado - Dale Woerner and Keith Belk

Keith Belk received American Meat Science Association's Distinguished Research Award (2017) and North American Meat Institute's Scientific Achievement Award (2017).

Dale Woerner received the American Society of Animal Science Early Career Achievement Award (2018) and Texas Tech University Distinguished Alumni Award of the College of Agricultural Sciences and Natural Resources (2018). He also served as the Chairman of the American Meat Science Association Reciprocal Meat Conference (2018).

The following reports were completed and submitted in 2017:

- Gifford, C.L., Belk, K. E., and Woerner, D.R. October 2017. Identifying altered metabolism and health effects from consuming beef cattle fed genetically modified crops. Final report submitted to the National Cattlemen's Beef Association by the Center for Meat Safety & Quality, Department of Animal Sciences, Colorado State University, Fort Collins, CO., 40 p.
- Roseland, J.M., Nguyen, Q. V., Patterson, K. Y., Woerner, D. R., Gifford, C. L. 2017. USDA nutrient data set for retail lamb cuts, for the USDA food composition database. Nutrient Data Laboratory, Agricultural Research Service, US. Department of Agriculture. Available online: https://www.ars.usda.gov/ARUserFiles/80400525/Data/Meat/Lamb_Labeling_Doc.pdf.
- Reyes, A. A., B. R. Bullard, H. E. Davis, G. Geornaras, D. R. Woerner, J. N. Martin, K. E. Belk, R. J. Delmore. 2017. Use of *Pediococcus acidilactici* as a surrogate for *Escherichia coli* O157:H7 and *Salmonella* to determine lethality for validating a cooking process on heat-treated ready-to-eat ground-and-formed and whole-muscle beef jerky. Submitted to Monogram Foods Solutions.
- C. J. Weissend, K. L. Holzer, K. L. Huebner, K. E. Belk, P. Morley, I. Geornaras, J. K. Parker, J. Metcalf, S. M. Lakin, Z. Abdo, D. R. Woerner, H. Yang, R. Delmore, T. C. Bryant, C. McMurphy, N. Meyer, J. Szasz, and J. N. Martin. 2017. The use of a yeast fermentation product or essential oil as an alternative to Tylosin in the diets of finishing cattle. Final

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report submitted to National Cattlemen's Beef Association by the Center for Meat Safety & Quality, Department of Animal Sciences, Colorado State University, Fort Collins, CO. 122 p.

- Kesterson HF, Woerner DR, Engle TE, Martin JN, Delmore RJ, Belk KE. 2017. U.S. Beef Variety Meats - Nutrient Analysis of Ten Raw Beef Variety Meat Items. Final Report prepared for National Cattlemen's Beef Association.
- Djimsa, B. A., Woerner, D. R., Martin, J. N., Delmore, R. J., Belk, K. E. 2017. Understanding the impact of carcass size, rate of chilling, and electrical stimulation on muscle tenderness, juiciness, and color. Submitted to the National Cattlemen's Beef Association. Centennial, CO.
- D.A. Gredell, H.L. Laird, R.K. Miller, C.R. Kerth, and D.R. Woerner. 2017. Beef Flavor Myology – Coulotte, Tri-Tip, and Flank. Final report submitted to National Cattlemen's Beef Association.

Kentucky – Surendranath Suman

Surendranath Suman received the Meats Research Award, American Society of Animal Science (2018).

Mississippi – Thu Dinh and Kalyn Coatney

Thu Dinh published 4 articles and 1 abstract, and graduated 1 Ph.D. and 1 M.S. student. Dinh was invited to give a presentation on lipid oxidation in rendered fat at the 2018 Pet Food Alliance Summer Meeting. Dinh also received SEC Travel Award to visit Dr. Suman's laboratory to facilitate collaboration.

Kalyn are preparing two articles to report his findings.

Montana - Carl Yeoman

- 3 manuscripts were published in Nature Scientific reports (n=2) and the Journal of animal Science.
- Shown that feed efficiency involves microbes in the rumen, small intestine, and hind gut
- Shown that feed efficiency involves microbial taxa associated with healthy phenotypes
- Shown that maternal microbial reservoirs (i.e. vagina, colostrum, and teat) make major and important contributions to the neonatal gut microbiome.
- Demonstrated that an animal's immunological development corresponds (and may therefore be, at least partially, dependent on the succession of the ruminant gut microbiota.
- Identified several microbial taxa that show strong correlative relationships to animal productivity
- Identified several microbial taxa that show strong correlative relationships to immunological development.
- Invited speaker Animal Microbiome Congress (Kansas City, KS)
- Plenary speaker Midwestern Section of the American Society for Animal Sciences (Omaha, NE)

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Nebraska – Gary Sullivan and Chris Calkins

Nebraska published 15 peer-reviewed manuscripts, 10 abstracts at scientific meetings, and 12 peer-reviewed extension research reports. In addition, six science-based presentations about beef were given to international audiences.

Nevada – Amilton de Mello

A total of 8 peer-reviewed manuscripts were published, 10 abstracts at scientific meetings and 1 extension report. A total of 6 extension presentations about beef production were given to state audiences. Amilton de Mello received the University of Nevada Early Career Innovator Award (2018).

North Dakota - Robert Maddock

Beef reports and publications were developed from completed research, noted below in the publications section. Data collected is being used to develop new project ideas. In addition, data is being compiled from various related projects to develop best practices for cattle feeding in the northern plains utilizing low cost of gain and low input practices.

4. Activities

California - Scott Fausti

Fausti: Completed statistical analysis of survey data collected by South Dakota State University and South Dakota state NASS office located in Sioux Falls SD.

Colorado - Dale Woerner and Keith Belk

The following activities were taken up by the PIs (Dale Woerner and Keith Belk) for knowledge dissemination.

- Hosted large, multi-day workshops to discuss industry issues and present research findings.
- Served as invited speakers at scientific meetings to present research.
- Served as members of advisory boards for research foundations.
- Integrated research findings into university courses and curriculum.
- Published numerous peer-reviewed articles from research conducted as a result of this project.

Kentucky – Surendranath Suman

Research training was provided to Shuting Li, Hyun Kim, and Yifei Wang on muscle proteome isolation, spectrophotometry, two-dimensional electrophoresis, analyses of mass spectra, and evaluation of meat quality.

Mississippi – Thu Dinh and Kalyn Coatney

Research on beef quality and safety led to various trainings for 2 Ph.D. students, 1 M.S. students on meat oxidation and discoloration, shelf life study, and chromatographic techniques to determine small biological compounds such as fatty acids.

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Montana - Carl Yeoman

Research has been performed to understand the role of the gut microbiota in animal health and productivity using modern molecular techniques, including DNA sequencing, metagenomics, and metabolomics. The following proposal were awarded: Bair Ranch Foundation grant to **Yeoman CJ** (Co-PIs Carr C, Bothner B). 2019 - 2021. Identification and Cultivation of Methyllycaconitine-Degraders from Wild Ruminants to Protect Against Larkspur Poisoning of Range Cattle. USDA – AFRI grant to Menalled F (Co-PIs Bourgault, M, Seipel T, Trowbridge A, Weaver D, **Yeoman CJ**). 2018 – 2022. Diversifying cropping systems through cover crops and targeted grazing: impacts on plant-microbe-insect interactions, yield and economic returns.

Nebraska – Gary Sullivan and Chris Calkins

Stability of the sarcoplasmic reticulum was studied by a diverse team of scientists (meat science, ruminant nutrition, lipid biochemists) to determine the effects of altered fatty acid composition in beef on the calcium release, proteolysis and tenderness.

The effects of antimicrobial interventions (organic acid treatments and high pressure processing) on the shelf life and quality characteristics of beef products were investigated by a team including meat scientists, food scientists, and microbiologists.

Spoilage and microbial populations of sliced deli roast beef were investigated throughout shelf life using advanced high-throughput sequencing techniques. The impact of ingredients and processing steps used in beef processing are being evaluated by a team of meat scientists and microbial ecologists.

Nevada – Amilton de Mello

Research has been performed to evaluate the effects of current food safety interventions during beef processing, aging methods on beef, and to understand changes in muscle determined by gene expression. One 1 Ph.D. was co-advised and graduated in her home institution whereas Nevada graduate a M.S. student. Currently, research training is being provided to 1 Ph.D., 2 M.S., and 3 undergraduate students. Basic meat quality analysis, microbiology assays, gas chromatography and mass spectrometry, western blot, DNA sequencing, and bioinformatics are currently being performed by students.

North Dakota - Robert Maddock

Results of various projects have been presented at various field day events. Approximately 250 beef cattle producers have been presented research results in an easy to use format.

5. Milestones

In general, the committee has proposed a symposium (concurrent) session based on this project to be held at the 2019 Reciprocal Meat Conference (American Meat Science Association). The 2018, the W-4177 annual meeting included industry speakers from the U.S. Meat Export Federation and Diamond V Mills, Inc.

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California - Scott Fausti

The PI completed initial statistical analysis of South Dakota Feedlot data.

Colorado - Dale Woerner and Keith Belk

Keith Belk invited as a keynote speaker for the International Congress of Meat Science and Technology (ICOMST) to discuss 'Genetics and microbiology of meat' in 2018.

Kentucky – Surendranath Suman

To characterize the biochemical mechanisms to improve color stability of fresh beef.

Michigan – David Ortega

To increase market access for US beef and meat products in China.

Mississippi

To increase the understanding of meat oxidation and develop novel processing methods to improve safety and quality of beef products.

Nebraska – Gary Sullivan and Chris Calkins

Calkins made an invited symposium presentation "Challenges and Technologies for Postmortem Prediction of Beef Tenderness" at the Joint meeting of the American Society of Animal Science and the Canadian Society of Animal Science in July 2018 in Vancouver, BC, Canada.

Nevada – Amilton de Mello

Amilton de Mello was appointed by the United States Secretary of Agriculture as an advisor for the National Advisory Committee on Meat and Poultry Inspection (NACMPI). New 7 bacteriophages targeting the individual adulterant 7 STECS were identified, amplified, and are being tested in simulated industry conditions. Preliminary microRNA data was generated. In summary, Nevada developed a new food safety intervention method and showed that microRNA expression in beef decreases after 14 days of aging.

North Dakota - Robert Maddock

Planned research projects were completed through data collection and are in various states of being published and otherwise reported. New projects are being initiated.

6. Impact Statements

Colorado - Dale Woerner and Keith Belk

The research undertaken at Colorado State University will enable the beef industry to understand consumer preferences for flavor, and enable them to take advantage of premium pricing to ensure long-term profitability and sustainability. Knowledge acquired through

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investigations of antimicrobial resistance will facilitate an informed decision making regarding antibiotic usage for livestock production.

Kansas – Glynn Tonsor

Allocation of U.S. beef industry resources, and alignment with the industry's Long-Range Plan, are improved given the actionable knowledge that followed from the research-based assessment of U.S. beef demand strength and determinants.

Kentucky – Surendranath Suman

The long-term goal of this project is to develop novel strategies and characterize the biochemical mechanisms to improve color stability of fresh beef and to enhance the economic competitiveness of the United States beef industry. Experiments are conducted to evaluate the effects of innovative technologies on color stability of fresh beef (i.e., whole-muscle cuts and ground beef) and to explain underlying biochemical/cellular mechanisms involved. This strategy, addressing both applied as well as fundamental aspects, will also explain the biomolecular interactions in postmortem skeletal muscle matrix governing meat color stability.

Michigan – David Ortega

Dr. Ortega provided expert testimony to U.S. Congress in April 2018 on U.S.-China Food Policy issues. Topics included the food safety situation in China, meat trade, and the effects of recent trade events.

Mississippi – Thu Dinh and Kalyn Coatney

Our long-term goal is to discover novel pathways through which quality attributes of beef product can be manipulated to be more stable and consistent to meet consumers' demand and novel technologies that can be used to ensure safety of beef products, especially grass-finished beef and minimally processed beef. Currently, our research has led to a greater understanding of how endophyte-infected tall fescue impacts beef quality. We also provided evidence of the financial benefits for the beef industry to use pre-rigor beef in the production of cooked beef sausage. These findings contributed to the search for novel processing methods to increase quality of beef products.

Nebraska – Gary Sullivan and Chris Calkins

Research has been conducted investigating the effects cattle diet, biochemical processes (oxidative stress), ingredient technologies, and antimicrobial processes on beef and beef products quality and shelf life. These can be used by beef producers and processors to ensure production of high quality beef.

Calkins received two grants from the Nebraska Beef Council: 1) Science of Dry Aged Beef (8/2018-7/2020), 2) Why are high marbled steaks more tender than low marbled steaks (8/2018-7/2019).

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Nevada – Amilton de Mello

Long term goals are 1. to develop novel and efficient strategies to decrease the incidence of pathogens of major beef safety concern such as Salmonella and STEC, 2. To determine practices to improve overall quality attributes, and 3. to provide better understanding about how animal feeding affects gene expression and nutritional values of beef.

North Dakota - Robert Maddock

Low input cattle production does not result in decreases in carcass or meat quality. Research collaborators at NDSU have received additional funding from NC-SARE to continue research into this area. In addition, funding into beef quality traits of carcasses of various weights has been started with data collection nearly complete as of August 2018. Our previous research has shown that smaller-framed cattle may be more efficient and the follow up research will determine if carcass weight is related to carcass and meat quality attributes.

7. Publications

California - Scott Fausti

1. Matthew Diersen and Scott Fausti (2017), “Small- and Medium-Sized Feedlots: Management and Marketing Survey Results”, Economics Research Report 2017-1, Department of Economics, South Dakota State University, Brookings South Dakota (December 21, 2017).

Colorado - Dale Woerner and Keith Belk

1. Doster, E., P. Rovira, N. R. Noyes, B. A. Burgess, X. Yang, M. D. Weinroth, S. M. Lakin, C. J. Dean, L. Linke, R. Magnuson, K. I. Jones, C. Boucher, J. Ruiz, K. E. Belk, and P. S. Morley. 2018. Investigating effects of tulathromycin metaphylaxis on the fecal resistome and microbiome of commercial feedlot cattle early in the feeding period. *Frontiers in Microbiology*; Volume 9 | Article 1715.
2. Gredell, Devin A., Jordan H. McHenry, Dale R. Woerner, Jerrad F. Legako, Terry E. Engle, J. Chance Brooks, J. Daryl Tatum, and Keith E. Belk. 2018 Palatability characterization of fresh and dry-aged ground beef patties. *Meat Science and Muscle Biology. First Look*.
3. Weinroth MD, Scott HM, Norby B, Loneragan GH, Noyes NR, Rovira P, Doster E, Yang X, Woerner DR, Morley PS, Belk KE. 2018. Effects of ceftiofur and chlortetracycline on the resistomes of feedlot cattle. *Appl Environ Microbiol* 84:e00610-18. <https://doi.org/10.1128/AEM.00610-18>.
4. Seman, D. D. Boler, C. Carr, M. Dikeman, C. Owens, J. Keeton, D. Pringle, J. Sindelar, D. Woerner, A. De Mello, T. Powell. 2018. Meat Science Lexicon. *Meat Science and Muscle Biology. First Look*. Doi: 10.22175/mmb2017.12.0059
5. Harris, M. K., L. C. Eastwood, C. A. Boykin, A. N. Arnold, K. B. Gehring, D. S. Hale, C. R. Kerth, D. B. Griffin, J. W. Savell, K. E. Belk, D. R. Woerner, J. D. Hasty, R. J. Delmore, Jr., J. N. Martin, T. E. Lawrence, T. J. McEvers, D. L. VanOverbeke, G. G. Mafi, M. M. Pfeiffer, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, and A. M. Stelzleni. 2018. National Beef Quality Audit – 2016: assessment of cattle hide characteristics, offal

W4177: Enhancing the Competitiveness and Value of U.S. Beef

- condemnations, and carcass traits to determine the quality status of the market cow and bull beef industry. *Transl. Anim. Sci.* 2:37-49. doi:10.1093/tas/txx002
6. Woerner, Dale R., Ifigenia Geornaras, Jennifer N. Martin, Keith E. Belk, Gary R. Acuff and James S. Dickson. 2018. Use of Non-Pathogenic *Escherichia coli* Surrogates as Predictors of the Survival of Non-Typhoidal *Salmonella*, non-O157 Shiga Toxin-Producing *E. coli* and *E. coli* O157 Populations after High Hydrostatic Pressure Processing. *Journal of Food Protection* JFP-17-385.
 7. Roseland, J. M., Q. V. Nguyen, L. W. Douglass, K. Y. Patterson, J. C. Howe, J. R. Williams, L. D. Thompson, J. C. Brooks, D. R. Woerner, T. E. Engle, J. W. Savell, K. B. Gehring, A. M. Cifelli, S. H. McNeill. 2017. Fatty acid, cholesterol, vitamin, and mineral content of cooked beef cuts from a national study. *J. Food Comp. and Anal.* <https://doi.org/10.1016/j.jfca.2017.12.003>
 8. Yang, X., B. R. Bullard, I. Geornaras, S. Hu, D. R. Woerner, R. J. Delmore, J. B. Morgan, and K. E. Belk. 2017. Comparison of the efficacy of a sulfuric acid-sodium sulfate blend and lactic acid for the reduction of *Salmonella* on prerigor beef carcass surface tissue. *J. Food Prot.* (In press).
 9. D. D. Boler and D. R. Woerner. 2017. What is meat? A perspective from the American Meat Science Association. *Animal Frontiers.* doi:10.2527/af.2017.0436.
 10. Hasty, J. D., M. M. Pfeifer, L. C. Eastwood, D. A. Gredell, C. L. Gifford, J. R. Levey, C. M. Cashman, D. R. Woerner, J. N. Martin, R. J. Delmore, W. B. Griffin, D. L. VanOverbeke, G. G. Mafi, C. A. Boykin, D. S. Hale, C. R. Kerth, D. B. Griffin, A. N. Arnold, J. W. Savell, D. L. Pendell, and K. E. Belk. 2017. National Beef Quality Audit-2016: Phase 1, Face-to-face interviews. *Transl. Anim. Sci.* 2017.1. doi:10.2527/tas2017.0039.
 11. McNeill, S. H., A. M. Cifelli, J. M. Roseland, K. E. Belk, D. R. Woerner, K. B. Gehring, J. W. Savell, J. C. Brooks, L. D. Thompson. 2017. Gluten analysis in beef samples collected using a rigorous, nationally representative sampling protocol confirms that grain-finished beef is naturally gluten-free. *Nutrients.* 9:936-940, doi:10.3390/nu9090936.
 12. Gifford, C., L. O'Connor, W. Campbell, D. Woerner, and K. Belk. 2017. Broad and inconsistent muscle food classification is problematic for dietary guidance in the U.S. *Nutrients*, 9:1027; doi:10.3390/nu9091027.
 13. Scott-Bullard, B. R., I. Geornaras, R. J. Delmore, D. R. Woerner, J. O. Reagan, J. B. Morgan, and K. E. Belk. 2017. Efficacy of a Blend of Sulfuric Acid and Sodium Sulfate against Shiga Toxin-Producing *Escherichia coli*, *Salmonella*, and Nonpathogenic *Escherichia coli* Biotype I on Inoculated Prerigor Beef Surface Tissue. *Journal of Food Protection*, Vol. 80, No. 12, 2017, Pages 1987–1992. doi:10.4315/0362-028X.JFP-17-022.
 14. Harris, M. K., L. C. Eastwood, C. A. Boykin, A. N. Arnold, K. B. Gehring, D. S. Hale, C. R. Kerth, D. B. Griffin, J. W. Savell, K. E. Belk, D. R. Woerner, J. D. Hasty, R. J. Delmore, Jr., J. N. Martin, T. E. Lawrence, T. J. McEvers, D. L. VanOverbeke, G. G. Mafi, M. M. Pfeiffer, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, and A. M. Stelzleni. 2017. National Beef Quality Audit – 2016: Transportation, mobility, live cattle, and carcass assessments of targeted producer-related characteristics that affect value of market cows and bulls, their carcasses, and associated by-products. *Transl. Anim. Sci.* doi:10.2527/tas2017.0063

W4177: Enhancing the Competitiveness and Value of U.S. Beef

15. Eastwood, L.C., C.A. Boykin, M.K. Harris, A.N. Arnold, D.S. Hale, C.R. Kerth, D.B. Griffin, J.W. Savell, K.E. Belk, D.R. Woerner, J.D. Hasty, R.J. Delmore Jr., J.N. Martin, T.E. Lawrence, T.J. McEvers, D.L. VanOverbeke, G.G. Mafi, M.M. Pfeiffer, T.B. Schmidt, R.J. Maddock, D.D. Johnson, C.C. Carr, J.M. Scheffler, T.D. Pringle and A.M. Stelzleni. 2017. National Beef Quality Audit-2016: Transportation, mobility, and harvest-floor assessments of targeted characteristics that affect quality and value of cattle, carcasses, and by-products. doi:10.2527/tas2017.0029. *Translational Anim. Sci.* 1:229-238.
16. Boykin, C. A., L. C. Eastwood, M. K. Harris, D. S. Hale, C. R. Kerth, D. B. Griffin, A. N. Arnold, J. D. Hasty, K. E. Belk, D. R. Woerner, R. J. Delmore Jr., J. N. Martin, D. L. VanOverbeke, G. G. Mafi, M. M. Pfeiffer, T. E. Lawrence, T. J. McEvers, T. B. Schmidt, R. J. Maddock, D. D. Johnson, C. C. Carr, J. M. Scheffler, T. D. Pringle, A. M. Stelzleni, J. Gottlieb and J. W. Savell. 2017. National Beef Quality Audit–2016: In-plant survey of carcass characteristics related to quality, quantity, and value of fed steers and heifers. doi:10.2527/jas.2017.1543. *J. Anim. Sci.* 95:2993-3002.
17. Boykin, C.A., L.C. Eastwood, M.K. Harris, D.S. Hale, C.R. Kerth, D.B. Griffin, A.N. Arnold, J.D. Hasty, K.E. Belk, D.R. Woerner, R.J. Delmore, Jr., J.N. Martin, D.L. VanOverbeke, G.G. Mafi, M.M. Pfeiffer, T.E. Lawrence, T.J. McEvers, T.B. Schmidt, R.J. Maddock, D.D. Johnson, C.C. Carr, J.M. Scheffler, T.D. Pringle, A.M. Stelzleni, J. Gottlieb, and J.W. Savell. 2017. National Beef Quality Audit-2016: Survey of carcass characteristics through instrument grading assessments. *J. Anim. Sci.* doi:10.2527/jas2017.1544

Kansas – Glynn Tonsor

1. Tonsor, G.T. "Producer Decision Making under Uncertainty: Role of Past Experiences and Question Framing." *American Journal of Agricultural Economics*. Forthcoming.
2. McKendree, M., G.T. Tonsor, C. Wolf. "Animal Welfare Perceptions of the U.S. Public and Cow-Calf Producers." *Journal of Agricultural and Applied Economics*. Forthcoming.
3. Tonsor, G.T. (2018). "Public Animal Welfare Discussions in the United States: Perspectives from a Missouri Farm Boy Turned Economist." *Animal Frontiers*. 8(1):4-7. ([LINK](#)).
4. Coffey, B.K., G.T. Tonsor, and T.C. Schroeder. (2018). "Impacts of Market Changes and Price Momentum on Hedging Live Cattle." *Journal of Agricultural and Resource Economics*. 43:18-33. ([LINK](#)).
5. Wu, Q., L.L. Schulz, and G.T. Tonsor. (2018). "Using Expert Knowledge to Understand Adoption of Biosecurity Measures for Mitigating Tier 1 Disease Risks in the U.S. Livestock Industry." *Journal of Agricultural Sciences*. 10(1):12-26. ([LINK](#)).
6. Wu, Q., L.L. Schulz, G.T. Tonsor, and J.M. Smith. (2017). "Expert Views on Effectiveness, Feasibility, and Implementation of Biosecurity Measures for Mitigating Tier 1 Disease Risks in the U.S. Swine, Beef Cattle, and Dairy Industries." *Journal of Veterinary Science & Technology*. 8:435. ([LINK](#)).
7. Shang, X. and G.T. Tonsor. (2017). "Food Safety Recall Effects across Meat Products and Regions." *Food Policy*. 69:145-153. ([LINK](#)).
8. Tonsor, G.T. and E. Mollohan. (2017). "Price Relationships between Calves and Yearlings: An Updated Structural Change Assessment." *Journal of Applied Farm Economics*. Vol. 1: Issue 1, Article 3. ([LINK](#)).

W4177: Enhancing the Competitiveness and Value of U.S. Beef

9. Lister, G., G.T. Tonsor, M. Brix, T.C. Schroeder, and C. Yang. (2017). "Food Values Applied to Livestock Products." *Journal of Food Products Marketing*. 23(3):326-341. ([LINK](#))
10. Johnson, K.K., and D.L. Pendell. "Market Impacts of Reducing the Prevalence of Bovine Respiratory Disease in United States Beef Cattle Feedlots. *Frontiers in Veterinary Science – Veterinary Epidemiology and Economics*. Published.
11. Hasty, J.D.^a, M.M. Pfeifer^a, L.C. Eastwood^a, D.A. Gredell^a, C.L. Gifford^a, J.R. Levey^a, C.M. Cashman^a, D.R. Woerner, J.N. Martin, R.J. Delmore, W.B. Griffin, D.L. VanOverbeke, G.G. Mafi, C.A. Boykin, D.S. Hale, C.R. Kerth, D.B. Griffin, A.N. Arnold, J.W. Savell, D.L. Pendell, and K.E. Belk. "National Beef Quality Audit-2016: Phase 1, Face-to-face interviews." *Translational Animal Science* 1(2017)3:320–332. [doi:10.2527/tas2017.0039](https://doi.org/10.2527/tas2017.0039)
12. Marsh, T.L., D.L. Pendell, and R. Knippenberg. "Animal health economics: aid to decision-making on animal health interventions – case studies in the USA." *OIE Scientific and Technical Review* 36(2017)1:137–145. <http://dx.doi.org/10.20506/rst.issue.36.1.2604>
13. Kessler, B.A.^a, D.L. Pendell, and R.M. Enns. "Hedonic prices of yearling bulls: Estimating the value of a pulmonary arterial pressure score." *The Professional Animal Scientist* 33(2017)1:113-119. <https://doi.org/10.15232/pas.2016-01503>
14. Pendell, D.L., J.L. Lusk, T.L. Marsh, K.H. Coble and S.C. Szmania. 2016. "Economic Assessment of Zoonotic Diseases: An Illustrative Study of Rift Valley Fever in the United States." *Transboundary and Emerging Diseases* 63: 203–214.
15. Tonsor, G.T. "Concentration of U.S. Beef and Pork Exports." Kansas State University, KSU-AgEcon-GT-2018.1. March 2018. ([LINK](#))
16. Tonsor, G.T., J.L. Lusk, T.C. Schroeder. "Assessing Beef Demand Determinants." January 2018. ([LINK](#)).
17. Pudenz, C., L. Schulz, and G.T. Tonsor. "Biosecurity and Health Management by U.S. Pork Producers – 2017 Survey Summary." December 2017. ([LINK](#))
18. Mitchell, J.L. and G.T. Tonsor. "Feeder Cattle Price Spreads." Kansas State University, KSU-AgEcon-JMGT-2017.1 November 2017. ([LINK](#))
19. Schroeder, T.C. and G.T. Tonsor. "Developing and Assessing a New Composite Fed Cattle Value Report. Report Submitted to the USDA Agricultural Marketing Service. November 2017. ([LINK](#))
20. McKendree, M., G.T. Tonsor, L.L. Schulz. "Feedlot Risk Management and Benchmarking Survey Summary." Michigan State University, Staff Paper 2017-07. October 2017. ([LINK](#))
21. Tonsor, G.T. "Updated Retail Beef Demand Indices." Report Submitted to the Cattlemen's Beef Board. September 2017. ([LINK](#))
22. Coffey, B.K., G.T. Tonsor, and T.C. Schroeder. "What Influences Ability to Hedge Live Cattle?" Kansas State University, AM-BKC-2017.1 February 2017. ([LINK](#))
23. Tonsor, G.T. and T.C. Schroeder. "Creating and Assessing Candidate Food Service and Retail Beef Demand Indices." Report Submitted to the Cattlemen's Beef Board. January 2017. ([LINK](#))
24. Tonsor, G.T. and J.L. Mitchell. "Evaluating Cattle Cycles: Changes over Time and Implications." Kansas State University, AM-GTT-2017.1 February 2017. ([LINK](#))
25. Pendell, D.L., and K. Herbel. "Differences Between High-, Medium-, and Low-Profit Cow-Calf Producers: An Analysis of 2012-2016 Kansas Farm Management Association Cow-Calf

W4177: Enhancing the Competitiveness and Value of U.S. Beef

Enterprise.” Kansas State University, Department of Agricultural Economics (Publication: KSU-AgEcon-DP-KH-2016.1). December 2017.

Kentucky – Surendranath Suman

1. Neethling, N.E.; Suman, S.P.; Sigge, G.O.; Hoffman, L.C.; Hunt, M.C. 2017. Exogenous and endogenous factors influencing color of fresh meat from ungulates. *Meat and Muscle Biology*, 1: 253–275.
2. Wu, J.; Nair, M.N.; Suman, S.P.; Li, S.; Luo, X.; Beach, C.M., Bohrer, B.M.; Boler, D.D. 2017. Ractopamine-induced changes in sarcoplasmic proteome profile of post-rigor pork semimembranosus muscle. *South African Journal of Animal Science*, 47: 640–647.
3. Nair, M.N.; Ramanathan, R.; Rentfrow, G; Suman, S.P. 2017. Intramuscular variation in mitochondrial functionality of beef semimembranosus. *South African Journal of Animal Science*, 47: 635–639.
4. Neethling, N.E.; Sigge, G.O.; Hoffman, L.C.; Suman, S.P. 2018. Color stability of fallow deer (*Dama dama*) infraspinatus, longissimus thoracis et lumborum, and biceps femoris muscles during refrigerated storage. *Meat and Muscle Biology*, 2:162–176.

Michigan – David Ortega

1. Lin, W., Ortega, D.L, Caputo, V. (2018). “Are ex-ante hypothetical bias calibration methods context dependent? Evidence from Online Food Shoppers in China.” *Journal of Consumer Affairs*. In press.

Mississippi

1. Dinh, T. T. N., Legako, J. F., Miller, M. F., & Brooks, J. C. (2018). Effects of USDA quality grade and cooking on water-soluble precursors of beef flavor. *Meat science*. 146, 122-130.
2. Vu, P. T. T., Holtcamp, A. J., Sukumaran, A. T., Le, M. V. V., Nguyen, D. H., & Dinh, T. T. N. (2018). Effects of market type and time of purchase on oxidative status and descriptive off-odors and off-flavors of beef in Vietnam. *Meat Science*, 145, 399–406.
3. Sukumaran, A. T., Holtcamp, A. J., Campbell, Y. L., Burnett, D., Schilling, M. W., & Dinh, T. T. (2018). Technological characteristics of pre-and post-rigor deboned beef mixtures from Holstein steers and quality attributes of cooked beef sausage. *Meat science*. 145, 74-78
4. Sukumaran, A. T., Holtcamp, A. J., Englishbey, A. K., Campbell, Y. L., Kim, T., Schilling, M. W., & Dinh, T. T. (2018). Effect of deboning time on the growth of Salmonella, E. coli, aerobic, and lactic acid bacteria during beef sausage processing and storage. *Meat Science*, 139, 49-55.

Montana - Carl Yeoman

1. Yeoman CJ, Ishaq SL, Bichi E, Olivo SK, Lowe JL, Aldridge BM. 2018. Biogeographical differences in the influence of maternal microbial sources on the early successional development of the bovine neonatal gastrointestinal tract. *Scientific Reports*. 8: 3197. DOI:10.1038/s41598-018-21440-8
2. Perea K, Perz K, Olivo SK, Williams A, Lachman M, Ishaq SL, Thomson J, Yeoman CJ. 2017. Feed efficiency phenotypes in lambs involve changes in ruminal, colonic, and small

W4177: Enhancing the Competitiveness and Value of U.S. Beef

intestine-located microbiota. *Journal of Animal Sciences*. 95(6):2585-2592. doi: 10.2527/jas.2016.1222

3. Henderson G, Cox F, Ganesh S, Jonker A, Young W, et al. 2015. Rumen microbial community composition varies with diet and host, but a core microbiome is found across a wide geographical range. *Scientific Reports* 5: 14567. doi:10.1038/srep14567

Nebraska – Gary Sullivan and Chris Calkins

Peer Reviewed Manuscripts

1. Posthuma, J., Rasmussen, F., Sullivan, G. 2018. Effects of nitrite source, reducing agents, and holding time on color development in a cured meat model system. *LWT – Food Science and Technology*. 95:47-50.
2. Gupta, J., Bower, C. G., Sullivan, G., Cavender, G. 2018. Effect of Differing Ingredients and Packaging Technologies on the Color of High Pressure Processed Ground Beef. *Journal of Food Quality*. Volume 2018:Article ID 4590143,
3. Gupta, J., Bower, C, Cavender, G., Sullivan, G. 2018. Effect of different myoglobin states on color changes in high pressure processed raw ground beef. *LWT – Food Science and Technology*. 93:32-35.
4. Bower, C.G., Stanley, R.E., Fernando, S.C., Sullivan, G.A. 2018. The effect of salt reduction on the microbial community structure and quality characteristics of sliced roast beef and turkey breast. *LWT- Food Science and Technology*. 90:583-591.
5. Cleveland, B.D., Buntyn, J.O., Redfield, A.L., MacDonald, J.C, Sullivan, G.A. 2017. Effect of feeding distillers grains during different phases of production and addition of postmortem antioxidants on shelf life of ground beef. *The Professional Animal Scientist*. 33:555-566.
6. Sun, S., Sullivan, G., Stratton, J. Bower, C., Cavender, G. 2017. Effect of HPP treatment on the safety and quality of beef steak intended for sous vide cooking. *LWT – Food Science and Technology*. 86:185-192.
7. Dierks, N.T., Cleveland, B.D., Varnold, K.A., Erickson, G.E., Sullivan, G.A. 2017. Effects of feeding wet distillers grains to cattle during different times of production on cooked beef patties characteristics during storage. *The Professional Animal Scientist*. 33:54-62.
8. Yeh, Y., Omaye, S. T., Ribeiro, F., Calkins, C., de Mello, A. S. (2018). Evaluation of palatability and muscle composition of novel value-added beef cuts. *Meat Science*, 135, 79-83.
9. Ribeiro, F. A., Domenech-Pérez, K. I., Contreras Castillo, C., Wilkerson, E. K., Voegelé, H., Hart, K. B., Herrera, N. J., Calkins, C. 2018. Effects of dietary fat source on beef strip loin steak display life. *Journal of Animal Science* 96:2665-2674.
10. Chao, M. D., Domenech-Pérez, K. I., Senaratne-Legagala, L. S., Calkins, C. (2017). Feeding wet distillers grains plus solubles contributes to sarcoplasmic reticulum membrane instability. *Animal Production Science*. <http://dx.doi.org/10.1071/AN16784>. Published online Aug. 8, 2017.
11. de Mello, A. S., Jenschke, B. E., Senaratne, L., Carr, T. P., Erickson, G. E., Calkins, C. (2017). Effects of finishing diets containing wet distillers grains plus solubles on beef quality attributes and fatty acid profile. *Meat Science*, 136, 16-22.

W4177: Enhancing the Competitiveness and Value of U.S. Beef

12. Chao, M. D., Domenech-Pérez, K. I., Calkins, C. (2017). Feeding vitamin E may reverse sarcoplasmic reticulum membrane instability caused by feeding wet distillers grains plus solubles to cattle. *The Professional Animal Scientist*, 33, 12-23 (corrigendum 780-781).
13. Chao, M. D., Domenech-Pérez, K. I., Voegele, H. R., Kunze, E. K., Calkins, C. (2017). Effects of dietary antioxidant supplementation of steers finished with 30% wet distillers grains plus solubles on fatty acid profiles and display life of strip loins. *Animal Production Science*. <http://dx.doi.org/10.1071/AN16719>. Published online May 17, 2017.
14. Domenech-Pérez, K. I., Calkins, C., Chao, M. D., Semler, M. E., Varnold, K. A., Erickson, G. (2017). Impact of feeding de-oiled wet distillers grains plus solubles on beef shelf life. *Journal of Animal Science*, 95, 709-717.
15. Nubiato, K., Mazon, M. R., Antonelo, D. S., Calkins, C., Konda Naganathan, G., Subbiah, J., Silva, S. 2018. Hyperspectral image bench-top system to classify the tenderness of Nellore cattle beef. *Infrared Physics and Technology*. 89:247-254.

Scientific Meeting Abstracts

1. Rasmussen, F.D., Sullivan, G.A. 2018. Comparison of nitrite sources and reducing agents on reactions with myoglobin and cysteine using a model meat curing system. Reciprocal Meat Conference, Kansas City. MO, June 24-27, 2018.
2. Calkins, C., Konda Naganathan, G., Hart, K. B., Domenech-Pérez, K. I., Schmidt, T. B. (2017). Potential Errors in Determination of Longissimus Muscle Area in Carcasses from Heifers Fed With or Without Zilpaterol Hydrochloride. Savoy, IL: Reciprocal Meat Conference. American Meat Science Association. <http://www.meatscience.org/docs/default-source/Events-and-Education/RMC/abstract-in-numerical-order!.pdf>.
3. Ribeiro, F. A., Domenech-Pérez, K. I., Wilkerson, E. K., Voegele, H., Herrera, N. J., Hart, K. B., Calkins, C. (2017). Relationship Between Dietary Fat Source and Beef Display Life. In 63rd International Congress of Meat Science and Technology: Nurturing Locally, Growing Globally., Declan Troy, Ciara McDonnell, Laura Hinds, Joseph Kerry (Ed.), (pp. 109-110). Wageningen: International Congress of Meat Science and Technology. Wageningen Academic Publishers.
4. Ribeiro, F. A., Kunze, E. K., Domenech-Pérez, K., Herrera, N., Voegele, H., Hart, K., Calkins, C. (2017). Effects of Dietary Fat Source and Modified Distillers Grains on Beef Quality. (Supp. 2 ed., vol. 95, pp. 59-60). *Journal of Animal Science*.
5. Herrera, N. J., Kunze, E. K., Domenech-Pérez, K., Ribeiro, F. A., Chao, M. D., Calkins, C. (2017). Relationship of Proteolysis and Superoxide Dismutase Activity to Tenderness of Prime and Select Grade Beef. (Supp. 2 ed., vol. 95, pp. 185). *Journal of Animal Science*.
6. F. A. Ribeiro, K. Domenech-Perez, N. Herrera, K. Hart, C. Calkins. (2018) Sarcoplasmic reticulum membrane instability caused by dietary fat source may affect early postmortem tenderization of beef. Savoy, IL. Reciprocal Meat Conference. American Meat Science Association. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
- A. P. B. Fruet, A. M. Cavender, J. L. Nörnberg, C. R. Calkins, A. S. De Mello (2018) Effects of antioxidants on lipid stability, color parameters, and aerobic plat count of beef patties from steers fed distillers grains. Savoy, IL. Reciprocal Meat Conference. American Meat Science

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Association. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0

- Hart, K.B., Ribeiro, F.A., Henriott, M.L., Herrera, N.J., and Calkins, C.R. (2018) Quality effects of beef from cattle fed high-protein cord distillers grains and other ethanol by-products. Savoy, IL. Reciprocal Meat Conference. American Meat Science Association. <http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018->
- Feeding distillers grains plus solubles with different moisture levels affects the fatty-acid profile of value-added beef cuts. A. P. B. Fruet, F. M. Giotto, G. C. Miller, J. L. Nörnberg, C. R. Calkins, A. S. De Mello (2018) http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
- Malheiros, J.M., Braga, C.P., Grove, R.A., Ribeiro, F.A., Calkins, C.R., Admec, J., Chardulo, L.A. 2018. Influence of oxidative damage to proteins on beef tenderness. International Congress of Meat Science and Technology. Melbourne, Australia.

Peer-reviewed Extension Research Reports

- Rasmussen, F.D., Bower, C.G., Sullivan, G.A. 2018. Quality of ground beef from cattle fed distillers grains containing different amounts of oil. Nebraska Beef Cattle Report. MP105:126-127.
- Posthuma, J.A., Rasmussen, F.D., Sullivan, G.A. 2018. Factors that influence cured color development using a cured meat model system. Nebraska Beef Cattle Report. MP105:128-130.
- Gupta, J., Bower, G., Cavender, G., Sullivan, G.A. 2018. Effect of myoglobin state on color stability of high pressure processed ground beef. Nebraska Beef Cattle Report. MP105:131-133.
- Gupta, J., Bower, G., Cavender, G., Sullivan, G.A. 2018. Effect of ingredients and packaging on high pressure processed ground beef color. Nebraska Beef Cattle Report. MP105:134-137.
- McCoy, A., Burson, D., Sullivan, G. 2018. Antimicrobial interventions and application time effects on ground beef quality. Nebraska Beef Cattle Report. MP105:138-139.
- Voegelé, H. R., Domenech, K. I., Kunze, E. K., Ribeiro, F. A., Jenkins, K., MacDonald, J., Calkins, C. (2017). Effect of Feeding Field Peas on Fresh Beef Quality. (pp. 101-103). Nebraska Beef Cattle Report.
- Chao, M. D., Buntyn, J. O., Schmidt, T., Ca, C. R. (2017). Fatty Acid Composition of Beef Fed OmniGen-AF at Receiving or Finishing. (pp. 104-106). Nebraska Beef Cattle Report.
- Kunze, E. K., Herrera, N. J., Domenech-Pérez, K. I., Chao, M. D., Calkins, C. R. (2017). The Influence of Diet and Oxidation on Calcium Retention of the Mitochondria in Fresh Beef. (pp. 99-101). Nebraska Beef Cattle Report.
- Calkins, Chris R. (2018). Production of high-quality beef – The Nebraska Advantage. (pp. 123-126). Nebraska Beef Cattle Report.
- Herrera, Nicolas J., Kunze, Emery K., Domenech-Pérez, Katherine I., Ribeiro, Felipe A., Chao, Michael D., Calkins, Chris R. (2017). Relationship between Marbling, Superoxide Dismutase, and Beef Tenderness. (pp. 141-142). Nebraska Beef Cattle Report.

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11. Calkins, Chris R., O'Daniel, Jenna J., Konda Naganathan, Govindarajan, Hart, Kellen B., Domenech- Pérez, Katherine I., Schmidt, Ty B. (2018). Potential Variation in Determination of Longissimus Muscle Area in Carcasses from Heifers Fed With or Without Zilpaterol Hydrochloride. (pp. 143-144). Nebraska Beef Cattle Report.
12. Ribeiro, Felipe A., Domenech-Pérez, Wilkerson, Emery K., Voegelé, Hope, Hart, Kellen B., Calkins, Chris R. (2018). (pp. 144-147). Nebraska Beef Cattle Report.

Professional Presentations

1. Calkins, C. R., The Science Behind Quality Beef, Univ. of Campinas workshop – Brazil, Campinas, Brazil, "Production of High-Quality Beef - The Nebraska Advantage", Seminar, International, Invited. (December 13, 2017).
2. Calkins, C. R., The Science Behind Quality Beef, Univ. of Campinas workshop – Brazil, Campinas, Brazil, "The Importance of the Prediction of Tenderness for the Commercialization of Beef", Seminar, International, Invited. (December 13, 2017).
3. Calkins, C. R., Cornhusker Beef Nutrition Conference, Univ. of Nebraska Extension, Ithaca, NE, "Factors Controlling Tenderness in Beef", Invited. (November 3, 2017).
4. Calkins, C. R., ANUGA - the World's Largest International Food Show, Albers Meat Distributors, Cologne, Germany, "Quality Beef from Nebraska", International, Invited. (October 9, 2017).
5. Calkins, C. R., ANUGA - the World's Largest International Food Show, Inalca Beef Marketing Co., Cologne, Germany, "Quality Beef from Nebraska", Seminar, International, Invited. (October 8, 2017).
6. Calkins, C. R. ANUGA - the World's Largest International Food Show, Meta Foods, Atlanta, GA, Cologne, Germany, "Science of Beef Quality", Session, International, Invited. (October 8, 2017).
7. Calkins, C.R. Joint meeting of the American Society of Animal Science and Canadian Society of Animal Science. "Challenges and Technologies for Postmortem Prediction of Beef Tenderness." International, Invited. (July 10, 2018).

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Peer-reviewed articles

1. Fruet, A.P.B., de Mello, A.S., Trombetta, F., Stefanello, F.S., Speroni, C.S., de Vargas, D.P., de Souza, A.N.M., Rosado Júnior, A.G., Tonetto, C.J., Nörnberg, J.L. 2018, "Oxidative stability of beef from steers finished exclusively with concentrate, supplemented, or on legume-grass pasture" [Meat Science](#)
2. Fruet, A.P.B., Trombetta, F., Stefanello, F.S., Speroni, C.S., Donadel, J.Z., De Souza, A.N.M., Rosado Júnior, A., Tonetto, C.J., Wagner, R., de Mello, A.S., Nörnberg, J.L. 2018, "Effects of feeding legume-grass pasture and different concentrate levels on fatty acid profile, volatile compounds, and off-flavor of the M. longissimus thoracis" [Meat Science](#)
3. Seman, D.L., Boler, D.D., Carr, C.D., Dikeman, M.E., Owens, C.M., Keeton, J.T., Pringle, T.D., Sindelar, J.J., Woerner, D.R., de Mello, A.S., Powell, T. M. 2018, "Meat Science Lexicon" [Meat and Muscle Biology](#)

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4. Yeh, Y., de Moura, F., Van de Broek, K., de Mello, A.S. 2018, "Effect of ultraviolet light, organic acids, and bacteriophage on Salmonella populations in ground beef" [Meat Science](#)
5. de Mello, A. S.; Ringkob, T., Yeh, Y. 2017, "Effects of long spray-chilling on water pocket development in ribeyes" [Meat Science](#)
6. de Mello, A.S., Jenschke, B.E., Senaratne, L.S., Carr, T.P., Erickson, G.E., Calkins, C.R. 2017, "Effects of finishing diets containing wet distillers grains plus solubles on beef quality attributes and fatty acid profile" [Meat Science](#)
7. Yeh, Y., Purushothaman, P., Gupta, N., Ragnone, M., Verma, S. C., de Mello, A. S. 2017, "Bacteriophage application on red meats and poultry: Effects on Salmonella population in final ground products" [Meat Science](#)
8. Yeh, Y., Ribeiro, F.A., Omaye, S.T., Calkins, C.R., de Mello, A. S. 2017, "Evaluation of palatability and muscle composition of novel value-added beef cuts" [Meat Science](#)

Abstracts

1. EFFECTS OF FEEDING PECANS ON CARCASS CHARACTERISTICS, COLOR, LIPID STABILITY, AND NUTRITIONAL VALUES OF LAMB. F. M. Giotto, E. L. A. Ribeiro, F. A. Grandis, F. Fernandes Junior, L. S. Leite, A. S. De Mello. RMC 2018. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
2. EFFECTS OF INCLUSION OF TANNIC ACID ON COLOR, LIPID STABILITY, AND SENSORY ATTRIBUTES OF GROUND BEEF PATTIES. A. P. B. Fruet, A. M. Cavender, M. A. Fonseca, J. L. Nörnberg, A. S. De Mello. RMC 2018. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
3. EFFECTS OF ANTIOXIDANTS ON LIPID STABILITY, COLOR PARAMETERS, AND AEROBIC PLATE COUNT OF BEEF PATTIES FROM STEERS FED DISTILLERS GRAINS. A. P. B. Fruet, A. M. Cavender, J. L. Nörnberg, C. R. Calkins, A. S. De Mello. RMC 2018. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
4. EFFECTS OF QUALITY GRADE AND AGING TIME ON YIELDS, OBJECTIVE TENDERNESS, PROTEIN DEGRADATION, AND MICROBIAL GROWTH OF DRY AND WET AGED SHORT LOINS. A. M. Cavender, Y. Yeh-Parker, F. M. Giotto, B. S. Ferguson, A. S. De Mello. RMC 2018. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
5. FEEDING DISTILLERS GRAINS PLUS SOLUBLES WITH DIFFERENT MOISTURE LEVELS AFFECTS THE FATTY ACID PROFILE OF VALUE-ADDED BEEF CUTS. A. P. B. Fruet, F. M. Giotto, G. C. Miller, J. L. Nörnberg, C. R. Calkins, A. S. De Mello. RMC 2018. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0
6. EFFICIENCY OF ENVIRONMENTALLY ISOLATED BACTERIOPHAGES AGAINST THE 'BIG SIX' AND O157:H7 STECS IN GROUND BEEF. E. L. Shebs, E. S. Torres, Y. Yeh-Parker, A. S. De Mello. http://meatscience.org/docs/default-source/events-and-education/rmc/amsa-2018-71st-rmc-abstracts-7-18-2018-final.pdf?sfvrsn=8ae28fb3_0

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7. HIGH PRESSURE PROCESSING (HPP) DOES NOT AFFECT TEXTURE AND SENSORY ATTRIBUTES OF SMOKED HAMS CURED BY CONVENTIONAL AND ALTERNATIVE METHODS Y. Yeh, H. Thippareddi, A. S. De Mello. RMC 2017. http://meatscience.org/docs/default-source/Events-and-Education/RMC/abstract-in-numerical-order!.pdf?sfvrsn=d77b8fb3_0
8. CARCASS TRAITS OF STEERS FINISHED ON LEGUME AND GRASS PASTURE AND IN FEEDLOT SYSTEM. A. P. B. Fruet, F. S. Stefanello, F. Trombetta, A. N. Motta de Souza, A. G. Rosado, Jr., C. J. Tonetto, A. S. De Mello, J. L. Nörnberg. RMC 2017. http://meatscience.org/docs/default-source/Events-and-Education/RMC/abstract-in-numerical-order!.pdf?sfvrsn=d77b8fb3_0
9. FATTY ACIDS PROFILE AND QUALITY ATTRIBUTES OF BEEF FROM STEERS FINISHED ON LEGUME AND GRASS PASTURE A. P. B. Fruet 1, F. S. Stefanello, F. Trombetta, A. N. Motta de Souza, A. G. Rosado, Jr., C. J. Tonetto, A. S. De Mello, J. L. Nörnberg. RMC 2017. http://meatscience.org/docs/default-source/Events-and-Education/RMC/abstract-in-numerical-order!.pdf?sfvrsn=d77b8fb3_0
10. EFFECTS OF ULTRAVIOLET LIGHT, ORGANIC ACIDS, AND BACTERIOPHAGE INTERVENTIONS ON SALMONELLA POPULATIONS IN GROUND BEEF. RMC 2017. Y. Yeh, F. de Moura, K. Van Den Broek, M. Fonseca, A. S. De Mello. RMC 2017. http://meatscience.org/docs/default-source/Events-and-Education/RMC/abstract-in-numerical-order!.pdf?sfvrsn=d77b8fb3_0

Extension report

1. Introducing the Bonanza Cut, Redefining the beef eating experience. 2017. http://naes.unr.edu/demello/documents/Bonanza_Cut.pdf

North Dakota - Robert Maddock

1. Şentürklü, S., D. G. Landblom, **R. J. Maddock**, T. Petry and S. I. Paisley. 2017. Effect of retained ownership and vertical integration within an integrated cropping system among yearling steers of differing frame score on feedlot performance, carcass measurements, and systems economics following delayed feedlot entry. *Translational Animal Science* 2017 1:193-197.