

### Current Research Projects

#### **Leveraging a current market hog lymph node study to further understand *Salmonella* transmission and internal colonization, Kansas State University, Texas Tech University, Triumph Foods**

This project will probe a possible relationship between *Salmonella* antibodies in oral fluids and internal colonization of market hog carcasses by determining if antibody testing of oral fluids can be used as an effective antemortem screening tool to assess a group/lot of pigs for *Salmonella* risk. Further, it will characterize internal colonization within market hogs by detecting and enumerating *Salmonella* in lymph nodes and tonsils, cecal contents, spleen, and oral fluids.

*Funded in part by the National Pork Checkoff.*

#### **Development and validation of an antimicrobial database to predict microbial load reduction on raw pork components against *Salmonella*, University of Illinois at Urbana-Champaign**

This study will implement a high-throughput miniature assay to evaluate *Salmonella* reduction after pork carcass wash with antimicrobial treatments. Response surface methodology will be used to determine synergistic or antagonistic interactions between antimicrobials and optimize combinations to reach desired *Salmonella* reductions. The results are intended to validate the predicted interactions between antimicrobials in laboratory experiments, as well as build an antimicrobial database in which additional antimicrobial treatments data can be added as new compounds become relevant against *Salmonella* in pork.

*Funded in part by the National Pork Checkoff.*

#### **Exploring the use of ProbiCon as a direct-fed microbial to reduce the *Salmonella* burden in market hogs, Kansas State University, USDA-ARS-U.S. Meat Animal Research Center, Triumph Foods**

This study will evaluate the influence of direct fed microbials (DFM) on pig performance, morbidity, and mortality throughout the feeding period. The feces and mesenteric lymph nodes of market hogs fed a control or DFM augmented diet will be collected to establish the impact of each diet on *Salmonella* internalized in the lymphatic system. By determining *Salmonella* serotype and presence of highly pathogenic *Salmonella* (HPS), it evaluates whether *Salmonella* diversity and/or presence of HPS is impacted by probiotic administration.

*Funded in part by the National Pork Checkoff.*

#### **Dietary modeling the nutritional impact of removing/adding/substituting meat and poultry servings to the healthy dietary patterns, Nutrition Impact LLC, NutriScience LLC**

This project will model the effect of removing or adding a serving of minimally processed and further processed meat and poultry or substituting a serving of various foods with a serving of minimally processed and further processed meat and poultry on nutrient profiles in the healthy dietary patterns identified in the Dietary Guidelines for Americans, 2020-2025.

*Funded in part by the Beef Checkoff.*

#### **Effect of clean label antimicrobials on the inhibition of *Clostridium perfringens* and *Bacillus cereus* during extended cooling of uncured beef and poultry products, University of Wisconsin-Madison, Cargill**

This study will compare the effect of clean label antimicrobial ingredients on the inhibition of *Clostridium perfringens* and *Bacillus cereus* in model uncured beef and poultry products, having different moisture, pH, and salt contents, with a primary focus on extending Phase 1 cooling from 120 to 80°F.

*Research funded in part by the Beef Checkoff.*

#### **Effects of helium gas utilization in Modified Atmosphere Packaging (MAP) on beef quality, Texas A&M AgriLife**

This project will determine if the inclusion of various levels of helium gas in modified atmosphere packaging (MAP) impacts color shelf-life or microbiological reductions on steaks surfaces.

**A Cross-Sectional Investigation of *Salmonella* in Market Hog Lymph Nodes, Kansas State University, Texas Tech University, Triumph Foods, LLC, Smithfield Foods, Inc., JBS Foods, Clemens Food Group**

A cross-sectional study design will be employed to investigate the prevalence and concentration of *Salmonella* in up to 6 lymph nodes and tonsils of market hogs. Prevalence and concentration data will be subsequently used to design a risk-assessment mapping of the carcass for prioritization of node-removal for pathogen control. The study also intends to address knowledge gaps regarding *Salmonella* prevalence by region and/or season in the United States.

*Research funded in part by the National Pork Checkoff.*

**Effects of proportioning meat and plant-based protein-rich foods within the U.S. Healthy Eating Pattern on cardiovascular disease risk factors, Purdue University**

This project will assess the effects of consuming different proportions of red meat and plant-based, protein-rich foods incorporated into a U.S. Healthy Eating Pattern on cardiovascular disease risk factors in adults at high risk of developing a heart-related disease.

*Research funded in part by the Beef Checkoff.*

**Meat as a First Solid Food on Risk of Overweight and Neurodevelopment in Infants, University of Colorado Anschutz Medical Campus, University of Colorado Denver**

Early complementary feeding is a unique and malleable period to prevent rapid weight gain and later obesity, and is also a critical phase for neurodevelopment. Meat is an excellent source of high-quality protein and micronutrients, which are critical for the normal development of older infants. This research will conduct a randomized controlled trial to comprehensively evaluate the effect of meat on growth, body composition, risk of overweight and neurodevelopment, with a protein intake at the reported population median. Findings from this study will be generalizable and help inform future dietary guidance.

*Research funded in part by the Beef Checkoff.*

**Tests of *Salmonella* Sub-unit Proteins as Vaccines for Broiler Chickens, USDA-ARS U.S. National Poultry Research Center**

This project will identify the *Salmonella* protein antigens that are able to induce humoral immune response in broilers, and consequently these antibodies can prevent *Salmonella* colonization in the broiler gastrointestinal tracts.

**Research Funded by the Beef Checkoff and Administered by the Foundation**

**Impact of sanitization and natural biofilm communities on *Salmonella* prevalence at processing plants, USDA-ARS, U.S. Meat Animal Research Center**

This study will evaluate the efficacy of commercial sanitizers against *Salmonella* harbored within environmental mixed biofilms by measuring biofilm forming ability and community structure of environmental biofilms before and after sanitization. It will compare environmental microbial communities and *Salmonella* survival in mixed biofilms before and after sanitization to determine the impact of different sanitizers on controlling *Salmonella*.

**Novel TaqMan assays for the specific detection and simultaneous differentiation of virulent and avirulent non-O157 Shiga toxin-producing *Escherichia coli* strains, Florida State University, USDA-ARS, U.S. Meat Animal Research Center**

This study intends to standardize six multiplex TaqMan assays for the identification of virulent strains of *E. coli* O26, O111, O45, O103, O121, and O145 serogroups. Further, it will demonstrate the applicability of the standardized assays in inoculated food samples and red meat enrichments from national red meat surveillance programs through a direct comparison with the FSIS MLG 5C.01 reference method.

**Effect of Minimally Processed Meat and Further Processed Meat on Biomarkers and Risk Factors for Cancer and Cardiovascular Disease—Phase I, USDA-ARS-Beltsville Human Nutrition Research Center**

A randomized diet controlled crossover study will be conducted with diets containing either minimally processed or further processed meat to assess how the diet effected biomarkers associated with cardiovascular disease. This study will also examine the effect of the background diet on health outcomes.

*Funded by the Foundation for Meat and Poultry Research and Education and the National Cattlemen's Beef Association (NCBA) on behalf of the Beef Checkoff. NCBA has primary oversight responsibility for this project.*

**Using empirical evidence, modeling, and risk assessment methods to estimate the public health impact of incorporating enumeration and virulence as part of the criteria for evaluation of *Salmonella* contamination in ground beef in the US, EpiX Analytics, Colorado State University**

This project will develop a quantitative microbial risk assessment to assess the potential public health impact of incorporating enumeration and virulence evaluation strategies as part of the criteria for evaluation of *Salmonella* contamination in ground beef in the U.S. Additionally, using existing surveillance data the effect of season and regional sources of the live cattle on changes in *Salmonella* prevalence, virulence, and enumeration in ground beef and trim will be estimated.

**Evidence-based, quantitative risk assessment to control salmonellosis attributable to ground beef: Evaluating and mitigating the contribution of lymph nodes to *Salmonella* contamination, University of Nebraska-Lincoln, U.S. Meat Animal Research Center, USDA ARS, Michigan State University, The University of Vermont, University of California**

This project will characterize the distribution of both prevalence and concentration of *Salmonella enterica* in bovine deep tissue lymph nodes (DTLNs) by lymph node type, production source, region and season using systematic review and meta-analysis approaches. The relative contributions of DTLNs and the efficacy of their removal at processing on salmonellosis risk associated with ground beef consumption will be evaluated using a quantitative microbial risk assessment approach.

**Risk assessment model to assess the impact on public health of ground beef lots based on the contamination level and presence of highly virulent or multidrug resistant strains, University of Minnesota**

This project will develop a risk assessment model using existing Food Safety and Inspection Service prevalence and enumeration data to assess the impact of ground beef lots characterized by contamination level and presence of highly virulent or multidrug resistant strains on public health. Results of this model could be used to evaluate potential impact on public health of model performance standards based on *Salmonella* spp. enumeration level (CFU/g) and strain characteristics to reduce the number of human cases due to ground beef consumption.

**Research Funded by the National Pork Checkoff and Administered by the Foundation**

**Risk assessment model to assess the impact on public health of pork based on the contamination level and presence of highly virulent or multidrug resistant strains, University of Minnesota**

This project will build upon a risk assessment model developed using existing FSIS prevalence and enumeration data to assess the impact of raw pork characterized by contamination level and presence of highly virulent or multidrug resistant strains on public health. Results of this model could be used to evaluate potential impact on public health of model performance standards based on *Salmonella* spp. enumeration level and strain characteristics to reduce the number of human cases due to pork consumption.

**Recent Research Findings**

**Maximizing the dietary pattern of older adults: the effects of protein intake on protein kinetics, University of Arkansas for Medical Sciences**

The impact of this study on the meat and poultry industry is a positive one in all regards. First, in the format of a 2-meal consumption pattern in older individuals, the findings demonstrate a positive effect of consuming a double the recommended dietary allowance (RDA) amount of high-quality protein. These results also indicate that the RDA (literally defined as the amount of protein required to maintain protein balance) and the commonly consumed NHANES amount are insufficient protein intakes in the 2-meal format for older individuals. The divergent results of improved whole-body protein balance without affecting skeletal muscle, together with previous findings, suggest that an additional feeding of high-quality protein is required to improve skeletal muscle turnover. This recommendation is consistent with the potential ingestion of a pre-prepared quality protein source that is common to the meat and poultry industry.

*Research funded in part by the Beef Checkoff.*

### **Current Knowledge and Gaps on the Mechanistic Development of Cancer in Humans Associated with Processed Meat and Poultry Product Components, University of Wisconsin-Madison**

This review summarizes data in the scientific literature which explain, mechanistically, how components found in processed meats and poultry products might contribute to carcinogenesis. Components discussed include those intrinsic to red meat and poultry as well as those which might be contaminants in red meat and poultry. The review also examines ingredients used in processed meat and poultry products and, importantly, processed-induced contaminants. A discussion of the strengths, weaknesses, and gaps in current knowledge related to potential mechanisms of carcinogenesis related to processed meats and poultry products is presented.

*Research funded in part by the Beef Checkoff.*

### **Detection of African swine fever virus (ASFv) in pork meat products by PCR assay, Iowa State University**

The study validated PCR assay tests for ASFv in various pig offal and pork products, including blood, and meat to determine the best sample(s) for testing and monitoring. The tests found that ASFv could be found in lungs, hearts, tonsils, kidneys, livers, ears, and lymph nodes, suggesting that ASFv can persist in infected pigs for a long time as expected, and unprocessed pork and offal from those pigs may harbor the virus. This should be considered for procuring pork meats from an ASF-positive country or herd and developing biosecurity/control measures.

*Funded jointly with the National Pork Checkoff.*

### **Pathogen Growth in Alternatively Cured Ham and Bacon during Cooking, Cooling, and Process Deviations, Iowa State University and Smithfield Foods**

This study evaluated the inhibitory effects of four curing brines using nitrite from a natural source (*i.e.*, pre-converted celery juice powder) in processed meat products with a natural label during “real world” cooking and chilling procedures, including instances of process deviation, as well as non-continuous cooling. The effect of the lethality cycles was far greater than any difference between the brines.

### **Improving Validation Methods for *Salmonella* Lethality on the Surface of Multiple Impingement-Cooked Meat and Poultry Products, Michigan State University, University of Wisconsin**

The study identified critical limits (*i.e.*, humidity, air velocity, surface time-temperature), relative to achieving target *Salmonella* lethality on the surface of impingement-cooked products. Process humidity and product variability should be considered in regulatory requirements and process validations. Findings are intended to improve the ability of the meat and poultry industry to comply with Appendix A or provide alternatives for lethality support.

*Research funded in part by the Beef Checkoff and the National Pork Checkoff.*

### **Recent Beef Checkoff Funded Research Findings**

#### **Effects of deep cleaning sanitation on biofilms and pathogens, USDA-ARS-Meat Animal Research Center**

The study suggested that deep cleaning sanitization might disrupt the pre-existing microbial community and alter the natural population composition. Disruption of the environmental biofilm community may have unexpected effects resulting from the lack of competition within the multispecies mixture and the survival/recruitment of species with high colonizing capability to the community.