the remarkable progress made in identifying genes and genomic regions affecting meat quality traits in the pig.

Key Words: Pig, Meat Quality, Genetics

412 Validation of carcass merit quantitative trait loci (QTL's) and integration of QTL information into genetic programs for improvement of carcass merit. E. J. Pollak*[1], M. E. Dikeman[2], C. Gill[3], and D. W. Moser[2], [1]*Cornell University,* [2]*Kansas State University,* [3]*Texas A&M University*.

Genetic evaluations for traditional carcass characteristics have been published for limited numbers of sires by various beef breed associations. Collection of carcass information is difficult, which limits the amount of information generated for these traits. The routine carcass field data collected do not include observations for measures of tenderness or any information on sensory panel assessment of meat quality, prohibitive due to costs and logistics. An objective of the National Cattlemens Beef Association's Carcass Merit Project (CMP) was to collect data on tenderness and sensory panel assessments along with the traditional carcass characteristics from a set of legacy bulls from all breeds participating in the project. These data are being used to provide information for the calculation of expected progeny differences (EPD's) and to validate the segregation of quantitative trait loci (QTL's), discovered in the Texas A&M Angleton Project, in these breeds. Eleven QTL's are being validated, six for Warner-Bratzler shear force, three for marbling, and one each for sensory panel tenderness scores and rib eye area.
Estimates of heritability for shear force measures on Simmental and Angus cattle in the project were 0.22 and 0.25, respectively. Genetic evaluations, ignoring QTL information, for Simmental bulls in the CMP result in a spread of sire EPD's of 0.45 kg of shear force. To date, nine bulls representing four breeds have completed the progeny test required and the DNA analysis in the CMP. Five of the six tested shear force QTL's have been found to be heterozygous ($p \leq 0.05$) in at least one bull. One of the nine bulls has been found to be heterozygous for the QTL for the sensory panel score of tenderness. The difference in progeny group performance, groups defined by which marker allele was inherited for the tenderness QTL, in one Simmental bull was almost as large as the spread in sire EPD's for that breed. A pleiotropic effect of one QTL (tested as a shear force QTL) with marbling has been found. Evidence for segregation of the three marbling QTL and the rib eye area QTL has not been found in the nine tested bulls.

Key Words: Carcass traits, Quantitative trait loci, Expected progeny differences

413 Impact of breeding and genetics on poultry carcass and meat quality. D. L. Fletcher*, *University of Georgia, Athens, GA USA*.

The role of poultry breeding and genetics on carcass and meat quality issues has undergone constant change over the past 150 years. Early poultry breeding efforts were focused on such characteristics as fighting ability, egg production, and improving and maintaining the characteristics of pure bred stock. Poultry meat quality was not a major emphasis. After World War II, the poultry meat industry began to vertically integrate and with dramatic developments in nutrition, disease control, and management, the economics of production were so improved that poultry consumption skyrocketed. During this period, selection programs for commercial strains were also concerned primarily with economy of production including such factors, as growth rate, feed conversion, health, and uniformity. Quality issues included white feathering and fast feathering traits, as well as traditional livestock selection criteria for live animal and carcass conformation, fleshing, meat yield, and avoidance of skeletal defects. By the late 1970's through the 1990's, although most selection criteria were still related to economy of production, programs relative to market demands for increased breast meat yield and reduced carcass fat were given some attention. Other than for breast meat yield (both an economic and quality issue) and fat content, the only other area of selection interest relative to quality has been in attempting to reduce the PSE-like condition common in turkeys. With the dramatic changes in the marketing of broilers from a predominantly whole carcass market to further processed meat products, the issues relative to traditional quality attributes have almost completely disappeared. Current and future selection programs are likely to continue to focus on economy of production but may also begin to incorporate quality issues such as PSE-like conditions, meat and parts proportions (weights, thickness, "bun coverage", and trim waste), functional properties, possible composition modification (nutrient and health-based designer foods), and welfare.

Key Words: Poultry genetics, Poultry carcass quality, Poultry meat quality

Meat Thermoprocessing: Products and Processes

414 Thermoprocessing, products and processes: Introduction. S. M. Lonergan*, *Iowa State University*.

Development of new meat products continues to be a priority of meat processors interested in capturing and improving the inherent value of muscle foods. Pre-cooked products such as fully cooked bacon, beef crumbles and beef patties have been very successful in food service markets. Recently these products have gained a portion of the retail market. Growth of retail opportunities for these products is dependent on continued development of ingredient, processing, cooking and packaging technologies to ensure safety, consistency, quality and cost efficiency.

415 Thermodynamic cooking methods. J Gaydos*, *Stein Inc.*.

The thermodynamic merits of various available cooking methods used for a variety of prepared meat products will be discussed.

Key Words: Thermodynamic, cooking, methods

416 Thermal processing and microbial stability. B.P. Marks*, *Michigan State University*.

Growth in the fully-cooked market sector and evolving federal regulations are creating a need for better information related to thermal inactivation of pathogens. In particular, federal regulations governing the safety of fully-cooked meat products are shifting from a command-and-control basis to performance standards. This shift increases the burden on processors to ensure that a new or modified process achieves target lethality levels. Although product characteristics (e.g., fat content and pH) and process parameters are known to affect thermal resistance of bacteria, most reported information is from laboratory studies that encompass a limited range of conditions. The validity of using this information in evaluating process lethality is uncertain. Consequently, there is a significant need for validated technical tools that can be used to evaluate the lethality of dynamic cooking processes. This presentation will (1) summarize the current state-of-knowledge related to thermal inactivation of pathogens in meat products, (2) highlight limitations of available inactivation models, and (3) outline current research aimed at developing tools that are directly applicable to evaluating the lethality of commercial cooking processes.

Key Words: Pathogens, Cooking, Models

417 Enhancement of cooked meat quality and safety via packaging. Tom Rourke*, *Emmpak Foods, Milwaukee, WI*.

The standard packaging methods used to improve cooked meat quality and safety are vacuum and modified atmosphere. The efficacy of these systems is well documented when the residual oxygen level is 0.5% or less. Common modified atmosphere packaging (MAP) gas mixtures are 70-80% nitrogen and 20-30% carbon dioxide. Some success has been attained incorporating antimicrobial agents (fungicides, antibiotics, organic acids) directly into packaging films. Oxygen scavengers in the form of polymer additives of film-adhering packets have been extremely successful in preventing aerobic microorganisms, especially molds, on cooked meat products. Edible coatings and films as a final processed meat package is a promising area of research. They are commonly produced from lipids, polysaccharides or proteins and have several distinct advantages such as: biodegradability, edibility, excellent appearance and

oxygen barrier. In addition, these coatings and films can serve as a carrier for a variety of edible antimicrobial agents. Technologies designed to pasteurize processed meats after final packaging have received copious attention. Post pasteurization of vacuum packaged cooked products consists of hot water or steam immersion followed by immediate chilling. Irradiation (gamma, electron beam or X-ray) of cooked vacuum or MAP packaged products can produce very acceptable product at the correct dose. High pressure processing involves submerging the packaged meat product in water increasing the pressure to 87,000 psi. The process has no effect on product color, texture, flavor, or package purge. Post pasteurization, irradiation and high pressure all increase product shelf life and significantly reduce pathogens.

Key Words: Packaging, Cooked meat, Food safety

Molecular Manipulation to Influence Mammary Development and Function

418 Physiological phenotypes of estrogen receptor knock-out mice. K.S. Korach*[1], [1]*NIEHS/NIH, Research Triangle Park, NC.*.

Estrogen receptors (ER) play a crucial role in development and reproduction. Gene targeting allowed generation of mice homozygous for either the disrupted ERα (αERKO) or ERβ genes (βERKO). αERKO mice were unresponsive to uterotropic assays with estradiol, hydroxy TAM, or DES. Estrogen, EGF or IGF-1 treatment to induce DNA synthesis in αERKO uteri, even though EGF and IGF-1 signaling was shown to be intact by stimulation of c-fos also failed. Progesterone receptor mRNA was detected in αERKO mice, but was not stimulated by estrogen in the uterus, mammary gland or ovary, indicating an estrogen dependent and independent gene regulation. αERKO females are infertile and have hypoplastic uteri and hyperemic ovaries. The αERKO ovarian phenotype occurs developmentally and can be reversed by a GnRH antagonist. Serum estrogen and LH are elevated compared to WT or βERKO females. Analysis of the mammary glands of adult αERKO females showed a primitive ductal rudiment rather than the fully developed ductal tree seen in WT or βERKO mice. αERKO males are also infertile, with atrophy of the testes and seminiferous tubule dysmorphogenesis resulting in decreased spermatogenesis and inactive sperm. Bone length is decreased in αERKO of both sexes, but not in βERKO mice. αERKO males have reduced bone density and some alterations in cardiovascular function. Phenotypic differences were seen in sex and aggressive behavior in both αERKO males and females compared to the patterns in WT or βERKO mice. In contrast to the αERKO, the βERKO males are fertile with normal sexual behavior. Recent development of a viable double ER α/β-knock out shows a unique ovarian phenotype of transdifferentiation of granulosa to sertoli cells. Further characterization of the mice and comparison of the individual and double ER gene KO phenotypes will be required to more fully understand the physiological consequences of ER mediated actions and the specific roles of the two different forms of ER in estrogen hormone responsiveness.

Key Words: estrogen knockout, mammary , reproduction

419 Genetic manipulation of the IGF-I axis to regulate mammary development and function. D.L. Hadsell*, S.G. Bonnette, and A.V. Lee, *Baylor College of Medicine, Houston, TX.*.

Insulin-like growth factor I is believed to regulate several processes within mammary epithelial cells during mammary gland development. Firstly, IGF-I stimulates cell cycle progression, in both normal mammary epithelial cells and in breast cancer cells. Secondly, IGF-I can stimulate milk protein gene expression and/or milk synthesis in a number of model systems. Lastly, IGF-I inhibits apoptosis in both normal mammary epithelial cells and breast cancer cells. Our laboratory has studied the IGF-I-dependent regulation of these processes by using transgenic and knockout mouse models that exhibit alterations in the IGF-I axis. Our studies on transgenic mice that overexpress IGF-I during pregnancy and lactation have demonstrated that this growth factor slows the apoptotic loss of mammary epithelial cells during the declining phase of lactation while having minimal effects during early lactation on milk composition or lactational capacity. In contrast, our analysis of early developmental processes in mammary tissue from mice which carry a targeted mutation in the IGF-I receptor gene suggests that IGF-dependent stimulation of cell cycle progression is more important to early mammary gland development than potential anti-apoptotic effects. With both models, the effects of perturbing the IGF-I axis are dependent on the physiological state of the animal. The diminished ductal development that occurs in response to loss of the IGF-I receptor is dramatically restored during pregnancy while the ability of overexpressed IGF-I to protect mammary cells from apoptosis does not occur if the mammary gland is induced to undergo forced involution. Data from our laboratory on the expression of IGF-signaling molecules in the mammary gland suggests that this effect of physiological context may be related to the expression of members of the IRS, or insulin receptor substrate, family.

Key Words: Transgenic mice, Mammary, Apoptosis

420 Regulation of IGF signaling by IGF binding protein-3 in the mammary gland. Wendie Cohick* and Constance Grill, *Rutgers, The State University of NJ, New Brunswick, NJ/USA.*

The insulin-like growth factors (IGF) mediate mammary epithelial cell (MEC) growth and thus play a critical role in mammary gland growth and development. The biological activity of IGF is modulated by IGF binding proteins, a family of six structurally related yet distinct proteins. The immortalized bovine MEC line MAC-T synthesizes four forms of IGFBP. Under basal serum-free conditions, minimal IGFBP-3 protein is secreted. However, IGF-I specifically upregulates the synthesis of IGFBP-3, while having no effect on other IGFBP forms. Stable cell lines genetically engineered to constitutively express IGFBP-3 exhibit enhanced responsiveness to IGF-I in terms of DNA synthesis relative to mock-transfected cells (controls), suggesting that IGF-I regulation of IGFBP-3 acts as a regulatory loop that functions to increase IGF bioactivity. DNA synthesis is also increased relative to controls by factors that activate the IGF receptor but do not bind IGFBP, hence the mechanism does not require a physical interaction between IGF and IGFBP-3. IGF-I receptor number and affinity are similar between IGFBP-3 transfected and control cells. Therefore IGFBP-3 may enhance IGF action by directly influencing intracellular signaling events downstream of the IGF-I receptor. To investigate this, the signaling molecules that mediate IGF action in bovine MEC were first determined. IGF-I does not activate ERK 1/2, suggesting that IGF-I does not stimulate DNA synthesis via this MAP kinase pathway. In contrast, the p85 regulatory subunit of PI3 kinase co-precipitates with IRS-1 following stimulation with IGF-I, indicating involvement of the PI3 kinase signaling pathway. Activation of the downstream effector Akt is observed by 1 min and maximal by 15 min following exposure to IGF-I. Akt phosphorylation is greater at 1 min in MAC-T cells expressing IGFBP-3, relative to controls, and this enhanced activation is maintained through 10 h. In vitro kinase assays confirm that Akt activity is 1.4- to 1.9-fold higher in IGFBP-3 transfected cells. Therefore, IGFBP-3 may potentiate IGF-I activity by enhancing the activation of the PI3 kinase signaling pathway via Akt. Studies are in progress to further define the signaling molecules responsible for this effect.

Key Words: Mammary gland, Insulin-like growth factor binding protein-3, Signaling

421 Regulation of apoptosis during mammary involution by the p53 tumor suppressor gene. D. Joseph Jerry*[1], Ellen S. Dickinson[1], and Amy L. Roberts[1], [1]*University of Massachusetts.*

Regulation and functions of the p53 tumor suppressor gene have been studied extensively with respect to its critical role in maintaining the stability of genomic DNA following genotoxic insults. However, p53 is also induced by physiologic stimuli resulting in cell cycle arrest and apoptosis. In other situations, the activity of p53 must be repressed to prevent inappropriate removal of cells. The mammary gland provides a valuable system in which to study the mechanisms by which the expression and biological responses to p53 can be regulated under a variety of physiological circumstances. The proapoptotic role of p53 during involution of the post-lactating mammary epithelium is especially relevant to animal agriculture. We have utilized p53-deficient mice to establish the molecular targets of p53 in the mammary gland and biological consequences when it is absent. We have demonstrated that induction of the p21/WAF1 gene (Cdkn1a) is p53-dependent in the involuting mammary epithelium. Abrogation of p53 resulted in delayed involution of