

## Food Safety

### Interventions and Future Directions in Food Safety

**674 Preharvest intervention strategies to reduce food borne pathogens in food animals.** T. R. Callaway\*, R. C. Anderson, T. S. Edrington, R. O. Elder, K. J. Genovese, K. M. Bischoff, T. L. Poole, and D. J. Nisbet, *Agricultural Research Service/USDA, Food and Feed Safety Research Unit, College Station, TX.*

Annually, food borne pathogenic bacteria sicken more than 76 million Americans. Many of these illnesses are caused by consumption of foodstuffs produced from animals. Although post harvest intervention strategies are targeted at reducing bacterial contamination from the abattoir to the table, foodborne illnesses deaths still occur, suggesting that preharvest intervention strategies are needed to effectively reduce human foodborne illness. Several preharvest intervention strategies have been contemplated and are currently under investigation. Potential strategies to be discussed include vaccination, competitive exclusion, substrate-adapted competitive exclusion, the use of probiotics and prebiotics (e.g., fructooligosaccharides). Other strategies such as the use of bacteriophage to specifically target certain pathogenic bacteria, and the exploitation of the physiology of specific pathogens, the use of antibiotics to reduce specific pathogens, as well as the effects of management strategies (e.g., dietary changes, transportation and stress) will also be discussed. The use of preharvest intervention strategies at multiple critical control points can potentially reduce the incidence of human food borne illnesses by erecting multiple hurdles against entry of pathogens into the food chain.

**Key Words:** Preharvest Food Safety, Intervention Strategies, Pathogen Reduction

**675 Practical preharvest food safety interventions for dairy production.** P.L. Ruegg\*, *University of Wisconsin, Dept. of Dairy Science, Madison, WI.*

Consumers are increasingly concerned about the safety of their food and uncertain about food production practices. Apprehension regarding potential liability from illnesses related to consumption of tainted food products has some food retailers considering the extension of HACCP programs to farm production units. Potential threats to human health related to dairy products and dairy farming include: errors in pasteurization, consumption of raw milk products, contamination of milk products by emerging heat resistant pathogens, emergence of antimicrobial resistance in zoonotic pathogens, chemical adulteration of milk, transmission of zoonotic pathogens to humans through animal contact and foodborne disease related to cull dairy cows. Most dairy farmers feel

responsible for the safety of milk and beef that originate on their farms but linkage between farm production practices and the quality of processed products have been weak. The safety of dairy products can be enhanced by adoption of a number of management practices. All animals should be identified and accounted for throughout their life cycle and farmers must take responsibility for the market cattle leaving their farms. Systematic procedures that divert diseased animals and adulterated or abnormal milk from the marketing chain must be in place on all farms. Many potential pathogens are shed in feces and fecal contamination of milk products, carcasses and animal facilities and equipment must be minimized. The inappropriate or prophylactic use of antimicrobial agents must be minimized to ensure that antimicrobial resistance does not develop in animal pathogens. Consumers can have confidence in food safety programs on dairy farms that promote awareness and accountability for the products that are produced.

**Key Words:** Food Safety, Dairy Production, Zoonotic Disease

**676 Effective methods for postharvest intervention in dairy processing.** J. R. Stabel\*<sup>1</sup>, *USDA-ARS, National Animal Disease Center, Ames, IA.*

Food safety has become a top priority for regulatory agencies in the US. Illness and/or death due to contamination of food products with zoonotic pathogens is rare in the US but does occur. Recent outbreaks of Bovine Spongiform Encephalopathy and Foot and Mouth Disease Virus (FMDV) in the UK have raised concerns about contamination or transmission of pathogens from farm animals to consumers. Raw milk contains a number of pathogens and the potential is high for these pathogens to cause disease in consumers if the milk is not adequately treated to destroy or reduce the pathogen load. Proper intervention methods during the processing of food products significantly reduce the risks of transmission of infectious agents from the farm to the table. This paper will summarize methods of intervention used by dairy processing plants to improve the safety of dairy products for consumers. Methods include inactivation by heat (pasteurization and ultra-high-temperature); high hydrostatic pressure; irradiation and fermentation. Efficacy of these methods for inactivation of pathogens such as *Listeria*, *Yersinia*, *Salmonella*, *E. coli*, Bovine Leukemia Virus, FMDV and *Mycobacterium paratuberculosis* will be summarized. The potential for contamination of dairy products to occur post-processing in the dairy plant environment will also be discussed.

**Key Words:** Dairy products, Pathogens, Intervention methods

## Growth and Development

### Skeletal Muscle Plasticity, Development, and Hypertrophy

**677 Importance of muscle fiber types in animal agriculture.** D.E. Gerrard\* and A.L. Grant, *Purdue University, West Lafayette, IN USA.*

Adult skeletal muscle is a mosaic collection of muscle fiber types. There are four different muscle fiber types in porcine skeletal muscle, which are slow-oxidative or type 1, fast oxido-glycolytic or type 2A, and fast glycolytic 2X(D) and 2B fibers. This type of classification scheme is based solely on the different types of myosin heavy chain isoforms that predominate a given fiber type. Muscle fiber types are extremely sensitive to a myriad of physiological, environmental and cellular stimuli. Depending on the type and duration of a stimulus, muscle fibers can react by changing their contractile and metabolic capabilities. Therefore, fiber type composition in skeletal muscle is considered rather plastic in nature. From an agronomic standpoint, many production systems and programs provide sufficient stimuli to change muscle fiber type composition and, as a result, may alter production efficiency of the whole animal. After a discussion regarding muscle fiber typing and nomenclature, data regarding the effect of various production practices that change muscle fiber type will be explored. Furthermore, the role fiber type may play in controlling the development of meat quality will be discussed. Understanding how muscle fiber type is altered by various

stimuli may provide meaningful insights into how animal growth performance and meat quality can be improved.

**Key Words:** Muscle, Growth, Fiber type

**678 Heterogeneity of protein expression within muscle fibers.** Everett Bandman<sup>1</sup> and Benjamin W.C. Rosser\*<sup>2</sup>, <sup>1</sup>*University of California, Davis, CA USA*, <sup>2</sup>*University of Saskatchewan, College of Medicine, Saskatoon, Saskatchewan, Canada.*

Skeletal muscle fibers are elongated multinucleated cells. Along its length an individual muscle fiber may contain thousands of myonuclei, each controlling protein synthesis within its surrounding cytoplasm. Thus a muscle fiber can be considered a series of nuclear domains, each responding to distinct localized signaling mechanisms that may result in differential gene expression within a single fiber. This presentation examines a number of phenomena that result in distinct subsets of proteins accumulating within different regions of a muscle fiber during growth and development. These include changes in protein expression associated with muscle maturation, denervation, and activity induced fiber type transformation. Myosin heavy chain proteins are a fundamental structural and functional component of muscle fibers that are represented by different isoforms, each of which is the product of a separate gene that may be differentially expressed during development of distinct

muscle fiber types. We have found that in adult chicken pectoralis muscle, the tapered ends of fibers contain the neonatal myosin heavy chain isoform in addition to the adult isoform found throughout the length of the fiber. We have made similar observations studying mature pigeon muscle. Examination of serial sections along the length of muscle fibers of chicken pectoralis at different stages of development, illustrated that the transition from the neonatal to adult myosin heavy chain isoform proceeds as a gradient from the centrally located motor endplate towards the ends of a muscle fiber. Additional evidence demonstrates differences in the amount of cytoplasm per nucleus at the ends of chicken pectoralis muscle fibers throughout development. In denervated adult fibers, those myonuclei furthest from the endplate are the first to re-express neonatal myosin. We examine the hypothesis that during development neonatal myosin is initially suppressed near the motor endplate and that trophic factors emanating from the vicinity of the motor endplate represent a potential localized signaling pathway that may differentially modulate myosin heavy chain gene expression in nuclear domains along the length of the muscle fiber.

**Key Words:** Skeletal Muscle, Myosin, Heterogeneity

**679 Calcineurin and NFAT signaling in myogenesis.**  
G.K. Pavlath\*, *Emory University, Atlanta, GA USA.*

Adequate muscle mass is crucial for the maintenance of functional muscle tissue. However, the signaling pathways that control muscle growth are unclear. The nuclear factor of activated T cells (NFAT) proteins are a family of transcription factors whose activation is controlled by calcineurin, a Ca<sup>2+</sup> dependent phosphatase. Calcineurin and NFAT have distinct functions in multiple steps of myogenesis. Several NFAT isoforms are expressed in skeletal muscle. However, individual NFAT isoforms are activated during different stages of muscle development. Specifically, the NFATC2 isoform is activated only in newly formed myotubes. We have shown that adult NFATC2<sup>-/-</sup> mice exhibit reduced muscle size due to a decrease in the cross sectional area of individual myofibers, suggesting that muscle growth is blunted. The growth defect is intrinsic to muscle cells as the lack of NFATC2 in primary muscle cultures results in reduced cell size and myonuclear number in myotubes. These results implicate a novel role for the transcription factor NFATC2 in regulating skeletal muscle growth. Additional evidence suggests that NFATC2 either directly or indirectly regulates the expression of a secreted molecule that regulates muscle growth. Media conditioned by wild-type myotubes contains bioactivity that can rescue

the reduced cell and myonuclear number defect of NFATC2<sup>-/-</sup> muscle cells. IGF-1, a known regulator of muscle growth, does not mimic the effects of conditioned media. Biochemical characterization and fractionation of conditioned media from wild-type myotubes suggests that the factor is heat and protease sensitive with a molecular weight around 10kD. These studies may lead to the identification of novel factors that regulate muscle growth. Such factors may be useful for inducing muscle growth during periods of muscle loss associated with disease, disuse, or aging.

**Key Words:** muscle growth, growth factors, calcineurin

**680 Calcineurin signaling in skeletal muscle growth.**  
R.N. Michel\*, *Laurentian University, Sudbury, Ontario, Canada.*

The adult motor nerve confers to its target skeletal muscle fibers distinct morphological, biochemical and functional characteristics. This is not only achieved via nerve-mediated electrical activation signals but also by means of nerve- and muscle-derived trophic mechanisms. Though our understanding of these neural influences is rudimentary there is mounting evidence that the calcium/calmodulin-dependent phosphatase calcineurin is an important molecular signaling intermediate in this modulation. Specifically, calcineurin appears as a crucial link between upstream activity-related effectors and its specific downstream targets involved in the regulation of the muscle cell phenotype, and in particular, cellular size. Though the positioning of calcineurin at the nexus of growth is currently under debate (S. Dunn, A. Simard, R. Prudhomme and R.N. Michel, *Nature Cell Biology* 4: E46-47, 2002), its role in modeling skeletal muscle phenotype is uncontested. In this presentation, I will: 1) define the role of calmodulin-calcineurin signaling in the modulation of size and phenotype of all (fast and slow) skeletal muscle fiber types and in the promotion of satellite cell differentiation *in vivo*, 2) provide insight into the contribution of neural-linked upstream signaling and contractile loading factors in the activation of the calcineurin pathway, specifically our model of 'frequent muscle usage' above 'native' muscle activity levels as a prerequisite for calcineurin signaling, 3) provide evidence for the contribution of parallel signaling pathways cooperating with calcineurin during growth, and 4) identify the cellular substrates and gene targets of this phosphatase. Supported by NSERC Canada.

**Key Words:** nerve activity, cell signaling, muscle phenotype

## Horse Species

### Horses: Livestock Versus Companion Animals - Implication for Animal Agriculture

**681 Horses ARE companions, but...** M.A. Russell\*, C.M. Brady, E.A. Pajor, and A.M. Beck, *Purdue University, West Lafayette, IN USA.*

Internationally, horses have a strong affiliation with agrarian life and serve humans as food, war machines, transportation, and beasts of burden. They are included in Webster's definition of livestock: "domestic animals, such as cattle, horses, sheep, hogs, or goats, raised for home use or for profit". Many farmers, cowboys, and cavalry soldiers consider their horses as their co-workers and faithful companions. In North America, only 10-20% of the horses are owned with a commercial industry or profit motive (AHC, 1999) with availability of discretionary income determining the demand for horses. This is a function of the general, not the agricultural economy, and input suppliers and veterinarians will confirm that the majority of horseowners approach expenditures with a mentality more similar to cat or dog owners than to production farmers. Beck and Katcher (1996) reported that 87% of US Pony Club members surveyed responded that horses were part of the family and Melson (2001) reported that children "liked their horse better than a good friend". Webster defines pet as "any object kept for the affection, an animal kept for amusement or companionship, something cherished or a favorite". In interviews with youth ages ten to fourteen, 75% indicated that when they were upset they turned first to their horses (Covert et al., 1985). So are horses companion animals? They are big business! There is no doubt about the companion relationship between most horseowners and their horses, but politically we want to maintain the connection and importance of the horse industry to the agricultural business sector and heritage. There are justifiable legal, political, and economic reasons

for this position, however, the future viability of departments of animal sciences and veterinary medicine depends on how they respond to the changing demographics of our society. We must relate to an increasing number of people in a companion relationship with their animals in order to attract youth to our scientific disciplines, whether we wish to call them livestock or not.

**Key Words:** Companion animals, Horses

**682 The California perspective- politics, reality, and society.** C. Stull\*, *University of California, Davis, CA.*

Of the estimated one million horses residing in California, more than 3,000 were shipped out of state in 1997 for slaughter and sales as horsemeat for human consumption. Public opinion polls showed that California voters overwhelmingly oppose horse slaughter and oppose eating horse meat. A grass-roots organization, "Save the Horses," was founded to expose the "horrors" of horse slaughter. The Save the Horses proponents developed Proposition 6 for the November 1988 California ballot, which was successfully passed by 60 percent of the voters. Proposition 6 was entitled "Prohibition of Horse Slaughter and Sale of Horsemeat for Human Consumption Act of 1998," and made it a felony to possess, transfer, receive or hold any horse, pony, burro or mule with intent to having it killed for human consumption. Sale of horse meat is prohibited as a misdemeanor offense, with subsequent violations punishable as felonies. Arguments for supporting Proposition 6 contend that historically human beings and horses have enjoyed a special relationship, and believed Californians want to protect their companion and recreational