USDA-ARS-MWA Livestock Behavior Research Unit

Food Safety Fact Sheet

Livestock Behavior Research Unit

FALL 2010

Stress in Farm Animals and Food Safety: Is there a Connection?

By Dr. Marcos Rostagno

Stress in Farm Animals: Farm animals are challenged by different management-associated stressors, and consequently, develop varying degrees of stress responses during their lives. Each environment poses its unique set of stressors to which the animal responds. Factors that can cause stress when they act excessively within any animal production system include water and/or feed restriction, heat, cold, overcrowding, and handling (i.e., interaction with humans, or human manipulation of the animals). Additionally, most farm animals are transported at some stage in their lives. The handling, loading, transporting and unloading of animals can have substantial detrimental effects on their well-being by causing stress. Moreover, during this process, animals can be exposed to a range of challenging stimuli including, increased human contact, transport (vibration, movement, and jolting), novel/unfamiliar environments, food and water restriction, changes in social structure (through separation and mixing during transport and/or at the final destination), and changes in climatic conditions (i.e., heat, cold). These challenges perturb the homeostasis of the animals and an adaptive response is activated in an attempt to restore balance.

The Connection between Stress and Food Safety: Stress reduces the fitness of an animal, which can be expressed through failure to achieve production performance standards or targets, or more drastically, through injury, disease and death. Stress in farm animals can also have detrimental effects on the quality of food products (meat, egg, and milk).

The gastrointestinal tract is the primary habitat of a variety of bacteria, including foodborne pathogens. Colonization of farm animals by pathogens such as *E. coli* O157:H7, *Salmonella*, and *Campylobacter*, and their subsequent distribution along the human food chain are a major public health and economic concern for the food industries.

The nervous system of the digestive tract is an integrative network located within the gastrointestinal wall that controls its microcirculation, motility, and secretions. It is bidirectionally linked to the central nervous system forming the brain-gut axis. Although we are only beginning to understand the complex physiology of brain-gut interactions involved in stress -related gastrointestinal alterations, there is increasing evidence that stress reactions via the brain-gut axis are not only responsible for functional disorders, but also contribute to inflammatory disorders and infections of the gastrointestinal tract. Additionally, the intimate connection (anatomical and functional) of immune and nervous systems provide another pathway for the stress effects on susceptibility to infections. This interaction has until recently been the central pillar to support the hypothesis on the effects of stress on infections, however, it does not provide a complete explanation of what really occurs.

The gastrointestinal tract is an environment in which, normally, there is a significant presence of catechola-

mine hormones (particularly, norepinephrine). During episodes of stress, catecholamines are released by the nervous system of the digestive tract, or spill over from the systemic circulation, causing significant local increases. These changes markedly affect the status and behavior of the intestinal microbial populations and colonizing pathogens, indirectly, through suppression of the immune system, and promoting physiological alterations in the gastrointestinal tract, and/or directly, on the intestinal tract microbial populations, including foodborne pathogens, by increasing their virulence and multiplication rate. Consequently, exposure of farm animals to stressors will lead to increased levels of foodborne pathogens in the gastrointestinal tract, and increased risk of contamination of their carcasses.

What can be done? Understanding when pathogen frequency and levels are the highest or when farm animals are most susceptible to infections is critical to help identifying critical times when prevention or control measures are needed. For instance, changes in management practices to promote animal well-being and minimize stress can reduce the effects on foodborne pathogens in the gastrointestinal tract, and therefore, reduce the risk of carcass contamination. Also, other potential intervention measures to be strategically applied include the manipulation (or stabilization) of the gastrointestinal microbial populations through the use of feed or water additives (e.g., organic acids, probiotics, prebiotics, symbiotics, and other products), making it more resilient to the effects of stress.

As briefly discussed, stress in farm animals has a significant deleterious effect on food safety through different potential mechanisms affecting the susceptibility of farm animals to infections as well as the carriage and shedding of foodborne pathogens. However, the precise mechanisms underlying this effect have not been fully elucidated. It is imperative that the issue receives more research attention in the interests of optimizing animal welfare and minimizing losses in product yield and quality, as well as food safety risks to consumers.

Bibliography

Bhatia, V. and Tandon, R.K. (2005) Stress and the gastrointestinal tract. *Journal of Gastroenterology and Hepatology* **20:** 332-339.

Cogan, T.A., Thomas, A.O., Rees, L.E., Taylor, A.H., Jepson, M.A., Williams, P.H., Ketley, J. and Humphrey, T.J. (2007) Norepinephrine increases the pathogenic potential of *Campylobacter jejuni*. *Gut* 56:1060-1065.

Dowd, S.E. (2007) *Escherichia coli* O157:H7 gene expression in the presence of catecholamine norepinephrine. *FEMS Microbiology Letters* **273:** 214-223.

Freestone, P.P.E., Sandrini, S.M., Haigh, R.D. and Lyte, M. (2008) Microbial endocrinology: How stress influences susceptibility to infection. *Trends in Microbiology* **6:** 55-64.

Humphrey, T. (2006) Are happy chickens safer chickens? Poultry welfare and disease susceptibility. *British Poultry Science* **47:** 379-391.

Lyte, M. (1993) The role of microbial endocrinology in infectious disease. *Journal of Endocrinology* **137:** 343-345.

Bibliography

Marketon, J.I.W. and Glaser, R. (2008) Stress hormones and immune function. *Cellular Immunology* **252:** 16-26.

Marques-Deak, A., Cizza, G. and Sternberg, E. (2005) Brain-immune interactions and disease susceptibility. *Molecular Psychiatry* **10:** 239-250.

Rastall, R.A. (2004) Bacteria in the gut: Friends and foes and how to alter the balance. *Journal of Nutrition* **134:** 2022S-2026S.

Richards, J.D., Gong, J. and de Lange, C.F.M. (2005) The gastrointestinal microbiota and its role in monogastric nutrition and health with emphasis on pigs: Current understanding, possible modulations, and new technologies for ecological studies. *Canadian Journal of Animal Science* **85:** 421-435.

Rostagno, M.H. (2009) Can stress in farm animals increase food safety risk? *Foodborne Pathogens and Disease* **6:** 767-776.

Steinman, L. (2004) Elaborate interactions between the immune and nervous systems. *Nature Immunolgy* **5:** 575-581.

Taub, D.D. (2008) Neuroendocrine interactions in the immune system. *Cellular Immunology* **252:** 1-6.

USDA-ARS-MWA
Livestock Behavior Research Unit

Poultry Science Building,
Purdue University,
125 S. Russell Street,
West Lafayette, IN 47907

Phone: 765-494-4604
Fax: 765-496-1993
E-mail: becky.atkinson-haley@ars.usda.gov

The mission of the LBRU is to develop scientific measures of animal well-being, through the study of animal behavior, stress physiology, immunology, neurophysiology, and cognition, that will allow an objective evaluation of animal agricultural practices. This method of study will allow the improvement of existing practices and invention of new practices that can enhance animal well-being and increase animal productivity. In addition, this unit will use and develop its knowledge of stress physiology and animal behavior to address concerns of pathogen contamination of livestock carcasses due to the stress of handling and transportation. The optimization of animal well-being will assist in improving animal health, increasing productivity and decreasing human exposure to dangerous pathogens.

Finding solutions to agricultural challenges

www.ars.usda.gov