## Symposium: Nonruminant Nutrition: Oxidative Stress and the Use of Antioxidants for Nonruminant Animals

**466 Oxidative stress during the lifecycle of animals.** W. P. Weiss* and D. C. Mahan, *The Ohio State University*, *Wooster and Columbus*.

Reactive oxygen species (ROS) are chemical compounds that contain oxygen and are highly reactive because they have, or can be easily converted to compounds that have, unpaired electrons. Common ROS in biological systems include superoxide, hydroxyl radical, hydrogen peroxide, and fatty acid peroxides. ROS are produced via normal oxidative metabolism and certain ROS are absolutely essential for cell signaling and other functions. However, because of their reactive properties, concentrations of ROS must be controlled, and sophisticated antioxidant systems have been developed to keep ROS in check. Oxidative stress occurs when the antioxidant system is overwhelmed by the production of ROS which can lead to increased prevalence of infectious disease via impaired immune cell function, longer term health disorders such as atherosclerosis, and perhaps various sudden death syndromes. For example mortality of weanling pigs was greatly reduced when they were injected with Se and/or vitamin E (two important components of antioxidant systems). Oxidative stress commonly occurs during an infection or other challenge to the immune system. Indeed, the massive production of ROS is essential to kill invading bacteria and trigger various immune responses. These ROS can also cause tissue damage and prolong the disease state; therefore, antioxidants are extremely important to certain types of immune cells. Oxidative stress is also associated with partition. The concentrations of serum antioxidants (e.g., ascorbic acid, glutathione peroxidase, Se, and vitamin E) in sows decline starting 80 d post coitum. Numerous studies have shown that serum concentrations of several antioxidants decrease markedly during the peripartum period and in some animals changes in antioxidant status has been associated with the immunosuppression that occurs during that period. Profitable swine and poultry production requires rapid production of lean tissue, larger litter sizes, and greater milk production and egg production. These requirements place increasing demands on the metabolic system of these animals which can lead to increased oxidative stress unless antioxidant systems are enhanced most likely via nutrition.

**Key Words:** Reactive Oxygen Species, Oxidative Stress

**467 Roles in animals of the antioxidant micronutrients vitamin E, vitamin C, and selenium.** R. F. Burk*, *Vanderbilt University*, *Nashville, TN*.

Three essential micronutrients have major antioxidant properties in animals: vitamin E is a lipid soluble free radical scavenger that protects membranes; vitamin C is a reducing substance in the aqueous phase; and selenium forms the active sites of the glutathione peroxidases and the thioredoxin reductases. These micronutrients interact with one another at a molecular level. Radical scavenging by vitamin E converts it to a free radical form, which is converted back to the active vitamin E by reaction with vitamin C at the membrane-aqueous interface. The resulting vitamin C free radical is converted back to the active vitamin C by the selenoenzyme thioredoxin reductase at the expense of NADPH. Nutritional deficiencies of each micronutrient occur and have been characterized. Severe vitamin C deficiency causes scurvy in most susceptible species, but the manifestations of severe vitamin E and selenium deficiencies vary from species to species. We have carried out studies in guinea pigs to assess the effects of mild deficiencies in two of these micronutrients that occur simultaneously. Combined mild deficiencies of vitamin E and selenium, each of which was too mild to affect the animal, caused massive skeletal muscle necrosis that was fatal. It was associated with mitochondrial abnormalities in the muscle. Combined mild deficiencies of vitamin E and vitamin C caused infarcts in the spinal cord and brainstem leading to death. These results demonstrate that combined mild deficiencies of antioxidant micronutrients can have serious effects on animal health and indicate the need to ensure adequate intake of all three antioxidant micronutrients. Supported by NIH ES02497.

**Key Words:** Oxidative Stress, Antioxidant Micronutrients, Central Nervous System Injury

**468 Bioavailability of natural and synthetic vitamin E in sows and their progeny.** C. Lauridsen*, *University of Aarhus*, *Tjele, Denmark*.

Two of the critical stages for dietary vitamin E as a nutrient for growth and health status in pigs are immediately after birth and after weaning. Supplemental vitamin E is usually added to animal feed in the form of all-rac-α-tocopheryl acetate, which is an equimolar mixture of all eight possible stereoisomers of which only the RRR stereoisomer possesses the natural configuration. Relatively little information is available in pigs concerning vitamin E delivery to the fetus during gestation or to the suckling progeny from milk. In addition, little is known regarding the effect of supplementing vitamin E to sow diets on the subsequent effect on the vitamin E status of the progeny after weaning. By feeding sows capsules with labelled vitamin E forms it was found (Lauridsen et al., 2002) that swine discriminate between RRR- and all-rac-α-tocopherol with a preference for RRR-α-tocopherol; thus, the official bioequivalence factor of 1.36:1 RRR- to all-rac-α-tocopherol is underestimated. The increased bioavailability the RRR-α-tocopherol resulted in a 2:1 ratio of the natural and synthetic vitamin E forms in milk and in the suckling progeny. In a subsequent experiment it was shown (Lauridsen & Jensen, 2005) that increasing dietary all-rac-α-tocopheryl acetate (70, 150, and 250 IU/kg) during lactation increased the concentration of α-tocopherol in milk and plasma of sows, and in tissues of the pigs at weaning (day 28 after birth). However, after weaning (from day 35 to 49 of age) a decrease in α-tocopherol concentration in most tissues was seen irrespective provision of a dietary level of all-rac-α-tocopheryl acetate at 70 IU/kg feed. In recent studies different nutritional strategies have been investigated to overcome the decrease in vitamin E status following weaning, e.g. by investigating different forms of natural and synthetic vitamin E (Lauridsen & Jensen, 2006), and vitamin C supplement (Lauridsen & Jensen, 2005).

References Lauridsen C, Engel H, Jensen SK, Craig AM, and Traber M 2002. J. Nutr. 132 (6): 1258-1264. Lauridsen C, Jensen SK. 2005. J. Ani. Sci. 83 (6): 1274-1286. Lauridsen, C, Jensen, SK. 2006. Proc. 19th Int. Pig Vet. Soc. Cong. pg. 293.

**Key Words:** Vitamin E, Sows, Pigs

**469 Synthetic antioxidant applications in nonruminants.** R. J. Harrell*, J. Andrews, V. Robinson, M. Vazquez-Anon, and S. Carter, *Novus International Inc.*, *St Charles, MO*.

Synthetic antioxidants are used to preserve feed quality by preventing the oxidation of lipids, which can lead to improved animal performance. Oxidation begins in feed and feed ingredients and can have a negative impact on the gastrointestinal tract and performance of animals fed oxidized fats. In the presence of oxygen and a catalyst, such as trace minerals, unsaturated fatty acids are oxidized forming free radicals. Generally, synthetic antioxidants control oxidation of lipids by acting as free radical scavengers. Examples include tert-butylhydroquinone, ethoxyquin, butylated hydroxytoluene, and butylated hydroxyanisole. Oxidation occurs in body tissues as a normal process and tissues have a complement of antioxidant compounds and enzymes to prevent oxidative damage including superoxide dismutase, catalase, glutathione, and vitamins E and C. Poor quality feed ingredients, disease, environmental conditions, and level of production can lead to oxidative stress. Oxidative stress occurs when the endogenous antioxidant capacity of the animal is not enough to control free radical formation. Accumulation of free radicals in the body would lead to tissue damage and reduced performance. A prime target for oxidative stress is the gastrointestinal tract and liver where studies have shown that feeding oxidized fat not only reduces the feed energy value, but also increases epithelial cell turnover, reduced immune function and hepatic function. Synthetic antioxidants are very effective at stabilizing dietary fat sources at the site of oxidation and the choice is dependent on the fat source. Certain antioxidants are more effective against animal based fats, whereas other antioxidants are more effective in preventing oxidation of vegetable oils. Synthetic antioxidants can partially ameliorate the negative effects of feeding oxidized fats by preventing further oxidation through control of peroxides leading to reduced damage to intestinal structure and function, preserving tissue antioxidant activity to reduce oxidative stress and improve performance.

**Key Words:** Antioxidants, Nonruminants, Synthetic