Goals for My Udder Health Research

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Mastitis in dairy cattle continues to be a major economic burden to dairy producers and negatively impacts milk safety and milk quality. Here in Florida, nearly 40 percent of bulk tank samples had SCC over 400,000/mL in 2012; signifying the prominence of mastitis in Florida. The overall cost of mastitis can be $250 - $350 per case, so substantial economic gains can be made from decreasing the incidence of mastitis. Proper hygiene, milking routine, and immunity are extremely critical for maintaining udder health. The main goal of my research is to minimize the impact of infectious diseases, such as mastitis, in livestock through understanding how genetic and environmental factors influence the immune system.

My research concentrates on the influence and regulation of vitamin D signaling in the immune system. Previous studies with an experimental model of mastitis in dairy cattle have revealed that the vitamin D pathway is activated in the udder in response to bacterial infection and ultimately functions to improve resistance to bacterial infection. In this pathway, the active vitamin D hormone, 1,25-dihydroxyvitamin D, is produced by in macrophages in the udder. The 1,25-dihydroxyvitamin D produced in the bovine macrophage acts in immune cells in the udder to improve host defense and limit inflammation. The main objectives of my current research are to 1) identify targets of the vitamin D hormone and the physiological significance of those targets in the immune system, and 2) identify the genetic, epigenetic and environmental (i.e. nutritional and pathogen) influences on vitamin D metabolism and the molecular basis of those influences.

We have recently discovered that 1,25-dihydroxyvitamin D increases expression of several beta-defensin antimicrobial peptide genes by 5-10 fold in macrophages of cattle. Beta-defensin antimicrobial peptides have potent bactericidal activity against gram-positive and gram-negative pathogens. At high concentrations, these peptides kill bacteria by piercing holes in the bacterial cell wall. They are a critical component of the cow's innate defense system, but their presence in the udder is weak during mastitis. Taking advantage of the influence of vitamin D signaling on the defensins may give the innate defenses of the udder the boost it needs to defend against mastitis pathogens.

In addition to the implications of this research in udder health, the actions of vitamin D in the immune system have significant implications for animal health in general. For instance, dairy calves fed waste milk without adequate supplemental vitamin D are vitamin D insufficient, which may impair their immune system. Also, the ability of the vitamin D hormone to suppress inflammation and improve host defense allows for the potential of alternative preventative and therapeutic strategies. My hope is that my research efforts will minimize the burden of infectious diseases in cattle, specifically mastitis, so that production efficiency and profitability of dairy herds can be improved.

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