

VITAMIN D, CALCIUM, AND PHOSPHORUS METABOLISM IN ALPACAS (*VICUGNA PACOS*): A REVIEW OF PHYSIOLOGY, DIETARY MANAGEMENT, AND INTERPRETATION OF CLINICAL PATHOLOGY IN A HIGH-ALTITUDE SPECIES

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Abstract

The alpaca (*Vicugna pacos*) is a camelid native to the Altiplano and neighboring high-altitude regions of Peru, Bolivia, and Chile. Domesticated for thousands of years, South American alpacas are managed in open rangeland pastures at elevations of 3500 to 5000 m (Petrie, 1995). Given this high-altitude habitat, much of the species' physiology is adapted to environmental extremes: seasonally-scarce forages with poor nutritional composition, low atmospheric oxygen saturation, and intense solar radiation. Adaptations to high UVB availability in its native range have presented particular nutritional challenges when managing the species outside of that home range, especially at high latitudes and low elevations. The species appears to have downregulated much of its ability to either absorb vitamin D₂ from forages or convert vitamin D₂ to D₃ via endogenous enzymatic activity, or both (Van Saun, 2009). Therefore, dietary vitamin D₃ requirements of alpacas in far Northern latitudes are significantly higher than those of other ungulate species in similar locations. Vitamin D-responsive rickets, characterized by angular limb deformities and beading along the ribs, is frequently seen among young growing animals in winter months (Van Saun *et al.*, 1996; Smith & Van Saun, 2001; Nelson *et al.*, 2014). However, serum phosphorus is the parameter most responsive to either hypo- or hypervitaminosis D (Van Saun *et al.*, 1996), rather than serum calcium as in most other mammalian species. Therefore, interpretation of clinical pathology and treatment of affected animals must differ from presumptive approaches based on generalized mammalian physiology. Diagnosis of clinical hypovitaminosis D is made by associating low serum vitamin D concentration with low serum phosphorus, and/or high serum calcium:phosphorus ratios. In a similar manner, hypervitaminosis D, which can also occur with overuse of concentrated supplements, is diagnosed through simultaneous presentation of high serum vitamin D with high phosphorus, and/or low calcium:phosphorus. In addition to their roles as exhibit and program animals in exotic animal facilities, and as companion animals, alpacas are part of a thriving international industry in fleece and textile production. Therefore, prevalence of hypovitaminosis D and related syndromes have been exacerbated by trends in the Northern hemisphere towards artificial selection of larger animals with denser fleece, which covers more of the animal's body. These physical changes simultaneously increase nutrient requirements and diminish opportunity for UVB exposure, increasing the importance of proper dietary management and clinical vigilance. Related South American camelids such as the llama seem to share these unusual physiological traits and economic influences on physical form, and serve as examples of paradoxical and complex challenges sometimes faced with *ex situ* nutritional management of exotic species.

Literature Cited

Nelson NC, Mattoon JS, Ivany Ewoldt J, Nichols S, and Anderson DE (2014) Thoracic imaging and respiratory surgery. In: Cebra C, Anderson DE, Tibary A, Van Saun RJ, and Johnson LW, Eds. Llama and Alpaca Care: Medicine, Surgery, Reproduction, Nutrition, and Herd Health, First Ed. pp 691-701.

- Petrie OJ (1995) Harvesting of textile animal fibres. FAO Agricultural Services, Bulletin 122. <http://www.fao.org/3/v9384e/v9384e00.htm>. Accessed June 15, 2019.
- Smith BB and Van Saun RJ (2001) Seasonal changes in serum calcium, phosphorus, and vitamin D concentrations in llamas and alpacas. *Am J Vet Res* 62:1187-1193.
- Van Saun RJ (2009) Nutritional requirements and assessing nutritional status in camelids. *Vet Clin Food Anim* 25:265-279.
- Van Saun RJ, Smith BB, and Watrous BJ (1996) Evaluation of vitamin D status of llamas and alpacas with hypophosphatemic rickets. *JAVMA* 209:1128-1133.