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# Nutritional diseases of South American camelids☆

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**Abstract**

Literature describing nutritional or nutrition-related diseases of llamas and alpacas was reviewed. Case reports of copper toxicity, polioencephalomalacia, plant poisonings and urolithiasis accounted for the greatest number of literature citations relative to llamas and alpaca nutritional diseases. However, the overall number of published studies detailing nutritional disease of llamas and alpacas is very limited. Metabolic bone disease, associated with Vitamin D deficiency, and hepatic lipidosis were metabolic diseases for which controlled research studies were completed to address underlying mechanisms. Circumstantial evidence would suggest llamas and alpacas are similar to other ruminants relative to most nutrient deficiency or toxicity disease problems. Llamas and alpacas are unique compared to other ruminant animals in their susceptibility to zinc and Vitamin D deficiency diseases. A zinc-responsive dermatosis has been described, but the true role of zinc deficiency is debated. Llamas and alpacas show a seasonal deficiency in Vitamin D resulting in a hypophosphatemic rickets syndrome. Camelids may have a lower capacity to endogenously synthesize Vitamin D or higher requirement compared to other species. Although mechanisms are not fully understood, llamas and alpacas are somewhat different in metabolic responses to negative energy balance and subsequent hepatic lipidosis. Further research is necessary to better define llama and alpaca nutrient requirements and metabolism as they directly impact potential for nutritional disease.


*Keywords:* Llama; Alpaca; Nutritional disease; Rickets; Hepatic lipidosis

## 1. Introduction

Nutrition can play a number of roles in mediating potential for a disease state. Nearly all nutrients are primary regulatory factors in controlling the immune system (Cunningham-Rundles, 2002, pp. 21–39). Thus, one or more nutrient deficiencies or toxicities can result in altered immune response and greater susceptibility to disease, primarily infectious. Altered nutritional status can adversely influence metabolic function resulting in a variety of metabolic diseases depending upon the nature of the aberrant nutrient or nutrients. Metabolic diseases can also negatively influence immune function and increase infectious disease susceptibility (Wentink et al., 1998; Lacetera et al., 2001). Consumption of deficient or toxic amounts of any essential nutrient can directly result in disease state characterized by

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nutrient-specific pathologic lesions. Clinical vitamin and mineral deficiency and toxicity diseases have been described (NRC, 1980, 1987; Underwood and Suttle, 1999; McDowell, 2000). Subclinical nutritional disease is present when nutrient intake is either above or below requirements, but not insufficient or excessive enough to induce classic signs of nutrient-specific deficiency or toxicity disease, respectively. Subclinical nutritional disease is associated with immune dysfunction, reduced reproductive capacity and productive inefficiency.

Although llamas and alpacas are considered to be susceptible to all nutrient deficiency and toxicity diseases described, very few published studies are available. Nutrient related deficiency and toxicity diseases are well recognized and appropriately treated, resulting in an under reporting of these conditions. Based on published reports, nutritional diseases of concern outside of South America include hepatic lipidosis, rickets, obesity, urolithiasis and copper toxicity. This paper will review nutritional diseases in llamas and alpacas, focusing primarily on those diseases to which literature reports have documented. The term camelids will be used in this paper to generically refer to llamas and alpacas and not inclusive of other members of the camelid family.

## 2. Nutrient deficiency diseases

### 2.1. Protein-energy malnutrition

Starvation is defined as a prolonged complete deprivation of feed intake. True starvation cases are the exception rather than the rule, but is most likely under reported. More typically encountered is a situation of protein-energy malnutrition (PEM) where energy, protein or both are deficient in the diet over a period of time. Body weight loss and a decline in body condition score are the most common clinical signs (Oetzel, 1988; Carmalt, 2000). Growing animals will also show a slowing or near complete cessation in gain. Pregnant and lactating females experiencing PEM may be prone to hepatic lipidosis (Tornquist et al., 1999). Due to higher requirements, young growing animals, late pregnant females and lactating females are the first to show signs (Oetzel, 1988). Time frame and severity of body weight and condition loss will be dependent upon the degree of dietary energy and protein deficiency.

Beyond physiologic state and its impact on increasing requirements, environmental conditions, especially extreme cold, will increase energy needs. Camelids raised in northern regions of North America are exposed to environmental temperatures much lower than their native habitat. In these cold conditions, camelids will expend additional energy to maintain body temperature. Data for other species suggest maintenance energy is increased 1% for every 1 °C below an animal's lower critical temperature (NRC, 1981). Based on data from sheep and assuming a full fleece, lower critical temperature for llamas and alpacas would be approximately 0–10 °C (NRC, 1981). If animals are wet, mud covered or exposed to wind chill, then maintenance energy may be increased as much as 75%. Clearly, PEM is a potential risk for llamas and alpacas raised in extreme northern climates (Carmalt, 2000).

Routine body condition scoring or body weight estimates can be used to diagnose potential problems. A thick fleece can readily hide body weight and condition changes from view, thus requiring a hands-on condition score or body weight measure. A body condition scoring system for llamas and alpacas ranking from 1 (emaciated) to 10 (obese) has been described (Johnson, 1994; Hilton et al., 1998). Once unexplained body weight or condition score loss has been identified, one needs to determine a cause. Chronic infectious, parasitic and dental diseases can induce body weight and condition losses similar to PEM (Oetzel, 1988; Carmalt, 2000). However, most animals afflicted with an infectious or parasitic disease have reduced appetites, in spite of their energy deficit. In contrast, PEM animals maintain a healthy appetite until near terminal stages. Protein-energy malnutrition is often a secondary sequella to chronic disease conditions. Animals identified early in the disease process can be recovered with appropriate feeding therapy and supportive care; however, those becoming weak and recumbent have a very poor prognosis even with aggressive therapy (Oetzel, 1988).

The most common reason for PEM is poor quality forages coupled with the animal's inability to consume sufficient amounts or increased requirement (Oetzel, 1988; Carmalt, 2000). In South America, growth and quality of forage is determined by seasonally intermittent precipitation pattern. During the wet season plant