Update on Camelid Nutrition

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The most recent National Research Council (NRC) report on nutritional requirements of small ruminants was published in 2007. For the first time nutritional requirement recommendations for llamas and alpacas were included. Much of the information presented to validate llama and alpaca requirements were based on a single paper that modeled requirements for various physiologic states based on extrapolations from sheep and goat models (Van Saun, 2006). Due to the lack of published feeding trials, no models were suggested for predicting mineral requirements of llamas and alpacas. As with any NRC publication, newly published information becomes available providing opportunities to improve upon the initial recommendations. This presentation will summarize more recent publications addressing nutrient requirements and other pertinent information in addressing nutritional management of llamas and alpacas.

Feed Intake Quandary

Feed intake is the cornerstone of nutrition and ensuring adequate nutrient intake in support of various physiologic states. Characterizing feed intake in llamas and alpacas has been a challenge. Early information suggested that maintenance feed intake was lower compared with other species based on observations documenting a longer retention time for forage particles in compartment-1 (C-1). The prolonged retention time provides for greater fiber digestibility by the fermentative microflora in C-1. This is an adaptive mechanism facilitating animal survival in the more hostile environment with only sparse, low quality forage available.

The NRC (2007) shows expected dry matter intake (DMI) for llamas and alpacas to range from 1.0 to 1.5% of body weight (BW). Summarized data from South America suggested higher intakes rates of 2.0% and 1.8% of BW for alpacas and llamas, respectively (San Martin and Bryant, 1989). Data from Chile suggested slightly lower DMI expectations for llamas (1.5% BW) and alpacas (1.7% BW) (Lopez and Raggi, 1992). If models to predict amounts of nutrients required are correct, then these differences in expected DMI will result in variable expectations for dietary nutrient density in providing these nutrients. This may explain differences in dietary energy and protein concentrations between North American and South American feeding guidelines.

To better address these differences studies directly measuring daily DMI in llamas and alpacas are needed. Unfortunately, estimating DMI for animals managed on pasture is extremely difficult. Eight published studies were identified that had sufficient individual intake data and adequately characterized feed composition to evaluate expected DMI and dietary factors that might control intake (Carmean et al., 1992; Lopez et al., 1998; Sponheimer et al., 2003; Robinson et al., 2005, 2006; Davies et al., 2007ab; Liu et al., 2009). Across these studies with 25 different forage comparisons, averaged DMI was 1.5 ± 0.4% BW for both llamas and alpacas.

Intake potential in llamas and alpacas was suggested to be related to dietary crude protein content with depressed intake resulting from low protein diets. In ruminant animals, microbial fermentation of fiber is the rate limiting step of intake and dietary NDF content is highly associated with feed intake regulation. From these seven studies, relationships between intake and dietary NDF and crude protein content were investigated. Unfortunately, no clear predictive relationships among DMI and protein or NDF intake were identified. In ruminants, NDF intake is maximized at approximately 1.2% BW. In these data, NDF intake as a percent of BW was lower (0.87 ± 0.26% BW) compared with other ruminant animals. This observation would be consistent with fiber retention within C-1 and greater degree of NDF digestibility. Using these data we might set desired NDF intake to range between 0.9 and 1.0 % BW as a guideline for predicting DMI potential or identifying amount of needed dietary fiber.

Energy Requirements for Lactation

Two studies have described maintenance energy requirements for llamas (Schneider et al., 1974; Carmean et al., 1992), though these studies had somewhat divergent determinations. However, both studies had similar determinations of fasting energy requirement. Other studies have estimated maintenance energy requirement for alpacas with similarity to the averaged value (72.85 Mcal/$BW_{kg}^{0.75}$) defined by NRC (2007). Other South American data are consistent with this energy requirement for alpacas (Flores et al., 1989). Two studies from New Zealand either suggested an energy requirement similar to NRC (Newman and Paterson, 1994) or a much higher energy requirement (Russel and Redden, 1997). Neither of these studies was designed to estimate maintenance energy requirements.

New studies have better characterized milk production in llamas over a lactation and changes in milk composition through the lactation (Pacheco and Soza, 2004; Vargas et al., 2004; Riek and Gerken, 2005). Milk composition was not found to differ in alpacas (Parraquez et al., 2003). Based on these new numbers it is recommended to increase energy requirements for milk production from 946 kcal ME/kg milk to 1296 kcal ME/kg milk. Using the data from Riek and Gerken (2005), lactation curves were modeled to help better predict milk output and total energy requirements in support of lactation.

New Perspectives on Protein Nutrition

There is only a single study that determined maintenance crude protein requirement (3.5 g CP/$BW_{kg}^{0.75}$) of llamas. Some recent studies from the BYU group have used individual feeding trials to assess protein requirements (Sponheimer et al., 2003; Robinson et al., 2005, 2006; Davies et al., 2007ab). A more recent study has also provided some data for evaluating protein requirement in alpacas (Liu et al., 2009). Although one study (Davies et al., 2007a) suggested a much higher (5.2 g CP/ $BW_{kg}^{0.75}$) for llamas, regression analysis of retained nitrogen onto intake nitrogen per unit of metabolic BW is consistent with the previous protein requirement value. There was a suggestion that protein requirements may differ between high and low altitude, but there is not sufficient data to support this hypothesis.

There are large differences in recommended dietary protein content necessary to support llamas and alpacas in differing physiologic states. The recommendations in the NRC (2007) report suggest 9% crude protein in dietary dry matter for maintenance. This is in contrast to recommendations in South America that range from 6.5 to 8.8% CP in maintenance diets. Both systems are using the same requirement model, but the difference comes from the differing feed intake expectations.

A protein feeding study was undertaken in Australia, but insufficient information was provided to use this study to assess protein requirement. Of interest in this particular study are the objectives of determining the amount of undegradable protein (UDP) in the diet relative to fiber production and reproductive performance (Blache et al., 2011). Supplementation of UDP numerically increased fiber yield, but diameter was greater in supplemented groups compared with the unsupplemented group. There also was not documented improvement in fiber quality with specific supplementation of the amino acid methionine. Similarly, no beneficial effects of UDP supplementation were found on improvement of male fertility and reproductive development. Clearly more research needs to be undertaken to better clarify dietary protein fractions in llamas and alpacas.

Mineral Requirement Modeling

The primary missing piece of describing nutrient requirements for camelids is the lack of published feeding studies defining requirements for minerals and vitamins. Initially models extrapolated from mineral requirements for beef cattle, sheep and goats in converting a requirement to an amount per unit body weight and adjusting for differences in intake (Van Saun, 2006). These models seemingly depicted current feeding practices, but had not been truly validated through controlled feeding trials. As a result the NRC (2007) did not use any suggested model and instead suggested using the models predicting mineral requirements for sheep. Unfortunately, the models generated by the NRC committee for sheep mineral requirements are based on a factorial approach rather than a dietary concentration. To use these models directly, one would have to assume the bioavailability of mineral sources was similar across species and the utilization of mineral in support of various bodily functions was similar in need and utilization efficiency.

Comparisons were made between the new NRC (2007) requirement models for sheep and goats in generating an appropriate model for llamas and alpacas. A summary of the adjusted recommendations for the microminerals are provided in Table 1. These suggested requirements are within typical feeding practices of llamas and alpacas in North America. These should be considered lower end of requirements and under certain circumstances may be adjusted upward to ensure the desired animal response. Inhibitory mineral interactions are not accounted for in these recommendations, so again dietary mineral content will need to be adjusted accordingly.

Table 1. Suggested dietary concentrations for the essential microminerals in llamas and alpacas for various physiologic states.

Nutrient	**Averaged Requirement**[1]	**Extrapolated Requirement**		
		Intake, mg/day[2]	**Diet, ppm**[3]	**Group**[4]
Cobalt	1.76 µg/kg BW	0.11–0.28	0.12–0.15	M, G, P, L
Copper	0.12 mg/kg BW	7.2–19.2	8–12	M, G
	0.15–0.18 mg/kg BW	9–27.2	9–12	P, L
Iodine	8.8 µg/kg BW	0.5–1.4	0.55–0.65	M, G, P
	15.7 µg/kg BW	0.9–2.5	0.65–0.75	L
Iron	0.6 mg/kg BW	36–96	35–40	M, G, P, L
Manganese	0.33 mg/kg	19.8–52.8	22–25	M, G, L
	0.52 mg/kg	31.2–83.2	28–30	P
Selenium	6.5–6.8 µg/kg BW	0.4–1.07	0.42–0.45	M, G
	7–7.5 µg/kg BW	0.44–1.2	0.46–0.5	P, L
Zinc	0.56 mg/kg BW	33.6–89.6	45	M, G
	0.8–1.3 mg/kg BW	60–160	55–60	P, L

[1]Extrapolated from nutrient requirements for beef cattle (National Research Council: *Nutrient requirements of beef cattle*, ed 7, Washington, DC, 1996, National Academy Press), sheep and goats (National Research Council: *Nutrient requirements of small ruminants: sheep, goats, cervids and New World camelids,* Washington, DC, 2007, National Academic Press).

[2]Estimated daily requirement based on a range of adult body weights from 60 to 160 kg.
[3]Dietary concentration (mg/kg) on dry matter (DM) basis. Nutrient density calculations based on an assumed range of DM intake between 1.25 and 1.5% of body weight.
[4]Physiologic states of maintenance (M), growth (G), lactation (L), and pregnancy (P) for which the requirement is defined.

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