

NUTRITION AND METABOLIC DISEASE: CAMELID



BASICS

OVERVIEW

- Camelids have a stomach divided into three compartments and are therefore referred to as modified or pseudo-ruminants. These compartments are referred to as the first (C1), second (C2) and third compartment (C3). C1 and C2 and the proximal portion of C3 have fermentation activity associated with microbial digestion of feed. Distal C3 secretes proteolytic enzymes and hydrochloric acid.
- Camelids do not have a gall bladder; bile flows on a continuous basis.
- Camelids can more readily utilize poor quality feed stuffs than true ruminants due to slower nutrient transit time, allowing for more complete microbial digestion and absorption.
- Camelids are 10-25% more efficient in the digestion of feed stuffs than sheep and goats.
- Camelids maintain a low dry matter intake of 1.8-2.0% (alpacas-llamas) of body weight. This is an adaptation to their high altitude South American native environment which allows them to survive on poor quality, low availability forage when coupled with their increased digestive capacity.
- Camelids graze and browse.
- Nutrient requirements for camelids are: CP (crude protein) 8-14%; NDF (neutral detergent fiber, a measure of total fiber) > 30%; and TDN (total digestible nutrients, a measure of energy content) of 50- 70%. Lower values are for maintenance; higher values support early growth or lactation.
- Dietary calcium levels should be 0.6-0.8% with phosphorous at 0.3-0.5%.
- Lactating and growing animals are usually fed to increase dietary protein to 12-14%. This can be met by good quality grass hay in most instances. If necessary grains can be used to increase levels.
- Alterations of the diet should be made for increased energy requirements as determined by body condition scoring.
- Diets severely restricted in energy and protein can lead to metabolic disorders including ketosis, hepatic lipidosis, and in pregnant females, birth of underweight crias, poor lactation, and poor quality colostrum.
- Mineral needs can be met with commercially available camelid supplements.
- Frequent body condition scoring is very important for maintaining proper nutritional health of camelids.

INCIDENCE/PREVALENCE

- Metabolic disease related to negative energy balance is a common sequel to any disorder that significantly reduces feed intake in adults and in crias

GEOGRAPHIC DISTRIBUTION

- New world camelids are native to the Andes in South America (Peru, Bolivia, Chile, and Argentina). These are high altitude and low humidity climates with little annual variation in temperature and photoperiod.
- Camelids are also now found in North America, Europe, Asia, Australia, and New Zealand at lower altitudes with large temperature and photoperiod extremes.

SYSTEMS AFFECTED

- Digestive.

PATHOPHYSIOLOGY

• Foregut

- Foregut motility ensures constant exposure of food to microbes and subsequent degradation.
- Eructation (burping of gases) may occur 3-4 times during each motility cycle
- Camelids have greater forestomach activity compared to the single, bi- or triphasic contraction per minute of true ruminants.
- C1 contractions average 4-6 per minute in the normal animal. They can increase in animals after eating.
- C1 and C2 are the compartments considered comparable to the rumen and contain ~ 90% of the total gastric volume. C1 is located on the left side of the abdomen and can be ausculted through the left cranial abdomen and left paralumbar fossa.
- C2 is located medial to C1 and dorsal to C3.
- C1 and C2 are lined with both stratified squamous epithelial cells and glandular mucous secretion cells.
- Glandular sacculi occur in C1 and glandular cells occur in C2 to increase fermentative capacity.
- The glandular cells may secrete bicarbonate to buffer the fluids.
- Cells of C1 and C2 absorb volatile fatty acids (VFA's) and digest nutrients by both salivary breakdown and microbial fermentation.
- Camelids are resistant to foregut gas accumulation and bloat
- C3 represents approximately 10% of the gastric volume.
- The distal 20% of C3 is glandular and acts comparably to the abomasum of ruminants; the proximal 80% is non-glandular and is involved in bacterial fermentation and digestion similarly to C1 and C2.

• Hindgut

- There is little information detailing the role of hindgut function in camelids.
- Absorptive processes appear identical to ruminant and non-ruminant animals.
- The hindgut has some fermentation capacity, but to a much lesser extent compared to the foregut.
- Primary purpose is water absorption along with some absorption of VFA's, vitamins and minerals.
- Camelids have a spiral colon which occasionally can become impacted and obstruct

• Selenium deficiency

- Camelids have a number of unexplained ill thrift, infertility, neuropathy, recumbency, and immunodeficiency syndromes similar to antioxidant deficiency disorders in other species.
- Some may be related to Vitamin E or selenium (Se) deficiency, but no published reports of either exist for llamas or alpacas.

- Injectable selenium products last in the body for less than 24-36 hours.
- The National Research Council guidelines suggest a daily Se requirement of 0.74 mg/day for alpacas and llamas
- Se is added to most commercial camelid salt mixes at up to 90 ppm. Many animals never receive this supplementation and do not show deficiency symptoms, regardless of their geographic location.
- **Zinc deficiency**
 - Zinc is better absorbed from legumes than grasses or grains.
 - Zinc absorption is inhibited by dietary calcium, iron, cadmium, oxalates, and organophosphates.
 - Vitamin C, lactose and citrate enhance the absorption of zinc.
 - Zinc deficiency symptoms may include: skin crusting and scaling, poor quality fiber, decreased food intake, foot abnormalities, and poor immune system function.
 - Skin lesions are reported to be the most common sequella to zinc deficiency, including alopecia, papules, plaques, thickening and scaling of the ventral abdomen, escutcheon, bridge of nose, inguinal region, inner thighs, and inner forearms. Parakeratosis is observed on biopsy, with inflammatory highlights; usually in animals older than 1-2 years of age.
 - These are the same lesions seen in chorioptic mange in camelids in North America and the mites are not easily found on skin scrapes. Most often animals treated for mange recover without zinc supplementation.
 - Diagnosis can be achieved via skin biopsies, measurement of plasma zinc concentration, tissue lesion scraping, lesion impression smears, and fungal and bacterial cultures to rule out differential diagnoses.
 - Treatment: 2-4 gm of zinc methionine orally daily. It is important to inform the owner that it may take 2-4 months for response. Decreasing the calcium level in the diet if it is high can help improve zinc absorption.
- **Rickets (hypophosphatemic rickets)**
 - Caused by a deficiency of Vitamin D leading to poor calcium absorption and weak bones
 - Often seen in the US Pacific Northwest, but can occur nationwide
 - Occurs in fall and winter born cria due to relative lack of sunshine during high bone growth period at 3 to 7 months of age
 - Manifestations of rickets:
 - "Quiet cria", poor growth, often recumbent
 - Lameness and pain on palpation of growth plate areas
 - Crooked front and/or rear leg(s)
 - Poor body condition due to reduced ability to compete for food
- **Laboratory testing:**
 - Low blood phosphorus concentration corresponds with low Vitamin D concentration and is a less expensive test
- **Treatment:**
 - Vitamin D3 injections at 1000 IU/lb body weight subcutaneously.
 - Recheck serum phosphorus in 1 to 2 weeks to determine need for additional medication
 - Camelids are very resistant to vitamin D toxicity however it has been reported in crias receiving parenteral overdoses
 - Remove crias from large groups to allow easy access to feed

- Prognosis
 - “Slow” crias show improvement within one week
 - Takes longer or additional injections if the condition is chronic
 - Monitor improvements in attitude and appetite
- Rickets prevention plan:
 - All fall and winter crias in the northern US should receive a vitamin injection at birth (usually vitamins A, D and E combined).
 - Repeat in October, December, and February at 1000 IU/lb of body weight SQ of Vitamin D3.

PREVENTION OF NUTRITIONAL DISORDERS

Body Condition Score (BCS)

- Use to assess individual animal and herd nutritional status
- Perform on a frequent basis - every time an animal is handled – make appropriate changes in roughage and grain supplements if necessary
- Scores can be recorded on a 1 – 5 scale; with 1 being very thin and 5 being obese.
- This allows the owner to determine if the animal may be gaining or losing weight.
- It is especially important to monitor BCS in the winter, during pregnancy, and during a growth phase
- The number one management error owners make is not checking BCS - this can result in animal deaths!
- Malnutrition occurs most often from overcrowding
- Camelids do not like to be touched and have long fiber for the coldest portions of the year, potentially allowing for disastrous situations in cold weather months if owners do not pay attention to BCS.
- Camelids can also suffer from malnutrition in warmer months if they do not have access to good enough quality roughage.
- It should be noted that animals often have differing capacities to process the same food supply, and separate feeding groups may have to be created especially for thin, young, or old animals in the cold weather months.
- BCS is determined by palpation of the dorsal lumbar region just rostral to the pelvis (See Figures 1 and 2 below).
 - BCS 1 is compatible with a very thin animal. It represents malnutrition and should be corrected promptly. These animals should be fed free choice water, mineral mix, good quality grass hay, and grain separately. They can be covered with sleeping bags or pony coats in winter to minimize caloric loss. They can also be kept in warm areas overnight. The cause of the situation should be investigated and may include abnormal dentition, poor feed quality or limited access to feed, overcrowding, parasitism, chronic disease, cancer, and others.
 - BCS 2 is assigned if there is a straight line from the dorsal spinous processes to the lateral vertebral processes in the dorsal lumbar region (see Figure 2). This score represents a thin animal.
 - BCS 3 is considered ideal and is represented by a slight upward curvature to this region.
 - BCS 4 and 5 are represented by greater curvature, and the dorsal spine is not as easy to palpate. BCS 5 is seen as a flat contour on top of the lumbar region and represents obesity.

- It is common to have most animals in a herd at a BCS of 3 with a low percentage at 2 and 4. BCS 1 and 5 are even less common and require investigation and correction.

Location for Checking BCS

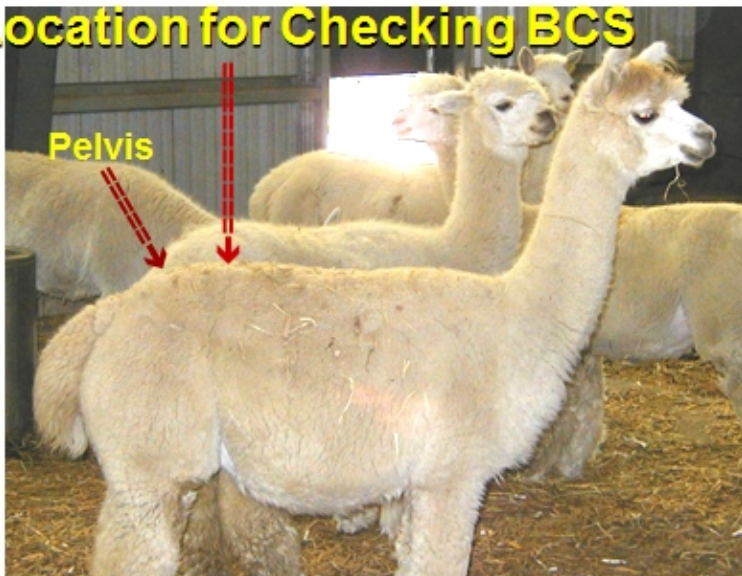


Figure 1: Location for assessing body condition score (BCS) in camelids

Body Condition Score

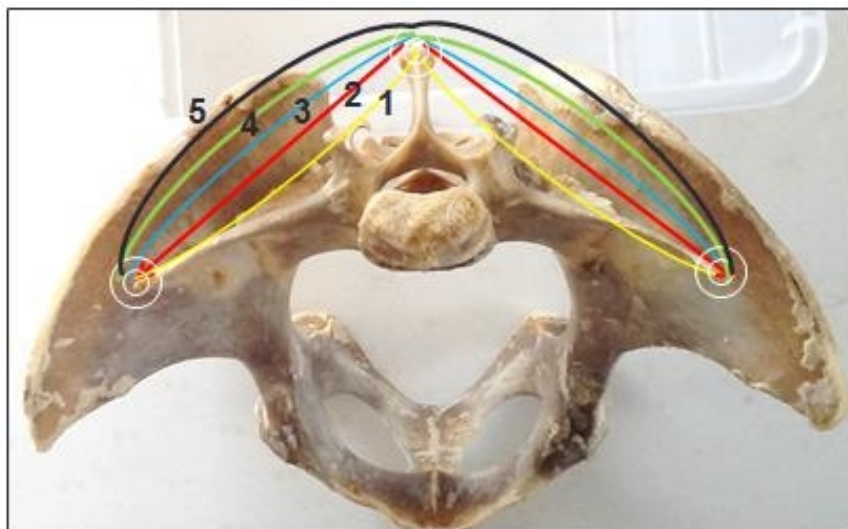


Figure 2: Establishing body condition score (BCS) in camelids by assessing the curve of the musculature in the region of the lumbar vertebral processes

- Supplementing dietary energy or protein does not have to occur slowly. Up to 20% of the total dry matter content can be corn or other grain supplements.
- Camelids are not as susceptible to grain overload as ruminants and can be allowed access to free choice grain supplementation.

Vitamin and Mineral Supplementation

- No controlled studies exist to date for camelids!
- Mineral needs can be met with a multitude of commercially available camelid supplements. These should be fed free choice in loose form in containers available to all animals.
- Vitamin A
 - Sufficient levels are provided by the animal's own conversion of carotene from hay and pasture
- Vitamin E
 - Functions as a cofactor with the cellular antioxidant selenium
 - Plant sources deteriorate over time in hay
 - Should be supplemented free choice in a mineral mix
- B Vitamins:
 - Manufactured in the camelid digestive tract
 - Do not need to be supplemented except for times of prolonged illness and anorexia, or in Amprolium toxicity (thiamine)
- Selenium
 - Camelid mineral supplements generally contain ≤ 90 ppm Se.
- Copper
 - Supplementation is required to support growth of high quality fiber, production of the red blood cell oxygen-carrying pigment hemoglobin, and enzyme systems for proper cardiac function.
 - Deficiencies could result in diarrhea, poor growth rate, anemia, poor quality fiber, weight loss, and skeletal abnormalities
 - Suspected cases of copper toxicity (including fatalities) have occurred in camelids fed horse feeds and high copper mineral mix with a high copper water supply; or with feeding good quality grain with hay that was found to be high in copper
- Zinc
 - Must be supplemented
 - Zinc deficiency may occur in camelids fed high amounts of calcium, such as with free choice alfalfa hay.
 - Uncommon but deficiency may present as hyperkeratotic dermatitis, decreased food intake, poor growth rate, joint problems, reproductive failure, or poor milk production.
 - Zinc complexed with the amino acid methionine is the form best utilized by camelids
- Calcium, Phosphorus, and Vitamin D
 - Essential for appropriate skeletal growth and maintenance
 - Supplementation is required in the proper quantities and ratio of calcium to phosphorus (1.5–2.0: 1) for the roughage being fed
 - Vitamin D is normally formed in the body by the action of sunlight on the skin activating the precursor in the blood stream
 - Deficiency issues can cause rickets in young, growing camelids.
- Sodium and Chloride
 - Provide in the mineral mix

Simplified Feeding Program for Camelids

- Free choice, balanced mineral mix
- Maintenance for adults - pasture/grass hay as verified by appropriate BCS
- Nursing and pregnant females and growing animals up to 18 months of age = free choice pasture/hay and supplemental grain as needed
- First cutting hay
 - Generally lower in protein and calories than good second cutting hay
 - Use for overweight animals
- Second cutting hay
 - Feed to reproducing females and young stock
- Grain can be provided if supplementation is needed
 - Cracked or flaked corn, soybean meal, crimped oats
 - Pellets
- Clean, fresh water
 - Heated in the winter when water consumption is often higher due to consuming "dry" hays in low humidity conditions
- Hay can be easily and inexpensively tested for protein and digestibility (a measure of caloric content)

Feeding crias

- Crias will lose approximately 1 pound during the first two days of life, and then start to gain thereafter.
- Crias average ½ to 1 pound (alpacas–llamas) of gain per day.
- Expect birth weight to double by 30 days of age.
- Minimize contact with the cria as much as possible. Imprinting is a common sequella to excessive handling and can lead to ‘berserk male syndrome’ in males, although this is uncommon even in bottle fed crias.
- Crias consume at least 10% of their body weight per day in 6-10 feedings; sheep milk is the best choice (diluted by 25%). If sheep milk is not available goat milk can be utilized.
- Whole vitamin D supplemented milk has also been used to successfully raise crias.
- Lamb milk replacer is the best milk replacer for camelids. The milk replacer should generally be diluted by 25% from label directions.
- Crias consume solid food as early as one week of age. Allow them free access along with their dams. They must be on a solid food diet by three months of age in order to continue growing.



MISCELLANEOUS

ASSOCIATED CONDITIONS

- **Heat Stress:**
 - Very important concern in hot, humid climates; obese animals are predisposed
 - Can result in sterility and death
 - Avoid obesity
 - Shearing fiber and providing fans will reduce impact of obesity

- Avoid over-consumption of protein during hotter periods.
- Poor quality roughage gives off more heat during digestion in camelids, so during high risk periods, increase food quality.
- Panting increases energy requirements
- During heat stress there is a slowed gut movement of ingesta which can predispose to colic.

- **Hepatic Lipidosis**

- Arises when caloric demands exceed dietary supply for a period of time
- Occurs in thin animals, possibly pregnant, which are underfed or do not have enough access to feed, especially in cold climates.
- Common also in diseased camelids as a complication related to increased catabolism and reduced appetite
- Liver function is altered as caloric needs are met through mobilization of peripheral fat which overwhelms hepatic processing pathways resulting in excessive fat deposition in the liver, and subsequent dysfunction
- Clinical signs include poor appetite, weight loss, and weakness
- Untreated lipidosis results in death due to metabolic failure

AGE-RELATED FACTORS

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- Crias average ½ to 1 pound (alpacas–llamas) of gain per day.
- Expect birth weight to double by 30 days of age.

ZOONOTIC POTENTIAL

- N/A

PREGNANCY

- During the last trimester of pregnancy, camelids should be body condition scored weekly and may require grain at up to 1-2 pounds per head per day. Adjust feed according to BCS.
- Llamas generally gain 45-60 pounds during pregnancy; alpacas gain 20-30 pounds.
- Nutritional requirements may increase by 50% over maintenance during lactation.
- Diets severely restricted in energy and protein can lead to ketosis, hepatic lipidosis, birth of underweight crias, poor lactation, and poor quality colostrum.

BIOSECURITY

- N/A

PRODUCTION MANAGEMENT

- Avoid overcrowding and check BCS frequently.
- Loose minerals should be supplied for free choice consumption by camelids. Several commercial mixtures are available.
- Heat stress is a very important camelid condition in hot humid climates; obesity can be a contributing factor.

SYNONYMS

- Hepatic lipidosis = fatty liver
- Hypovitaminosis D = rickets

SEE ALSO

- Body Condition Scoring

ABBREVIATIONS

- BCS= body condition score
- CP= crude protein
- C1= gastric compartment 1
- C2 = gastric compartment 2
- C3 = gastric compartment 3
- NDF = neutral detergent fiber
- TDN= total digestible nutrients
- VFA= volatile fatty acid

SUGGESTED READING

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