



FEEDING CAMELIDS



*International Lama Registry
Educational Brochure #6*

While the following is particularly directed at the llama, most is applicable to the alpaca and other members of the genus *Lama*. In their native environs, the alpaca shows a grazing preference toward moist lush forages, while llamas will tend to prefer more coarse dry vegetation, being more of “cafeteria style” eaters.

Llamas are much easier to feed and care for than most livestock. Because they are grazers of both grass and forbs and browsers of shrubs and trees, they are much more flexible in their choice of diet. Llamas, like other South American camelids (SAC), are more efficient at converting plant material into usable protein and energy than sheep and cattle, and are less prone to medical problems associated with feeding, such as bloat and grain overload (acidosis).

As a practicing/teaching veterinarian, the author’s nutritional recommendations are aimed at the overall long-term health of llamas. Because they are more efficient at converting plant material to usable energy, llamas may easily become over-conditioned through excessive feeding. Llamas in their natural environment do not routinely carry the abundance of fat that many North American llamas are currently doing, a situation which should be avoided. Over-fed llamas are often difficult to breed, having more problems in conception, delivery and lactation. In addition, their total life span is likely compromised.

BASIC SAC DIGESTIVE ANATOMY AND PHYSIOLOGY

All living creatures ingest their food, digest it by various means, absorb the majority and excrete the balance. The llama is a modified ruminant herbivore that ingests plant material and digests it in a unique, three-compartment stomach. The llama’s stomach is functionally similar but anatomically different from that of true ruminants (cattle, sheep and goats). The first compartment is essentially a huge fermentation vat which, through enzymatic and microbial processes, enables separation of plant material into readily digestible basic nutrients and semi-digestible cellulose.

The basic nutrients (proteins, fats and carbohydrates) are either absorbed directly or further broken down into simple sugars, amino acids or fatty acids. Cellulose is utilized by bacteria and protozoa in the fermentation vat to replicate their vast numbers. The resultant microbial protein is then digested.

Beyond the stomach, llamas are not notably unique in their digestive anatomy and physiology, however the relatively slow gastrointestinal transit time, efficient water absorption and pelleted feces all contribute to digestive superiority.

GENERAL LLAMA NUTRITION

All feedstuffs yield variable amounts of carbohydrates (energy), proteins, fats, minerals and vitamins. The llama’s requirement for these is influenced by age, demands for resting body maintenance, anticipated growth, activity, workload, state of pregnancy, lactation and environmental temperature. Providing optimum energy and protein is the basis for any llama feeding program. Like most herbivores, llamas are limited to an absolute maximum daily dry matter intake. For the llama, this figure appears to be 1.8-2.0% of body weight.

Energy Forage (pasture and hay or browse) should be a major contributor of energy to the diet. For certain circumstances, cereal grains (corn, oats, barley, etc) may be used as supplemental high-energy sources.

Energy requirements vary according to body size. In general, feeding efficiency for body maintenance increases with animal size. Metabolism studies at Colorado State University have determined that the maintenance energy requirement for llamas is 84.5 Kcal/BW^{0.75} (kg). Energy content of common feedstuffs have been or can be readily determined by analysis. Table 1 lists caloric energy values of some common forages. Using examples of animals weighing 110 lb (55 kg), 220 lb (100 kg) and 330 lb (150 kg) one can appreciate that efficiency of body energy maintenance increases with body size. Of particular note is the fact that springtime pastures are extremely high in energy content. Unless animals are growing, in late gestation, early lactation, extremely athletic, or exposed to prolonged cold temperatures, they should not be allowed free choice access to quality forages, or be supplemented with concentrates.

Protein The llama’s protein requirement is relatively low. Protein in adequate quantity and quality is necessary to replace aging body proteins and produce new protein for muscle, fiber and milk. Because llamas have an exceptional ability to recycle and utilize urea (the major by-product of normal protein breakdown in the body), they can do extremely well on a maintenance diet of 8 to 10% crude protein. Growing weanlings, advanced pregnant and nursing mothers require a 10 to 12% protein ration. A baby who must be weaned early for some reason will benefit from a 16% protein ration, gradually reduced to 12% by six months of age to maturity.

Table 2 lists several commonly used feedstuffs and their important macro-nutrient contents on a dry matter basis. Notice the wide variation of protein content. In most cases, quality grass hays will suffice to provide adequate protein intake. When protein supplementation is deemed

necessary, incorporation of alfalfa hay (up to 1/3 of the forage ration) will be adequate. The advantage of staying with an all-forage diet lies principally in that crude fiber in the total diet will not be markedly reduced. It is important not to exceed 1/3 of the total diet in alfalfa so as to not be feeding excessive protein as well as to prevent excessive intake of calcium relative to phosphorus.

Bear in mind that protein content of pasture and browse vary with the season. In spring, when plants are actively growing, protein content and quality is greater than at maturity. Again, be cautious about overfeeding protein as it is wasteful for the owner and a metabolic burden to the animal. While no feeding trials have to date been performed, it is the author's opinion that using nonprotein nitrogen sources (urea or biuret) should not be considered.

Fiber As with conventional ruminants, the SAC have an important need for adequate fiber in their diet. At this point, it would appear that the total diet should be approximately 25% or more of crude fiber. Based on observations from conventional ruminant species, lack of adequate fiber reduces gastric performance and seems to have a correlation with gastric or duodenal ulcers. Forages in general are the principle source of fiber, with grains generally being deficient for providing the level deemed important in llamas.

Water Ideally, fresh and clean water should be made available free choice at all times, however llamas are relatively tolerant to a degree of water deprivation. On the trail, one good drink a day will suffice. Depending on activity, environmental temperature and feed (i.e. green pasture vs dry hay), daily intake varies from 5 to 8% of body weight (i.e. 2 to 3 gallons for a 300 lb llama). Llamas may be reluctant to drink from unclean containers, including automatic watering cups.

Salt In most all management circumstances, loose salt should be offered free choice in a container sheltered from weather. Salt should be iodized except in areas where iodine deficiency is not known to occur. Trace mineralized salt is better than plain salt but should not to be considered as a mineral supplement. Combining salt with minerals (Table 3) has worked well to both encourage consumption as well as minimize over-consumption.

Calcium and Phosphorus A balanced daily intake of calcium and phosphorus is important, particularly to maximize growth of youngsters and for adult reproductive performance. The desired dietary balance of calcium:phosphorus normally is 1.2-2.0:1, which is commonly found in many grass hays/pastures. Because need for mineral supplements varies with forage diet,

forage analysis is ideal on which to base any specific mineral incorporation. A relatively simple, inexpensive mineral mix that meets the needs of most llamas on grass pasture is found in Table 3. This mix is meant to be offered free choice, with no other supplements (mineral or salt) being available. While consumption of mineral mixes may initially be limited, most llamas will generally consume up to 1 oz/animal/day. Modifications of the basic mineral mix are outlined in Table 4.

Grass hay, cereal grain hays and cereal grains provide significant amounts of phosphorus unless they originate from phosphorus-deficient soils.

Some notes of caution. Abnormal bone growth can result from deficiencies of calcium, phosphorus and vitamin D as well as imbalances of calcium to phosphorus. Excessive phosphorus intake may predispose animals, especially males, to urinary tract stones.

Vitamins Properly cured hay normally contains sufficient vitamins A, D and K but supplemental vitamin-mineral mixes can be offered to cover potential deficiencies. Research indicates that vitamin E is quickly lost in cured forages, making it necessary to supplement. It is believed that normal healthy llamas synthesize adequate B vitamins during digestion.

Trace Minerals Whether deficient or excessive, selenium, zinc, magnesium, cobalt and copper are significant diet factors. It is imperative that you consult a local nutritionist, county agent or veterinarian to learn if specific supplementation or reduction of these nutrients is required in your area. For example, too much selenium in the diet can cause alkali disease and "blind staggers," while too little can cause white muscle disease or interference with growth, reproduction and lactation.

FEEDING RECOMMENDATIONS

There are unlimited feeding options and combinations. Cost, local availability, and nutrient balance must all be considered in designing your own program. Forage analysis is the backbone of your feeding program.

Although llamas appear to be quite adaptable to a wide range of feeding schedules, including free choice and once-a-day feedings, regularity is important. The following are some thoughts on the major options and considerations.

Hay Because of its high protein content and relative availability, alfalfa hay is a popular food consideration for llamas. Keep in mind, however, that it is not the panacea forage for all llamas. Cost may be excessive, and protein

content certainly is, especially if it is overfed. For example, if the analysis of your alfalfa hay indicates a 16% protein content but your llamas eat only the leaves because you are feeding too generously, in all likelihood their protein intake actually exceeds 24%. Reduce the portion so they will eat the less protein-rich stem as well. Better yet, consider feeding alfalfa as a supplement rather than the total forage intake. Quality oat hay, pea hay, fescue, brome, timothy, orchard grass, clover hay and even some straw are viable options. When buying hay, look for the following:

Color An interior bale color of pure green (most vitamin A, D and E have been destroyed in pale green to yellow hay). **Leafiness** - Lots of leaves (that's where the protein is). **Moisture** - Softness, palatability and digestibility are greatly influenced by moisture content. Improper curing results in excess moisture causing hay to mold within three weeks after baling. Ideal hay moisture content is 12% or less. **Smell** - Look for that good "fresh" smell. Musty or moldy odors can spell problems. **Mold** - Never feed moldy hay. **Dust** - Avoid dusty hay but if there is no alternative, sprinkle flakes with water. Nutrient testing of your hay supplies is a good investment.

Pasture Pasture varies greatly from one area to the next, depending on climate and soil conditions. In addition, unless irrigated and fertilized it will vary tremendously during the growing season. Pastures and hay fields need to be fertilized occasionally. Your county extension agent can advise you on how to do a soil analysis and fertilize your pasture. Timothy, brome or orchard grass with a little bluegrass, white clover, and/or alfalfa, makes a good llama pasture. Free choice pasture allowing maximum dry matter intake may well be excessive nutrition for most of your llamas.

Complete Rations Some llama owners choose to feed commercially prepared, completely formulated pelleted rations. Although expensive, it is simple and convenient. If not fed in combination with hay or pasture, be sure the complete ration contains at least 25% roughage (e.g. alfalfa pellets). Although these rations may be nutritionally sufficient, they still lack bulk and will leave your llamas looking for more. Don't be tempted to overfeed the ration. Because these rations will generally be pelleted, llamas may occasionally choke—a very undesirable consequence.

SPECIAL FEEDING SITUATIONS

Changing Feed Any change in your feeding program should be implemented gradually. When switching from one hay to another, or even from the bales of one cutting to the bales of another, it is advisable to mix the two together, gradually increasing the amount of new hay.

Late Gestation and Lactation In the last 2.5-3 months of pregnancy, a gradual introduction of cereal grain (oats, corn, etc) could be given to a maximum of one pound daily with a simultaneous reduction of forage. Continue this level of nutrition for the first three months of lactation with a gradual reduction until weaning. If your llama is already fat, by no means offer her a grain supplement!

The Bottle Fed Baby Premature, weak or orphaned babies must be monitored closely so that individual needs, which can vary greatly, are met. Bottle feeding should be minimized because of the bottle-fed llama's strong tendency to imprint on and become aggressive toward people. If bottle feeding is necessary, the author recommends the baby receive 10% of its body weight in colostrum (ex. 25# cria gets 40 ounces) in 2 to 3 feedings within the first 6 to 8 hours, but certainly before 18 hours of life.

Colostrum is the new mother's sweet, thick, first milk secretion. The baby's survival is dependent upon receiving colostrum for immunological protection against disease, and for important nutritional starters (lactose for energy, vitamin A and some fat). Goat or cow colostrum may be substituted if llama colostrum is not available, but it is imperative that only first milking colostrum from any species source be used. Beginning the second day, the baby llama should receive no less than 10% of its body weight per day in goat milk if llama milk is unavailable. A second choice is "Land O'Lakes" lamb-milk replacer, preferably non-medicated, (diluted 1:6 parts water), or a comparably constituted product. Extreme caution should be taken regarding cleanliness of equipment associated with bottle and tube feeding.

The Growing Baby Llama babies just two to three weeks old will nibble at forages. It appears they are not effective consumers of feedstuffs, however, until two months of age. Young llamas generally eat with their moms, but creep feeders with limit fed 16% protein grain and hay mixes may be used effectively from three months of age to weaning.

Watch the baby's calcium:phosphorus balance as crooked legs may result from inadequate phosphorus intake caused by excess calcium in the diet, especially in alfalfa hay. A free-choice mineral supplement with phosphorus is crucial during this rapid growth period.

The Weaned Mother Young llamas are usually weaned at 4 to 6 months of age when the mother is well beyond peak milk production and is approximately 3 to 5 months pregnant. She should be on a maintenance diet only, which is nicely satisfied by grass or oat hay. Tapering off any grain feeding and stopping it completely at the time of weaning will aid in reducing milk flow.

The Malnourished Llama Classically it is assumed that malnutrition means underfeeding. However, in llamas there are two extremes as overfeeding, unfortunately, is becoming more common. Overfeeding can cause animals to overheat in hot weather and have fertility or birthing problems.

The “underfed” llama may not be simply underfed, but rather undernourished because some anatomical, physiological or disease condition causes poor utilization of food. If the principle problem is that they are being fed nutritionally inadequate food, a careful and gradual increase of dietary intake should take place under supervision of a veterinarian or nutritionist to bring feeding up to optimum levels.

The Fat Llama A target weight is to be established for the fat individual. Total control of dietary intake is assumed. One percent of target body weight in dry matter forage is offered along with free choice minerals (Table 3). If more than one individual is being dieted, be sure to provide adequate bunk space so as to minimize competition. Prevention of fat llamas is easier than the treatment.

Cold Weather Considerations Normally most llamas are not on full rations (i.e. 1.8% of body weight) of dry matter forage year around. When truly cold weather (below freezing) settles in, then a switch to free choice consumption will generally be adequate. For the truly unique situation requiring increased caloric density plus free choice forage, up to 1 lb/animal of cereal grains (corn/oats/barley) could be offered.

Heat Stress Prevention Since the heat increment production from forage digestion is greater than for concentrates, careful use of grains during hot humid weather along with reduction of hay consumption should have a favorable effect. However, crude fiber intake still needs to approach 25% of diet.

The state of the art of llama nutrition is currently based on extrapolation from work in South America, nutritional trials using North American feedstuffs, and opinion based on observations and experiences here in North America. The foregoing will hopefully serve as a guide to keep your llama’s nutrition in a middle-of-the-road path. Good common sense and attentive daily care goes a long way in raising a well-fed (not overfed) and content llama.

SUPPLEMENTAL READING

1. National Research Council, #15. Nutritional Requirements for Goats (available from National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20148).
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5. Johnson LW: The Llama Stomach: Structure and Function. Llama World 1983;1:12-13.
6. Biggs S: Backcountry Nutritional Needs of Llamas. Llama Life 6, Summer ed, 1988, p15.
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Table 1. Feedstuff caloric values (dry matter basis) amount (lb DM) and % BW to meet daily maintenance energy requirements of 110 lb, 220 lb, and 330 lb llamas

FEEDSTUFF	*MEm (Mcal/lb)	lb DM			% BW		
		110	220	330	110	220	330
HAYS							
Orchard grass	.96	1.63	2.69	3.78	1.48	1.22	1.15
Brome grass	.97	1.61	2.66	3.74	1.46	1.21	1.13
First alfalfa	1.04	1.5	2.48	3.50	1.36	1.13	1.05
Third alfalfa	1.07	1.46	2.41	3.39	1.33	1.10	1.03
Oat hay	.92	1.70	2.80	3.89	1.54	1.27	1.18
Oat straw	.86	1.81	3.0	4.22	1.65	1.36	1.28
SPRING PASTURES							
High fert rye grass	1.36	1.15	1.90	2.66	1.04	.86	.81
N.J. mixed grasses	1.32	1.18	1.95	2.75	1.07	.89	.83
Oregon mixed grasses	1.06	1.47	2.43	3.28	1.34	1.11	1.00
Colorado mixed grasses	1.10	1.42	2.35	3.28	1.29	1.07	1.00

* MEm - metabolizable energy for maintenance

Table 2. Percent protein, TDN, fiber, calcium and phosphorus content of several commonly utilized feedstuffs, on a dry matter basis.

	% protein	% TDN	% fiber	% CA	% P
Oats-grain	13.3	7	12.1	0.11	0.39
Corn, whole yellow	10.6	89	2.4	0.03	0.29
Whole cottonseed	20.0	100	20.0	0.15	0.71
Alfalfa hay	18.0	60	26.2	1.41	0.22
Oat hay	9.3	61	30.4	0.24	0.22
Brome grass hay	12.1	56	31.2	0.30	0.18
Timothy hay	8.5	57	33.5	0.41	0.19
Oat straw	3.0	52.7	39.8	0.19	0.09

* $TDN \times (.0202) - .204 = \text{metabolizable energy}$

Table 3. Llama mineral supplement (Average adult llama will consume one ounce per day)

50# trace-mineral salt, 50# steamed bone meal, 50# dry powdered molasses, 10# Zinpro 100*

	Mineral mix analysis	
	%	ppm
Protein	8.5	Mn 1025
Fat	4.0	Cu 145
Fiber	4.4	Co 34
Ash	63.0	Zn 5632
TDN	25.5	Fe 624
Ca	6.3	Mo 20
P	3.3	Se 4.9
Mg	0.016	
Na	14.0	
S	0.70	

* Zinpro Corporation, Edina, MN

Table 4. Modifications of mineral mix in Table 3

INDICATION	MODIFICATION
High alfalfa diet or springtime pastures	Replace 25 lbs of bone meal with monosodiumphosphate
Stored forage	Add 5 lbs of vitamin E (227,000 IU of d,l-alpha tocopheryl acetate/lb)
Selenium supplement <u>if necessary</u>	Up to 90 parts per million of selenium
Prevent grass tetany	1.5 lbs of magnesium oxide



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