



Grain Feeding: It's All About Energy

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A question often posed by llama and alpaca owners is in reference to the best type of grain to feed their animals. Should there be different “grains” fed in support of show, breeding or packing llamas and alpacas? To address this issue, we first need to be sure we are all on the same page in speaking about “grains” and understand what grains may contain. With this knowledge, we then can address how “grains” may be used in meeting requirements of llamas and alpacas. In many ways this topic is related to previous column subjects on forage quality (June) and feed analysis (August).

Understanding Terminology and Ingredient Sources

What is meant by the term grain? There are a collection of terms commonly used to describe the non-forage or supplement portion of a ration offered to an animal. These include grain, concentrate, supplement, pellet, mineral, cereal, commercial feed and others. Technically, these terms are not equivalent and can describe feed items with very different nutritional composition. Appendix A provides official definitions for these terms as determined by the American Association of Feed Control Officials (AAFCO). From these definitions we can see that grain has a very narrow scope compared to the terms concentrate and supplement, which represent feeds of increasing composition complexity.

Grain. Cereal grains are the seeds of important food producing plants for both

animals and humans. Cereal grains contain large amounts of starch and are readily digestible. Starch is the energy storage compound in plants. Thus cereal grains are fed to provide a digestible form of concentrated energy. With ruminant species, like llamas and alpacas, we need to feed cereal grains carefully as they are potentially rapidly fermented. Starch fermentation can provide glucose precursors, but can also generate lactic acid. Excessive accumulation of lactic acid can lead to a disease condition of forestomach acidosis. All cereal grains are not equal in their amount of starch and their predisposition to produce acidosis. In addition, processing of cereal grains can increase digestibility and propensity to induce acidosis. Processing methods modify grain particle size making the starch more available. Examples include grinding, flaking, extruding, and pelleting.

Table 1 compares the nutrient composition of common cereal grains. The nonfiber carbohydrate (NFC) fraction essentially quantifies the starch content, which ranges from a high of 75% (corn) to a low of 48% (oats). Notice the generally high (>76%) total digestible nutrient (TDN) content, a measure of energy, and the low (<20%) neutral detergent fiber (NDF) values. For comparison, most hay forages will range from 40 to 60% TDN and 40 to 65% NDF. Cereal grain crude protein (CP) content ranges between 9 and 14%, similar to the range in requirement for llamas and alpacas. Whether or not additional protein needs to be supplemented will depend upon the forage being fed and the needs of the

animal. Legume forages (i.e., alfalfa or clover), due to their inherently higher protein content, would not require additional protein with a cereal grain. In contrast, grass hays can vary tremendously in crude protein content and mature hays may require more protein supplementation. One last thing to note is the extremely low calcium (Ca) content of cereal grains. This requires additional calcium supplementation when grass hay and cereal grains are fed. Cereal grains also do not match up well with forages in meeting a number of other mineral requirements, making it necessary to include additional mineral supplements.

Concentrate. The given definition of a concentrate (Appendix A) suggests it might take many forms. Cereal grains are a form of an energy concentrate. As described, they are added to other feeds to provide additional energy to a supplement or complete ration. Similarly, other feed ingredients can provide a concentrated source of a specific nutrient to help complete a balanced diet. Soybean, canola, and cottonseed meals are examples of protein concentrates. Mineral and vitamin premixes, which are blends of specific mineral or vitamin sources, provide concentrated sources of respective ingredients to be further diluted in a supplement feed. Protein, mineral, and vitamin ingredients are clearly definable and different examples of concentrate feeds. There is another group of common feed ingredients that do not fit cleanly into a discrete category. These feeds are termed fiber byproducts.

The lower section of Table 1 shows a variety of byproduct feeds commonly fed to ruminants and included in many commercial feed supplements. These byproducts are derived from the cereal grain milling or brewing industries. These feed ingredients might be considered fiber concentrates as moderate to high NDF content is a common

characteristic among the group. Energy (TDN), crude protein, and mineral content is quite variable and some ingredients have specific nutrient content consistent with energy, protein, or mineral concentrates. In contrast to grains, fiber byproducts do not have high starch content providing available energy, but instead have fermentable fiber. This is a good thing as fiber fermentation provides available energy without inducing lactic acid production and lowering forestomach pH. For this reason, many feed manufacturing companies are replacing starch sources with fiber byproducts to reduce acidosis risk, yet maintain animal performance and health.

Supplements. At this point we have defined and discussed various feed items that can provide one or more specific nutrient sources (concentrates). These feed ingredients are then combined in some fashion to produce a supplement product. A supplement is the next level of complexity in mixing feed ingredients, yet not as complex as a complete feed. In most feeding situations a supplement is fed in addition to forage as part of the total ration. The term supplement best characterizes what most people would be providing to their llama or alpaca. In a majority of situations this supplement would be a commercial product that may or may not be specifically targeted for feeding llamas and alpacas. A few owners with sufficient numbers of animals may have a custom supplement produced for their farm. As one might suspect, given the lack of feeding standards for llamas, supplement nutrient content varies tremendously (Table 2). Some of this variation may be the result of products targeted to other species. Within the limited products targeted to llamas and alpacas, variation exists due to marketing schemes highlighting specialty ingredients, composition, or specific purpose products.

Beyond nutrient content, one is also faced with differences in supplement physical form. By far, pellets comprise the physical form of most llama and alpaca supplements. Supplements may also be ground, crumbled, flaked, or some combination. Llamas and alpacas have an exquisite ability to sort even the finest of particles, so a pellet form to the supplement better ensures consistent nutrient intake. During one of my research feeding trials, I observed how readily alpacas can sort pellets from grains and consume what they wanted and not what I intended. Molasses can be added to a supplement (e.g., sweet feed) to help keep different particle sizes together and promote intake.

Pellets can pose some problems. To manufacture a pelleted product, all ingredients must be ground finely and compressed with a binding agent to produce the pellet. Some pellets do not stay together and end up with many “fines” when they break apart. The fine grind needed to make the pellet increases ingredient availability and reduces effectiveness of fiber (e.g., potential acidosis risk). Some people are concerned about rapid consumption of pellets and potential for “choke”. This is probably much more than you wanted to know about feed supplements, but I hope it has given you some appreciation for the complexity of feed products and their application. Now let’s take this information to the practical level of making a decision on what supplement might be appropriate to feed.

What Supplement to Feed?

The type and amount of supplement to feed a llama or alpaca will depend upon the animal’s nutrient requirements and quality of the forage consumed. Requirement needs are determined by

physiologic state (i.e., maintenance, growth, pregnancy, lactation) and degree of activity or work. Intertwined with matching supplements to forage to meet requirements is your own feeding strategy or philosophy. My strategy in feeding llamas and alpacas is to maximize forage intake and minimize the feeding of supplement. I believe this fits the animal’s instinctive feeding behaviors, but realize that we wish to optimize animal health and productivity. Thus, some additional nutrients not provided by the forage will need to be fed in a supplement. The following discussion on supplement feeding strategies will come from this perspective.

Maintenance Feeding. Let’s start off easy. Take an animal at maintenance, the back-yard mobile lawn mower, which has the lowest level of nutrient requirements compared to other physiologic states. On average, moderate quality grass forage (8-10% CP) will meet energy and protein requirements. There will be need for mineral and possibly vitamin supplementation. The simplest solution is a free choice mineral supplement. Alternatively, one could offer a concentrated vitamin and mineral product with low intake rate (2 to 4 ounces/day). By comparison, products shown in Table 2 range from 5 oz to 1.1 lbs for expected intake in a 150-lb alpaca. The carrier could be a fiber byproduct with minimal cereal grains. Few of these products are commercially available, but I have seen a number of successful custom products used. Mineral and vitamin content will depend upon forage content and geographic area. If your maintenance animal must walk long distances to graze or generally is a “hard keeper”, then a supplement containing more energy will be needed. An appropriate supplement would contain 10-12% protein, an energy source, and the vitamin-mineral sources. Products using fiber byproducts easily could fit the need without a cereal

grain source. How much you feed will be directed by your assessment of body condition score and direction of needed condition score change.

Packing and Show Feeding. The next level of complexity is supplementing animals with higher energy requirements (e.g., packing) or being exposed to stress conditions (e.g., show animals). Energy is the primary nutrient to address with some increased need for minerals and vitamins in supporting the working animal. One could just feed some cereal grains for the energy, but there is more risk of over consumption and obesity. If cereal grains are fed, a mixture (e.g., corn-oats-barley) would be preferred to straight corn to help reduce the disease risk. Oats are a nicely balanced feed with moderate starch and fiber content; however, they can sometimes be difficult to find and relatively expensive. One could also feed a 10-12% protein supplement similar to that described for maintenance. A higher protein product would not be needed as you would be feeding a larger amount and there is not an increased requirement for protein with work. Again body condition will dictate how one adjusts the amount fed. In feeding working animals, it is best to spread the additional amounts to be fed over a week's time, rather than increase meal size for a limited number of days during the work.

Feeding show animals is an area that there is little science on which to base recommendations and more intuition and experience, so take the following comments with this perspective. Obviously we want show animals to look and act healthy and have an exceptional shine to the fleece. Ensure the supplement provides sufficient minerals and vitamins to help promote immune response and antioxidant function. Substitution of some inorganic mineral sources with chelated mineral sources (20% of total) might be appropriate. Protein

supplementation is important to fleece quality and luster as well as essential oils. Again, depending upon forage type, supplement protein content should be 14 to 16%. A little vegetable oil, soybean or canola would be preferred, could be added for essential fatty acids. Llamas and alpacas being similar to ruminant animals requires dietary fat content to be carefully controlled as fat can adversely disrupt the microbial populations in the fermentation vat. Supplement fat content should be below 4%. Again, I would prefer a fiber byproduct as the energy source in a show animal supplement. Cereal grains could easily lead to obesity concerns in supplemented animals. Fiber-based products have traditionally been used in other cattle, sheep, and goats being shown as they tend to help expand the gut and give the animal a "flush and fit" appearance.

Reproductive Animal Feeding. The final level of supplementation is meeting the needs of the highest nutrient requirement animals, e.g., growing crias, pregnant and lactating females. Energy and protein supplementation will be needed to support growth and reproduction. Supplement protein content should be between 16 and 18%. Energy sources could be cereal grains, but a blend of fiber byproducts and cereal grains would be appropriate. Additionally, mineral and vitamin content should be increased to ensure adequate intake. Use of chelated minerals may also have a place in supplements for these highly productive animals. Again, supplement amount fed needs to be adjusted according to your assessment of body condition score and forage quality. Table 3 compares supplement amounts needed to be fed with 10% protein hay to achieve diets of 12 and 14% total protein. Supplement protein content was varied from 14 to 18%. One can see from these data that feeding less than 18% protein supplement to animals

requiring higher protein diets (i.e., growing, pregnant, and lactating) requires more total supplement to be fed. An easy solution to this is to improve forage protein content by either feeding a better quality grass hay, or add some legume hay. By just increasing forage protein content to 12%, supplement feeding can be nearly eliminated or reduced by one-third. Again, this emphasizes previous discussions on the importance of forage quality.

Appendix A.

Feed component definitions (from Association of American Feed Control Officials Model Bill publication, 2005).

Concentrate – a feed used with another to improve the nutritive balance of the total and intended to be further diluted and mixed to produce a supplement or a complete feed.

Complete feed – a nutritionally adequate feed for animals other than man; by specific formula is compounded to be fed as the sole ration and is capable of

maintaining life and/or promoting production without any additional substance being consumed except water.

Grain - seed obtained from cereal plants, for example: corn, barley, wheat, oats, and rye. Typically grains contain relatively low fiber content and are high in energy value due to their high starch content.

Pellet – feed manufacturing process in which feed materials are finely ground and mechanically compressed through a die. One of many feed manufacturing processes that modify physical form of the feed to facilitate intake, mixture consistency and feeding ease.

Supplement – feed used with another to improve the nutritive balance or performance of the total ration and intended to be (a) fed undiluted as a supplement of other feeds, (b) offered free choice with other parts of the ration separately available, or (c) further diluted and mixed to produce a complete feed.

Table 1. Comparative nutrient content of common cereal grains and dried byproduct feeds.¹

	DM	NDF	TDN	CP	NFC	Fat	Ash	Ca	P
	%	----- % of Dry Matter -----							
Cereal Grains									
Barley grain	88	18.1	84	13.2	64.1	2.2	2.4	0.05	0.35
Corn grain, shelled	88	9	88	9.8	75.3	4.3	1.6	0.03	0.31
Oats grain	89	29.3	77	13.6	48.6	5.2	3.3	0.009	0.41
Rye grain	88	19	84	13.8	63.5	1.7	2	0.07	0.36
Sorghum grain	89	13.3	76	11.6	70.0	3.1	2	0.05	0.34
Wheat grain	89	11.8	88	14.2	69.7	2.34	2.01	0.05	0.44
Fiber By-Products									
Barley malt sprouts	93	46	71	28.1	17.5	1.4	7	0.19	0.68
Beet pulp	91	44.6	74	9.8	39.7	0.6	5.3	0.68	0.1
Brewers grains	92	48.7	66	29.2	7.3	10.8	4	0.29	0.7
Citrus pulp	91	23	82	6.7	60.0	3.7	6.6	1.88	0.13
Distillers grains	91	23	88	29.7	30.1	9.2	8	0.32	1.4
Rice bran	90.5	33	70	14.4	26.1	15	11.5	0.1	1.73
Soybean hulls	91	66.3	80	12.2	14.5	2.1	4.9	0.53	0.18
Wheat bran	89	42.5	71.5	17.3	29.6	4.3	6.3	0.13	1.18
Wheat middlings	89	36	83	18.5	40.0	3.2	2.4	0.15	1.0

¹Abbreviations: DM=dry matter; NDF=neutral detergent fiber; TDN=total digestible nutrients; CP=crude protein; NFC=nonfiber carbohydrates (includes starch); Ca=calcium; and P=phosphorus.

Table 2. Comparison of guaranteed (as fed basis) analysis of 12 commercial pellet supplements fed to llamas and alpacas.¹

Nutrient	Units	Commercial Pellet Products											
		A	B	C	D	E	F	G	H	I	J	K	L
Intake ²	lb/day	0.45	1.0	0.3	0.375	0.5	1.5	0.35	0.525	0.45	1.1	1.0	0.45
Crude Protein	%	14	16	18	15.2	14.1	14.1	15	10	8	14	14	13
Crude Fat	%	3	2	1.2	2.4	1.9	3.5	2.9	1	1	2	2	2
Crude Fiber	%	8	11.5	8	10	22.8	14.3	10	19.5	25	15	15	18
Total Ash	%		11.5	15	9.1	7.5	6	9.5				15	11
Calcium	%	1.4	2.1	2	2	0.7	0.6	2.01	1.6	1.4	0.9	1.2	1.65
Phosphorus	%	1.1	0.9	1.4	1	0.45	0.45	1	1.2	1	1.2	0.8	0.8
Magnesium	%	0.9		0.38	0.34	0.3	0.3	0.3		0.9	0.5	0.5	0.4
Potassium	%	1	1		1.07	1.23	0.82	0.95		1.1			1.2
Sodium	%		0.76		0.41	0.28	0.28	0.42			0.45		0.19
Chloride	%				0.7	0.46	0.46	0.68					0.31
Salt	%		0.7	1							1	1.2	0.5
Sulfur	%				0.28	0.26	0.19	0.26					
Cobalt	ppm			22	2.9	0.64	0.6	5.3			5	0.5	
Copper	ppm	12		500	16	20	25	25	50	15	25	25	50
Iron	ppm			400	480	353	270	400			425	200	
Iodine	ppm			400	3.9	1.9	1.9	0.21			2.5	1	
Manganese	ppm	85		2000	320	200	200	320		105	250	150	100
Selenium	ppm	4	2	7.7	2.1	0.65	0.65	3.5	4	4.5	4.5	4.5	6
Zinc	ppm	125		2400	410	211	210	500		140	400	200	300
Vitamin A	IU/lb	9000	8000	45000	17727	5909	8636	10909	11,000	8,000	13636	13500	9000
Vitamin D	IU/lb	1400	1000	17650	3017	1000	1000	5000	8,000	1,500	2272	2500	2800
Vitamin E	IU/lb	250	20	275	304	20.5	50	309	400	350	182	275	360

¹Adapted from Van Saun, R. Chapter 9. Nutrition, in The Complete Alpaca, 2nd ed., E. Hoffman, editor.

²Based on calculated intake rate using feed tag information for a 150 lb alpaca.

Table 3. Calculated daily supplement intake required to achieve a desired total dietary crude protein content of 12 or 14%. Calculations are based on feeding a 10% crude protein grass hay with supplement.

Supplement Crude Protein Content	Desired Dietary Crude Protein Content			
	12 %		14%	
	Lbs/day	% of Total Diet	Lbs/day	% of Total Diet
14%	1.5	50	3.3	100
16%	1.0	33.3	2.2	66.7
18%	0.75	25	1.65	50