

Phosphorus, Calcium & Vitamin D – “The 3 Amigos”

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Recently there has been a lot of talk in alpaca circles about phosphorus. Personally, I have been approached by many alpaca owners questioning whether it is something new and whether phosphorus supplementation is going to fix or solve this or that. Basically people have been trying to understand what it is all about! Hence it is timely to look at the topic of phosphorus and alpacas. But is it that easy? One of the key issues in this discussion is to understand that phosphorus has some very close relationships with calcium and in particular Vitamin D. Just looking at one without considering the others can lead to some incorrect conclusions; one must truly take a wider look to get the right answers.

The Relationship between Phosphorus, Calcium & Vitamin D

The body needs calcium and phosphorus for many essential functions and chemical reactions in the body. Most obviously calcium and phosphorus are essential in bone formation. Calcium and phosphorus levels in the blood are controlled by a complex situation involving three hormones vitamin D, calcitonin and parathyroid hormone. These hormones change the level of calcium and phosphorus in the body by

1. Increasing/decreasing the amount absorbed by the intestine (or excreted in faeces)
2. Increasing/decreasing the amount being excreted in urine
3. Increasing/decreasing the amount in of each in bone.

From our point of view, vitamin D is of most importance if we want to influence the calcium or phosphorus levels as neither of the other hormones are readily available.

Vitamin D – Background

Vitamin D is a fat soluble vitamin whose main action is to increase the amount of phosphorus and calcium that is being absorbed by the intestine. In normal animals vitamin D levels are achieved by oral consumption or by a chemical reaction that occurs from sunlight (U.V. light) hitting the skin. Vitamin D occurs in many forages but is naturally highest in sun dried feed such as hays. It is important to note that lush green feed such as grasses contain chemicals that may decrease the amount of vitamin D available to the animal This then puts a much greater emphasis on the ability of the animal to make its own vitamin D to meet its daily needs. Scientific research has shown that alpacas struggle to perform this chemical reaction very well leaving them very susceptible to phosphorus deficiency. Without adequate vitamin D levels, very little phosphorus will be absorbed from the intestine and the animal will suffer low phosphorus levels. Therefore to achieve necessary phosphorus (as well as calcium) levels in the body, alpacas need to have both adequate phosphorus (and calcium) intake and suitable vitamin D levels at all times of the year.

Vitamin D, Phosphorus & the Research

Alpacas have long been shown to have trouble maintaining adequate phosphorus levels in their bodies. Fowler back in 1990 described a rickets syndrome in young alpacas and llamas., 3 to 6 months of age. Affected crias presented showing decreased growth rates, a reluctance to move, shifting or varying limb lameness and joint enlargement, most commonly in the front carpus or “knee” joint. The only consistent clinical finding was that the affected animals had low blood phosphorus levels. Fowler assumed that since the crias were still suckling that they would be getting

enough calcium and phosphorus from the milk (rickets is due to either low blood levels of calcium, phosphorus or both). He also assumed that there would be enough Vitamin D being produced from the action of UV light on the skin and hence made an untested conclusion that the low serum phosphorus levels and subsequent bone abnormalities were due to inadequate phosphorus intake.

A subsequent study by Fowler in 1992 demonstrated that phosphorus supplementation significantly helped “rickets-affected” animals but failed to alleviate the problem altogether. This suggested that phosphorus deficiency alone did not adequately explain the changes and clinical signs being seen in these cria. Also supporting this conclusion is that in neither of these investigations was the author able to identify a particular dietary reason why these animals should have an inadequate phosphorus intake. Infact Fowler himself found that the best supplement to increase phosphorus levels in the affected alpacas was one that contained both phosphorus and vitamin D. Supplements with very high phosphorus levels but no vitamin D did not raise the blood levels of phosphorus as much demonstrating that both were missing from the diet. It has since been shown by another researcher that just increasing phosphorus intake in alpaca showing signs of rickets does not increase the phosphorus levels as would be expected unless extra vitamin D was also given to the animals. Dr Brad Smith undertook 3 more significant studies in 1994, 1995 & 1996 which followed on from Fowlers earlier work. In the first of these studies Smith looked not only at blood phosphorus levels but also at blood vitamin D levels. Interestingly he found in one of these studies that alpacas showing signs of rickets not only had lower phosphorus levels but had over 10 times lower vitamin D levels as well. In the second of these studies he showed that alpacas maintained on a set, well balanced diet showed variation in blood vitamin D and phosphorus levels which were related to the seasons i.e. lower in the low sunlight periods and higher in the sunnier months. Again this supports the importance of vitamin D as the major limiting factor because phosphorus intake was stable. The third study looked at the most suitable levels of vitamin D supplementation required to achieve the necessary body phosphorus levels. Within Australia similar work has been done in 1996 and 1997 which demonstrated the marked seasonal variations in vitamin D levels in alpacas in southern Australia and investigated the required amounts and frequency of vitamin D supplementation to maintain optimum health.

Normal Alpaca Phosphorus Levels

In alpacas we like to see a blood (or more correctly serum) phosphate level in excess of 1.5 mmol/L. Ideally levels of 2.0 mmol/L or above are preferred. Some laboratory reports have normal ranges extending to as low as 0.6mmol/L which is well below the level where clinical signs of rickets can be seen.

The normal phosphorus levels in an animal may vary with the following factors and so they should be taken into account when investigating alpaca blood phosphorus levels

1. Age – In normal animals, phosphorus levels will be highest when young then decline rapidly until about 12 months of age at which time they should remain at a constant levels.
2. Pregnancies +/- Lactation – These animals have a higher requirement due to phosphorus being lost in milk and being used to form the skeleton of the developing cria. This may lead to lower blood levels
3. Season – Higher blood phosphorus levels are seen in the late spring and summer months due to the increase in sunlight (U.V. radiation)
4. Digestive Upsets such as diarrhoea – Animals that are suffer from intestinal problems can suffer low blood levels of phosphorus due to decreased absorption from the diet & losses into the gut. Common to see low blood phosphorus when alpacas are suffering significant worm burdens
5. Kidney failure – Animals with kidney disease will often have very high phosphorus levels as the kidney cannot remove it from the blood stream for excretion in the urine

Phosphorus levels are often used as an indirect “rough” guide to blood vitamin D levels (blood phosphorus is a relatively cheap and simple test whereas blood Vitamin D testing is at least 5 times more expensive and sample collection is more complicated).

Signs of Phosphorus Deficiency

As has been discussed, one of the major signs of phosphorus deficiency is a condition known as rickets. This basically is a situation where the bones are not growing properly because there are insufficient amounts of the raw materials (calcium, phosphorus or both) available to make them. Rickets tends to be a more significant problem in young, growing animals. In mature animals one of the major signs of phosphorus deficiency is anaemia or low red blood cell count. Other signs such as weakness and weight-loss are in part due to the anaemia. This anaemia is due to the red blood cells bursting and one of the other major clinical signs is the presence of very dark (port coloured) urine due to the large amount of red blood cell breakdown “bits” being excreted out of the body. In domestic farmed animals this condition is rarely seen anymore due to the large amount of superphosphate which is applied to pastures (super has heaps of phosphorus in it). In the few cases I have seen in dairy cattle, the disease progresses quickly towards death often despite phosphorus treatment. Death occurs due to the loss of blood due to the ruptured blood cells. In mature animals, phosphorus deficiency appears to be reasonably well tolerated and many animals show very little obvious signs. Therefore the signs discussed above are generally reserved to cases where phosphorus levels are very, very low.

Vitamin D Supplementation

It is generally scientifically accepted that alpacas do require vitamin D supplementation. Studies in the US and Australia have shown that a dose of between 1000-2000 IU D3/kg bodyweight is the necessary amount (D3, often written as Cholecalciferol D3, is a type of Vitamin D). It has also been suggested that in southern Australia that such a dose (1000 IU D3/kg bodyweight) be given to crias in late autumn and again in mid winter and to adult females in mid winter. It is my opinion that this suggestion is a bare minimum and that some alpacas in southern Victoria require additional doses of D3. Animals at greatest risk are young, growing animals often with dark and/or dense fleeces. I do see many animals that despite following the above recommendation struggle to maintain adequate phosphorus levels and do benefit from a more intensive vitamin D dosing regime. Occasionally I will also use injectable phosphorus as well but normally only if animal is truly showing signs of rickets. The above finding suggests to me that there may be a genetic influence with some animals being better able to manufacture their own vitamin D than others. I also feel that the genetic improvement in the Australian alpaca fleece particularly the emphasis on density may also be a cause of why traditional vitamin dosing regimes fail on some farms.

Vitamin D can be given in either injectable or oral forms. In principal I prefer oral dosing as it is more natural as the body can pick or choose whether it wishes to absorb it or not versus injectable which gives the body little choice on absorption. Oral dosing is far more labour intensive so we often focus this on the most susceptible age groups i.e. young, growing or clinically affected.

Phosphorus Supplementation

Animals that are on good pasture from well fertilised soil are at a low risk of being truly phosphorus deficient. Maintaining adequate Vitamin D levels will ensure ample phosphorus is absorbed from the intestine. If unsure of pasture phosphorus levels then soil and pasture testing can be undertaken to determine status. Many of the commercial feed supplements contain phosphorus as well. Phosphorus injections are also available if deemed necessary in cases where increased levels are required rapidly. If phosphorus injections or supplements are used then ensure that adequate Vitamin D is also being given concurrently.

What should you do if you wish to investigate phosphorus/Vitamin D issues on your property?

1. Undertake a soil and plant tissue test with a reputable soil testing company to obtain baseline information on phosphorus availability on your property. Embarking on a planned soil fertility program is far more cost effective than individually trying to supply each animal with this and that. Remember true phosphorus deficiency in animals that have incredibly high needs for phosphorus, such as dairy cows, is virtually unheard of on improved pasture.
2. Speak to your veterinarian about the logistics of blood testing for either phosphorus (cheaper) or vitamin D levels (dearer). To gain maximum information it is prudent to test a wide range of animals young and old, growing and not growing to see if it truly is having any effects on your animals. You need to work out if it is a herd problem or an individual animal problem.
3. Seek advice from your vet about vitamin D supplementation programs for your animals in your area. Advice can also be sought about appropriate ways to supplement phosphorus if testing shows it is limiting on your property.
4. Consider phosphorus/vitamin D problems in young animals that do not appear to be growing well. This is the major group where the problem, if present on your property, will present. If phosphorus deficiency is only seen in occasional animals but other animals test normal considering increasing vitamin D supplementation to just the affected animals and monitor results.
5. Do not put all your eggs into one basket! Vitamin D/phosphorus deficiencies will not explain all your health problems. Ensure that you and your vet approach any health issue with a broad mind to enable the correct diagnosis to be made and appropriate treatment instigated