Feeding Prenatal Foals through to Young Horses

By The Nude Horse
(Equine Epidemiologist)

Ideally a foal will suckle within 20 minutes to 3 hours after foaling and readily take in the 15% of the immunoglobulin concentrates of colostrum. During the following 7 days of life a foal should suckle approximately 7 times every hour each suckle lasting 1-2 minutes. As the weeks go on, the frequency reduces to about 3 times per hour. From a mare fed nutritionally balanced feeds, the milk bar will provide all the necessary nutritional needs of foals for the first 6-8 weeks of age. Within days of foaling a young horse will likely begin to sample the grass, hay and hard feeds in their environment, increasing as milk concentration and production decreases.

Foals are dependent on enzymes to break down nutrients in the gut. Young foals start with high levels of lactase, an enzyme that digests milk. Adult horses depend on their gut microbes to ferment and release the nutrients from fibre in forage (soluble fibre). Young horses typically source these gut microbes from grazing on pasture grasses. For this reason, foals are often seen eating their dam's manure, a rich source of fibre fermenting bacteria. From 3-4 months of age, the young gut can begin to digest concentrates in hard feeds, this is the time to begin feeding the foal their own small hard feed. A common method is for the foal to have access to their own smaller feed portions in an area the mare cannot enter, known as a creep feeder.

Research shows foal health and skeletal development begins in the prenatal phase

Of interest copper supplementation of dams in late gestation may be protective against articular cartilage abnormalities/lesions in foals[2], prevention of skeletal problems[3] and a significant reduction in physitis score (swelling around the growth plates in young horses).[4]

White muscle disease has been attributed to selenium deficiencies from in gestation. WMD is characterized by myopathy resulting in weakness, impaired locomotion, difficulty in suckling and swallowing, respiratory distress, and impaired cardiac function. Selenium deficiencies can increase when a pregnant mare consumes high levels of unsaturated fats (vegetable oils.)[7] Selenium deficiency has been suggested to be involved in some cases of flexural deformities. Janicki et al. reported that foals from mares fed 3 mg per day had higher concentrations of IgG at 2, 4 and 8 weeks of age than foals from mares fed 1 mg or less of selenium per day.[6] Organic forms are shown to be more effective (Pagan et al).

Vitamin E has received considerable attention in recent years as a powerful antioxidant that reduces free radical activity. Vitamin E helps maintain membrane integrity in virtually all cells of the body. It also enhances immune response.

Creep feeder by O'Donnell Engineering (Ireland)

A study by Hoffman et al. reported that mares fed a minimum 160 IU of Vitamin E per kg of feed during the periparturient period had higher serum immunoglobulin G concentrations (IgG) than mares fed less. Suckling foals of mares fed the higher concentration of vitamin E had higher serum concentrations of IgG than foals of mares fed 80 IU per kg of feed.[8]

During the last trimester of gestation, two-thirds of fetal growth occurs and 85-90% of fetal calcium is accreted from the mare into the fetal bones. The pregnant mare should be fed a diet containing 0.45% calcium and 0.3% phosphorus. Protein requirements should also increase by 10% (NRC). Poor nutrition before and after foaling have been implicated in stress and early embryonic death.

Progesterone is critical to the maintenance of early pregnancy. Holtan and Hunt (1983) reported a positive relationship between dietary protein and progesterone concentrations. A study by Boyer (1999) showed mares fed 1000 g crude protein daily (for the 500kg horse) or less had a higher incidence of early fetal loss than mares fed 1400g CP/d.

Past histological foal feeding practices and long-term outcomes

Previous practise was to feed grain to young horses at a rate of 1kg per 100kg BW (Body Weight) daily at one month of age and increase to 1.5-2kg per 100kg BW daily from 7 weeks. In recent time studies show this technique is associated with increased risks of Developmental Orthopedic Disease, sugar resistant disease onset and gastro disorders. The need to feed a fortified and balanced mineral and vitamin supplement for foal development has been well documented.

Research Findings - postnatal foals

Studies have demonstrated the etiology of equine 'Developmental Orthopedic Disease' (DOD) in part is attributed to excessive amounts of non-fibre carbohydrates (grain-based feeds and vegetable oils) contributing to hormonal imbalances in foals. OCD lesions will generally develop within the first 11 months of life but may not be noticed until 3 to 5 years of age as the horse begins training.

Different Developmental Orthopedic Diseases:

1. Osteochondritis dissecans
2. Subchondral cystic lesions
3. Angular limb deformities
4. Physitis
5. Flexural deformities (these may have no defined cause, or may be secondary to osteochondrosis or physitis)
6. Cubodial bone abnormalities
7. Juvenile osteoarthritis

Osteochondrosis is one of the most important and prevalent developmental orthopedic diseases of horses. The term dyschondroplasia is preferred when referring to early lesions. The condition mainly affects articular growth cartilage, dyschondroplasia may progress to formation of cartilage flaps or osteochondral fragments (osteochondrosis). Often the first sign noted in foals is a tendency to spend more time lying down. This is accompanied frequently by joint swelling, stiffness and difficulty keeping up with other animals in the paddock. The idea that there is a multifactorial etiology (cause) has generally been accepted to include rapid growth, *high carbohydrate diet, mineral imbalance* and biomechanics (i.e. trauma to cartilage).

At trial, 11 out 12 foals aged 2.5 - 6 months of age that were fed 129% of the NRC daily recommended dietary energy (DE) developed signs of dyschondroplasia (DCP). The number of histological lesions of DCP were significantly greater in the High DE foals than in the control group. The high energy diet was grain and polyunsaturated oil based (rice-based pellets, corn oil and oaten chaff).[10]

Dyschondroplasia changes in stifle, hock and fetlock joints were also observed in foals fed high energy feeds of vegetable oil, grain (barley, wheat, rice) and oaten chaff/hay.

Additional trials too confirm there has been an increased incidence of OCD lesions in horses fed 130% of what the National Research Council (NRC) recommends for carbohydrate and protein.

A Canadian trial found physitis and flexural deformities occurred in 88% of 42 weanlings between weeks 6 to 8 of a study fed high dietary energy feeds (grain and polyunsaturated oils).

Various mineral imbalances have been implicated as causative factors with OCD, including high calcium, high phosphorus, low copper and high zinc. An epidemiologic study on clinical cases of DOD implicated low copper levels as the most consistent factor. Excessive zinc intake has been related to equine osteochondrosis also.

Studies by Gabel et al. recommend feeding weanling foal around 150 to 175 mg of copper daily. However copper requirement may vary among breeds. It has been recommended that ponies and draft horses be fed 10 mg/kg and that horses prone to copper deficiency be fed a total of 20-25 mg/kg diet. There has been established a relationship between low copper intakes in fast growing horses and inferior collagen quality, biomechanically weak cartilage and OCD lesions.[4]

Studies at Virginia Tech have confirmed that even under the best conditions pasture will fall short of some key mineral and vitamin requirements and may vary depending on the location of the farm (Greiwe-Crandell et al., 1997).

Therefore, care should be taken to ensure appropriate mineral supplementation during pregnancy and post-natal feeding. It is controversial whether correcting the diet, once signs have developed will assist resolution, but it may help limit or prevent further cases.

In a study at the University of Queensland Veterinary Science School the analysis of certain pastures revealed that some had mean crude protein concentrations below those recommended for growing horses, and a high proportion of the pastures were deficient in calcium, copper and zinc. The pastures with low calcium concentrations also had inverted calcium to phosphorus ratios (below 1:1). Diets containing inverted calcium to phosphorus ratios and low zinc and copper concentrations are associated with the development of DOD.

The importance of calcium and phosphorus to bone mineralization is well known. The ratio of calcium to phosphorus in the bone is 2:1. Horses should be fed diets containing calcium and phosphorus ratios around 3-4:1. Inverted calcium to phosphorus ratios are common when high-grain diets are fed with little or poor-quality forages. The NRC estimates that a growing horse requires a daily minimum of 16 g of calcium/kg of body weight gain.

Suggestions for foals presenting with physitis are to remove bran (grain based feeds) from their diet whilst ensuring adequate supplementation of calcium:phosphorus, protein content limited to <10% of dry matter and Vitamin D (dosage closely monitored to avoid hypervitaminosis D). [5] Note: Vitamin D acts in conjunction with calcium and phosphorus to promote and maintain proper bone formation and integrity. Deficiencies in Vitamin D can lead to poorly mineralized bones, but excesses also have been shown to result in weakened, porous bone.

Discovering the risks attached to feeding grain and grain biproducts (included in pelleted feeds often are bran & pollards) to foals, weanlings and horses in general, prevents many disease risks. Grains include oats, corn, barley, wheat and millet. Grains are the seeds of grasses hence high in sugar and simple carbohydrates. Cereal grain type hay & chaff (oaten, wheat, rye) are also high in sugar and Non-Structural Carbohydrates, averaging alarmingly between 22% - 39% NSC.

Lucerne

Lucerne hay (a legume) generally has a lower content (11%) NSC. Legumes are different from grasses and other plants because they form a symbiotic relationship with bacteria, rhizobia, in the nodules of their roots. These bacteria are capable of 'fixing' nitrogen in the atmosphere and air into ammonia and then ammonium, which the plant can then use to make protein (note that protein contains nitrogen in its amino acids). As such legumes (including lupins) tend to be a very good source of dietary protein. Protein is required daily for maintenance, lactation, young horse growth and reproduction. Lucerne hay contains between 15 – 21% Crude Protein compared to grain based hays averaging between 5 – 13% CP.

Benefits of feeding Copra, Beet-Pulp and Lupins

Fibrous and non-fibre carbohydrates, what is the difference? Non-fibre carbs are ones that turn into some type of sugar. Long has there been a suspicion that consuming large quantities of non-structural carbohydrates and starch contribute to insulin resistance – culminating in developmental bone disorders (Kronfield 1990) or founder. Hence finding an alternative energy source to non-structural carbohydrates feeds has become of keen interest. Corn, barley and oats are the "pastas" or starches of the horse world. Wheat bran and rice bran are intermediate in starch content while comparatively and beet pulp, lupins, copra and soy hulls are very low in starch content.

Copra, beet pulp and lupins, rich sources of the 'super fibre' type of polysaccharides. These super fibres have a high water-binding capacity (viscosity increases from the presence of fibrous polysaccharides). The fibres carry volumes of water and nutrients un-digested through the small intestines and on into the hindgut (large intestine) to release their nutrients and feed the good microbes such as Clostridium, Bifidobacterium, Lactobacillus, Staphylococcus, Enterococcus, Streptococcus, Enterobacter and Escherichia hence stimulating colonization of intestinal microflora.

Fibre types of Polysaccharides provide sustainable energy (slow release energy) and help stabilize blood sugar levels (reduction in glycaemic response). Polysaccharides fibre have also been claimed to increase the amount of feel-good chemicals in the brain, decrease gastric emptying, increase satiety, improve immune system health and assist liver function.

Lupins: Contain around 35% Crude Protein, great for building muscle. Lupins have an excellent amino acid profile and are high in lysine.

Copra: The nutritional composition reveals that the fibre fractions are like those of pasture grasses. Copra is approximately 8-10% coconut oil supply which is a cool low gL - sustainable energy source. Copra contains 22% Crude Protein and sports an impressive amino acid profile.

Beet Pulp: The digestible energy content of beet pulp is greater than most hay and less than most grain ingredients, making its reputation as a weight building feed supplement. It also contains about 8.6% protein . Soaked beet pulp is an efficient way to increase a foal's water consumption (soak fully to maximum size 1 hour at least before feeding in 5X volume of added water). The fibre in beet pulp is mostly soluble fibre, so it is more readily digestible than pasture, hay or chaff.

Daily dry Matter (DM) needs for growing horses expressed in <u>percentage</u> of body weight [9]

Weanling, 4 months	2.7
Weanling, 6 months	2.5
Yearling	2.3
Long yearling, 18 months	2.0
2 year old	1.9

Making your own hard feed is the best way to avoid the pitfalls of commercially prepared feeds that often include grains and grain bi-products. To this add a balanced minerals and vitamin supplement to ensure nutritional needs are successfully met.

Protein Requirements

Amino acids are the building blocks of proteins. Protein is made of chains of amino acids. Therefore, the horse's requirement is for amino acids. A young growing horse has a high requirement for the amino acids needed to build muscle and bone. The amino acid profile varies among different protein sources. In trial, when protein feed sources are supplemented with the amino acid lysine, growth rates improved (NRC, 1989).

Digestibility of protein is corelated to dry matter (DM) consumption. For example, when concentrates are fed along with lucerne hay, crude protein (CP) increased from digestibility of 28.5 to 83 percent. (NRC)

The quality of the protein supplement is determined by the amino acid profile rather than the crude protein content.

Although copra is recognized as being high in protein, 40% of the protein is bound in the fibrous fraction of the copra, thus reducing its bio availability. If copra is used as a major component of the diet for young, growing horses, additional lysine, threonine, and methionine supplementation should be a consideration.

NRC recommends for weanlings between 4-10 months of age a requirement of 4g of Crude Protein/kg BW (Body Weight)/ daily. Equating to 672g CP/d for a 4 month old (168kg) weanling. Yearlings – 17 months of age report a greater average daily gain when fed 3-3.3g CP/kg BW/d when feeding along with lucerne hay.

Expressed as % of Dry Matter

	Copra	Barley	Lupins	Oat grain	Wheat Bran	Corn Grain	Soya Meal	Beetpulp
Crude Protein	21.9	14.9	34.9	11.5	15.7	8.3	23.4	8.6
Arginine	2.4	0.61	3.71	0.96	1.18	0.41	2.24	0.35
Histidine	0.43	0.25	0.85	0.34	0.48	0.25	0.65	0.25
Isoleucine	0.83	0.45	1.54	0.53	0.54	0.31	0.73	0.4
Leucine	1.54	0.88	2.64	0.99	1.1	1.1	1.65	0.55
Lysine	0.66	0.44	1.65	0.44	0.66	0.33	0.77	0.55
Methionine	0.38	0.18	0.3	0.24	0.27	0.19	0.37	0.08
Cystine	0.33	0.22	0.55	0.44	0.33	0.22	0.44	0.11
Phenylalanine	0.92	0.67	1.34	0.72	0.68	0.43	1.17	0.33
Tryptophan	0.63	0.44	1.48	0.45	0.47	0.27	0.84	0.44
Threonine	0.72	0.44	1.32	0.48	0.57	0.38	0.71	0.41

Chart: Common feeds - amino acid profiles

Studies by Ott and Kivipelton (2002) concluded that ***lysine was the most important factor affecting growth*** and concluded that CP could be reduced in the diet if lysine was adequate. Studies have concluded that lysine intake for weanlings (4-10 months) should be 33 to 42 g/d. Yearlings (11-17 months) show improved average daily gain on 48-50 g lysine per day.

In Summary

Growing horses seem to be able to adapt to a variety of nutritional management systems if adequate nutrients are provided in the correct balance and a moderate rate of growth is maintained throughout the growth phase.

A balanced and codependently matched mineral and vitamin feed supplements needs to be started before and during gestation and continue in postnatal feeds. *Flowers Gold* is The Nude Horse's pick of most bioavailable and balanced feed supplement for pregnant mare and postnatal feeding.

Past histological foal feeding practices of concentrates of grain or grain bi-products have shown to cause Developmental Orthopedic Diseases. Safest alternative concentrates (less starch and NSC) are copra, lupins and beet-pulp. Feeding Dry Matter especially of lucerne hay *along with* safe concentrates (lupins, copra & beet-pulp), improves protein digestibility (hence utilization).

Feeding lysine reduces the daily requirement of Crude Protein. Lupins carry the highest source of lysine when compared to common alternative dry feeds. The amino acid profile of a feed (protein quality) is more important that the percentage of Crude Protein documented.

1.https://www.sciencedirect.com/science/article/pii/S1090023305800085
2. http://europepmc.org/abstract/MED/16314126
3. Firth EC, Pearce SG, Gee EK, et al. Copper status, copper supplementation and the incidence of developmental orthpaedic disease, in Proceedings. Internat Sem Osteochondrosis. 1999;45–46
4.https://pdfs.semanticscholar.org/ff6f/37278de9a01745af76d65dc00007b21c8ab6.pdf
5. https://www.merckvetmanual.com/musculoskeletal-system/lameness-in-horses/physitis-in-horses
6. Vervuert I, Coenen M, Holtershinken et al. Assessment of selenium status in horses, in Proceedings. KER Equine Nutrition
7. https://www.ncbi.nlm.nih.gov/pubmed/9106350
8. Siciliano PD, Lawrence LM. The role of vitamin E in the exercised horse. Vitamin E in Animal Nutrition and Management. Mount Olive, NJ: BASF, 1996
9. http://equi-analytical.com
10. Effects of dietary energy and protein on induction of dyschondroplasia in foals C. J. Savage, R. N. McCarthy, L. B. Jeffcott

Other reference sources:
http://csu-cvmbs.colostate.edu/academics/clinsci/equine-orthopaedic-research-center/orthopaedic-topics/Pages/orthopaedic-disease-development.aspx
NUTRITIONAL ASSESSMENT OF WEANLINGS AND YEARLINGS LARRY A. LAWRENCE Kentucky Equine Research, Versailles, Kentucky, USA
https://pdfs.semanticscholar.org/ff6f/37278de9a01745af76d65dc00007b21c8ab6.pdf
http://nicuvet.com/nicuvet/Learn/Pregnancy%20and%20the%20Periparturient%20Period%20in%20the%20Mare.pdf