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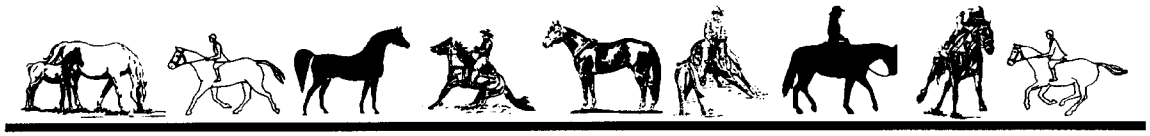

FEEDING YOUNG HORSES FOR SOUND DEVELOPMENT

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Industry trends dictate to a large extent the methods used in managing horses. It is common knowledge that early growth and development are important in halter futurity contenders and foals that will enter race training as yearlings. Horsemen realize that the marketing potential of young horses often hinges on evidence of significant early development. But, even without the demands of marketing or competition, it is important for all foals to develop soundly to ensure their longevity and usefulness.

An important decision for horse owners is whether young horses are to be fed for moderate or rapid growth **(see Figure 1)**. Either rate produces mature horses that are as big as their genetic base will allow. However, rapidly growing horses reach their mature height and weight much earlier than those fed for a moderate rate of growth.

A major concern of horsemen is the occurrence of bone and joint disorders, commonly called developmental orthopedic

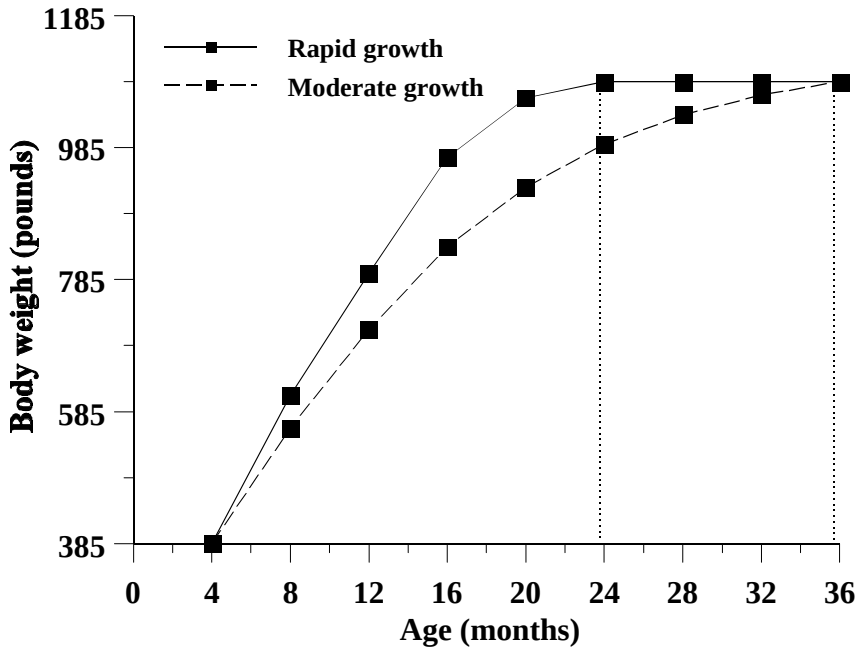

Figure 1. Example growth curve for young horses

disease (DOD) in young horses. This disease complex includes epiphysitis, osteochondrosis

and others. Common symptoms of DOD include enlargements and deformities of the ankles, knees and hocks, as well as contracted tendons, or "pulling up" in the pasterns. Bone radiographs indicate skeletal irregularities in many young horses.[31] Some horses never develop visible signs of DOD, while others have problems with appearance or lameness that interfere with growth and performance.

Developmental orthopedic disease appears to be heritable.[18] Horses with a genetic predisposition for large mature size often develop skeletal problems regardless of the manner in which they are managed. There are two other apparent causes of DOD: 1) nutrient imbalances; and 2) excessive forced exercise of confined horses. Thus, the way in which a horse is managed may contribute to skeletal problems. The frequency with which problems occur in horses genetically predisposed to skeletal problems has led to the misconception that horses fed to reach full growth at a young age will become unsound later in life. However, there are no data to support that speculation and there is no reason why either moderate or rapid development cannot be achieved in most young horses, in a manner that ensures they will be structurally sound when mature.

An adequate supply of major nutrients **(Table 1)** is important in promoting growth.[24] To help prevent skeletal problems, diets for young horses should be formulated carefully. Nutrients such as protein, calcium, phosphorus, other minerals and vitamins must be provided in correct amounts relative to each other and in balance with the amount of energy or "fuel" a horse is eating. Inadequate concentrations of protein, minerals and vitamins relative to the energy concentration in a diet may result in DOD in young horses.

Growing horses fed high energy diets with nutrient imbalances may gain weight faster than their bones can develop[26,28] and in that situation above average weight gains may not be compatible with optimal bone mineral deposition[25,37]. While feeding unbalanced, high energy diets may contribute to skeletal problems,[13] research has not shown that high protein diets cause DOD.[3] It is the nutrient imbalances, rather than the high energy diets, that can cause skeletal problems. [2,14,33] Gain in height by weanlings and yearlings decreases when diets are low in protein, calcium and phosphorus[11,26]. Conversely, young horses gain more height, weight and heartgirth when fed high energy diets with suitable amounts of protein and minerals[27]. When energy is limited, growth will be limited; when energy is available, growth will be enhanced. However, it is important to recognize that horses being fed for faster growth have a greater total requirement for protein, minerals and other nutrients than horses fed for slower growth.[24]

Table 1. Daily nutrient requirements of growing horses (1,100 pounds mature weight).

Class	Digestible energy (Mcals)	Crude protein (pounds)	Calcium (grams)	Phosphorus (grams)	Vitamin A (UIs)
Weanling (4 months)	14.4	1.60	34	19	8,000
Weanling (6 months)					
Moderate growth	15.0	1.65	29	16	10,000
Rapid growth	17.2	1.90	36	20	10,000
Yearling (12 months)					
Moderate growth	18.9	1.90	29	16	15,000
Rapid growth	21.3	2.10	34	19	15,000
Long yearling (18 months)					
Moderate growth	19.8	2.00	27	15	18,000
Rapid growth	26.5	2.60	36	20	18,000

Adapted from National Research Council, (1989).

Deficiencies of certain trace minerals may contribute to DOD.[7] From a survey of 19

breeding farms in Ohio and Kentucky, some have suggested that foals may require more copper than previously recommended.[20] However, there may have been other factors involved in the growth problems observed in that survey. In another study, three levels of copper were fed to weanlings with no effect on wither height or bone density[36]. Toxic amounts of zinc appear to interfere with copper absorption, but the varying copper:zinc ratios that occur in normal diets do not interfere with copper absorption.[9,41] Although the trace mineral needs of growing horses are not completely known, they should be fed concentrate feeds that contain adequate, balanced amounts of trace minerals and salt. High quality commercial feeds usually contain adequate trace minerals, but horsemen who prepare their own mixes will need to add trace mineral salt or vitamin/trace mineral premixes to concentrate diets.

USE OF SPECIFIC FEEDSTUFFS AND POTENTIAL PROBLEMS

Energy feeds such as oats, corn, barley and sorghum can be used in formulating a balanced concentrate. Oats provide the least energy per unit of weight and must be fed in larger amounts. Regardless of which energy sources are fed, they must be accompanied by sufficient high quality protein and necessary vitamins and minerals. When commercial feeds are mixed with some other cereal grain such as oats or corn,[12] a practice called "cutting," the nutrient:energy balance of the final diet is altered. This can ultimately contribute to growth abnormalities. Horseowners should also be aware that moldy corn poisoning can cause death in horses. Rations should be formulated only with the highest quality corn available and the use of corn screenings should be avoided entirely.[30]

Fats and oils can be used to increase the energy density of grain mixes. Most commercial horse feeds contain approximately 3 percent natural fat, which is shown on the feed tag. Some commercial feeds contain supplemental fat (Example: a feed tag indicating 8 percent fat means that approximately 5 percent added fat is being used). Horse owners should bear in mind that topdressing fat or oil onto a balanced diet dilutes the total nutrient balance. Therefore, the ration should be properly balanced if fat or oil will be added.

Protein supplements such as soybean, cottonseed and linseed meals can be used in formulated rations. Because of its higher lysine concentration, soybean meal provides better growth rates than cottonseed meal when fed in equal amounts.[23,29] Cottonseed meal can be used if at least half of the supplemental protein comes from soybean meal or if synthetic amino acids are used to correct deficiencies in specific amino acids.

High quality grass or legume hays work well in meeting the roughage needs of horses. Hay with even a small amount of mold should not be fed. Alfalfa hay can contain blister beetles. The beetles contain cantharidin, a compound which is highly toxic to horses. Before purchasing alfalfa hay horse owners should ask hay producers whether steps were taken to avoid blister beetles. Blister beetles can be found in other hays, but they are found more often in alfalfa than other sources of roughage.

Careful selection of high quality feedstuffs and accurate ration formulation will help ensure that the juvenile skeleton develops adequately as body weight increases. This is extremely important when young horses are receiving forced exercise. Horses being fitted and conditioned for sales, futurities and pre-race training are remodelling bone in response to work. While accurate ration formulation and feeding can't guarantee the absence of DOD, they will at least eliminate the possible nutritional causes of such problems.

CREEP FEEDING FOALS

Although brood mares can produce large amounts of milk, the nutritional density of the milk declines over time. The energy received from a mare's milk may not meet the requirements of a 4-month-old, or even younger, foal.[6] Nursing foals show an interest in eating soon after birth, often consuming small amounts of feed from the mare's trough. However, foals have very different requirements than mares, so a creep ration should be provided. Foals may gain 2.5 to 3 pounds daily, and with the right

feed, owners can take advantage of this early growth potential.

Creep feeders can be constructed in a pasture or corral and should be mare-proof. Placing feeders in areas where mares normally congregate, with easy access for foals, will encourage foals to start eating a creep ration and will minimize injury.

Creep feed should be introduced slowly and usually should be made available on a free-choice basis.[24] Having free access to creep feed improves the likelihood that foals will consume it in frequent small meals, similar to nursing. Feeders should be checked daily to monitor the amount eaten and prevent feed from becoming spoiled by weather, birds, rodents or other factors. Careful management is necessary, especially where several foals are using the same feeder. Sometimes one foal may become highly dominant and consume large amounts of creep feed while preventing the other foals from entering the feeder.

The concentration of protein, minerals and vitamins needed in a good creep feed is influenced by the amount of energy (calories) a young foal will eat. Feed tags do not usually indicate how many calories are in a feed, but they do list the percentages of crude fiber and fat. Both fiber and fat are indicators of caloric density and can be used to determine the minimum amounts of protein and minerals that should be in the feed. **Table 2** shows the percentages of protein, calcium and phosphorus needed in concentrates without supplemental fat. A grain mix with no supplemental fat usually contains 3 to 3.5 percent fat, the amount that occurs naturally in most grains.

Supplemental fat increases the total energy density of a grain mix. Therefore, at a given crude fiber level, feeds with supplemental fat need higher percentages of protein and minerals than grain mixes or concentrates containing no supplemental fat. **Table 3** shows minimum amounts of protein and minerals needed in grains of varying crude fiber content where 5 percent supplemental fat has been added (8 to 8.5 percent total fat shown on the tag).

Feeds tags will always show the percentage of crude protein, but may or may not include percentages of minerals. Ask the retailer or call the manufacturer directly to obtain this information.

From a practical standpoint, creep feeds should always contain at least 16 percent crude protein, .80 percent calcium and .50 percent phosphorus. When lesser amounts are provided, it is hard for young horses to consume enough protein (particularly lysine) and minerals in a reasonable amount of daily feed.

Many top quality brood mare feeds are well balanced and contain about 14 percent crude protein. But even though these feeds have suitable protein and calcium:phosphorus ratios for mares, they do not meet the requirements of foals. Relative to the amount of energy provided, such feeds often provide no

Table 2. Concentrations of protein and minerals needed in creep feeds of varying crude fiber levels with no supplemental fat (3.0 to 3.5 percent crude fat shown on tag)

If tag indicates crude fiber percent of	Then the following minimums are needed		
	Crude protein (%)	Calcium (%)	Phosphorus (%)
2	18	.90	.55
3	18	.85	.55
4	17	.85	.55
5	17	.80	.50
6-8	16	.80	.50

Table 3. Concentrations of protein and minerals needed in creep feeds of varying crude fiber levels with 5 percent supplemental fat (8.0 to 8.5 percent crude fat shown on tag).

If tag indicates crude fiber percent of	And, total crude fat percent of	Then the following minimums are needed		
		Crude protein (%)	Calcium (%)	Phosphorus (%)
2	8-8.5	19	.95	.60
3	8-8.5	19	.90	.55
4	8-8.5	18	.90	.55
5	8-8.5	18	.85	.55
6	8-8.5	17	.85	.55
7	8-8.5	17	.80	.50
8	8-8.5	16	.80	.50

more than 90 percent of the protein and 65 percent of the calcium needed by foals **(see Table 4).**

Table 4. Comparison of foal requirements and nutrients provided per unit of energy for foals eating a typical brood mare feed.

	Nutrient:calorie ratios (grams/Mcal DE)	
	Provided by brood mare feed	Requirements of foal
Protein	45.4*	50.0
Lysine	2.0*	2.1
Calcium	1.6*	2.4
Phosphorus	1.4	1.3

* Less than required by foal.

Such feeds may cause a deficiency of lysine, the primary amino acid needed for growth. Young horses on brood mare feeds may consume enough energy to gain weight while receiving an inadequate nutrient supply for proper growth and skeletal development. The result is often fat foals with improperly developed musculoskeletal systems. In the absence of creep feeding a balanced foal ration, the only way to avoid such a situation is to feed brood mares a grain mix that will meet the nutrient requirements of the foal. In most cases it is more economical to creep feed the foal in a separate feeder. **Table 5** shows an example creep ration for young foals.

Even when foals do have access to a balanced feed they should be observed carefully to make sure they do not sort, thereby consuming an unbalanced diet. Because foals tend to be picky eaters, pelleted creep feeds are preferable to textured feeds when sorting is a problem. They are not harmful to horses if the feeds are of top quality and the pellets are firm enough to force horses to chew them.

FEEDING WEANLINGS

Research has shown that gradually weaned foals exhibit less stress than abruptly weaned foals.[22] Whenever foals are weaned, the transition will likely be smoother and growth of foals will be improved if they have been creep fed.

The weaned foal that will weigh 1,100 pounds at maturity is expected to gain 1.5 to 2 pounds daily at 6 months of age. Total daily intake of hay and concentrate will usually range from 2 to 3.0 percent of the horse's body weight. Higher levels of intake are difficult to achieve and may overwhelm the digestive capabilities of a weanling.

At weaning, many horses are placed in confinement to facilitate a fitting program of some type. Young horses that are stalled and given forced exercise need the correct nutrient balance to minimize joint disorders and allow for the increased skeletal remodeling that occurs in response to work. Because these young horses must lay down bone in support of both

Table 5. Creep feed and weanling ration (weanling ration designed to be fed with good quality grass hay or grazing.*)

Ingredients	Percent	Pounds/ton
Cracked corn	40	800
Oats	32.5	650
Soybean meal	20	400
Molasses	5	100
Calcium carbonate	1	20
Dicalcium phosphate	1	20
TM salt	.5	10
Vitamin A	+	+

CALCULATED ANALYSES

C.P. = 16.5%
Lysine = .80%
Dig. energy = 1.39 Mcal/lb.
Fat = 3.2 %
Fiber = 5.5%
Calcium = .80%
Phosphorus = .50%
Vit A added at 1,200 IU's/lb.

***Important: Read section on use of feedstuffs and potential problems**

growth and exercise, an inadequate nutrient supply can produce weak, fibrous bone rather than strong, dense bone.

An exclusive diet of oats and alfalfa hay continues to be popular with many horseman. While both are excellent feedstuffs, a 70:30 ratio of oats to alfalfa hay provides only 86 percent of the lysine and 81 percent of the calcium needed by a weanling, relative to the caloric density of that diet **(see Table 6)**. Also, a 50:50 diet of oats and alfalfa, which is commonly fed, provides even less of the required nutrients.

Table 6. Comparison of weanling requirements and nutrients provided per unit of energy for a weanling eating oats and alfalfa hay.

	Nutrient: calorie ratios (grams/Mcal DE)	
	Provided by oats/alfalfa	**Required by weanling**
Protein	49.2*	50.0
Lysine	1.8*	2.1
Calcium	1.7*	2.1
Phosphorus	1.2	1.2

*** Less than required by weanling.**

This does not mean that oats and alfalfa hay should not be fed as part of the daily diet; but the diet is unbalanced and supplemental nutrients are needed to help prevent swollen physes, joints and other skeletal problems. In one study, horses fed only oats and alfalfa were compared to horses fed a balanced concentrate with alfalfa. Horses eating only oats and alfalfa got fatter, while those eating the balanced concentrate gained more height.[11]

Young horses can be developed equally well with either grass or legume roughage. The type and quality of hay or grazing available will influence the nutrient concentration needed in the grain or concentrate mix. Research has shown that high quality alfalfa is more digestible than grass hay, but good quality grass hay is more digestible than average quality alfalfa.[10] The added "bloom" that some horse owners recognize when feeding alfalfa is due to the additional energy in alfalfa as compared to many grass hays. This same appearance can be achieved when grass hay is being used as the roughage source by ensuring that the grain mix has been balanced for nutrients according to the nutrient content of the hay being fed.

The ration shown in **Table 5** was designed to be fed with high quality grass hay in a 70:30 grain-to-hay ratio.

Weanlings with access to good quality alfalfa hay generally need less protein and calcium in the concentrate mix. However, the grain mix should always contain at least as much calcium as phosphorus and enough protein to meet amino acid requirements. Although alfalfa contains much more calcium and protein than grass hays, some of the calcium may be unavailable and much of the protein is

not absorbed in the form of amino acids needed for growth.[10,17] **Table 7** shows a weanling ration formulated to be fed with alfalfa.

FEEDING YEARLINGS

As young horses become yearlings, the nutrient concentration in proportion to energy levels in feedstuffs becomes lower but no less important. Yearlings not being fitted for sales, futurities or early training can be developed at a moderate rate of growth on all forage diets[15,32]. Forage availability is as important as forage quality in determining growth rates.[1,39] Yearlings being fitted or conditioned and receiving forced exercise will require a combination of roughage and concentrate, regardless of whether moderate or rapid growth is desired. Yearlings receiving top quality grass hay or grazing can be fed a balanced ration, such as that shown in **Table 7**, at a 65:35 ratio of grain-to-hay. If lower quality hay is being fed (less than 7.5 percent crude protein), a ration higher in protein and other nutrients would be required. Yearlings fed top quality alfalfa hay (minimum 15 percent crude protein) will require a grain or concentrate containing at least 12 percent crude protein. Since hay quality is quite variable, serious horse owners can benefit by taking core samples from the hay supply to be analyzed for nutrient content.

LEVELS OF FEEDING

Some of the very best formulated rations do not yield desirable results simply because of the manner in which they are fed. Even the most carefully balanced grain mix will only be as effective as the feeding management program in which it is used. Hay and grain intake varies according to the individual and is influenced by exercise. Body condition should be monitored routinely[16] and horsemen must increase or decrease the feed allowance based on a horse's appearance. Remember that all horses' requirements are on a weight rather than volume basis. The grain rations shown in **Tables 5 and 7** contain more energy than plain oats, meaning that from 10 to 15 percent less concentrate is normally needed to achieve a similar appearance in body condition. **Table 8** shows examples of various amounts of hay and concentrate to be fed. These are **minimum** amounts needed to meet the average horse's requirements. Feed intake should be increased gradually, making sure that hay intake remains adequate. Note the differences in feed intake for moderate versus rapid growth.

EXERCISE

Epiphysitis, osteochondrosis and some expressions of "contracted tendons" may result from nutrient imbalances in young horses receiving excessive forced exercise in deep footing. Obviously, horses being conditioned for shows or sales must be kept in confinement and worked, but the manner in which they are

Table 7. Weanling ration (to be fed with alfalfa hay*) or yearling ration (to be fed with grass hay*)

Ingredients	Percent	Pounds/ton	CALCULATED ANALYSIS
Cracked corn	47.5	950	C.P. = 14.7% Lysine = .66% Dig. Energy = 1.42 mcal/lb Calcium = .66% Phosphorus = .63% Vit A added at 1500 IU's/lb.
Oats	30	600	
Soybean meal	15	300	
Molasses	5	100	
Calcium carbonate	.5	10	
Dicalcium phosphate	1.5	30	
TM salt	.5	10	
Vitamin A	+	+	

*** Important: Read section on Use of Feedstuffs and potential problems.**

Table 8. Examples of various daily feeding amounts for young horses being fed rations shown in tables 5 and 7* (1,100-pound mature weight).

Age	Alfalfa hay (pounds)	Pounds 14% mix (Table 7)	Grass hay (pounds)	Pounds 16% mix (Table 5)	Total feed (pounds)
Weanlings					
Moderate growth	3.75	8.75			12.5
Rapid growth	4.00	10.00			14.0
Moderate growth			3.75	8.75	
Rapid growth			4.00	10.00	
Yearlings					
Moderate growth		10.00	7.00		17.0
Rapid growth		11.25	7.25		18.5

* Combinations of hay and grain shown represent MINIMUM amounts to meet requirements. Adjust intake gradually according to desired body condition based on individual variability and exercise. Horses should be fed at least twice daily. Dividing total amounts shown into at least two equal feedings will minimize digestive disorders.

worked is very important. Intense, hard work should be introduced gradually to encourage proper bone remodeling. Sudden changes in stress will cause the skeletal system to remodel bone and it takes time to develop the needed strength. The conditioning program should provide adequate free exercise if at all possible. Some conditioning programs alternate intense work with free exercise and less intense work on a weekly basis to provide time for bone remodeling to occur. It is important to remember that the skeletal system must be developed first and the muscle system later. The skeletal system is best stimulated by very short work periods on firm footing, followed by free exercise on soft footing.[4] Excessive forced or free exercise on firm footing may cause trauma to the juvenile skeleton.

ANABOLIC STEROIDS

There has been a great deal of interest in the use of anabolic steroids and their effect on the horse industry. Controlled research trials have shown that growth rates are not improved in horses injected with varying levels of anabolic steroids.[5] However, these studies did observe altered sexual behavior in treated horses.[34,35] Injected stallions had decreased scrotal width and testicular weight was 40 to 60 percent less than in untreated horses. Sperm motility, concentration and total sperm per ejaculate were all severely lowered by steroid treatment. Injected mares had small, hard ovaries typical of winter anestrous mares. These mares cycled less regularly and often exhibited abnormal behavior such as mounting and teasing. There is also evidence that anabolic steroids may actually cause premature closure of the physes of long bones,[19] resulting in cessation of growth. These studies all suggest that the use of anabolic steroids for growth promotion is detrimental to young horses.

BLOOD AND HAIR ANALYSIS

Blood and hair analyses are sometimes used as indicators of nutritional status. However, it should be pointed out that blood calcium levels normally remain fairly constant at the expense of calcium mobilization from the bone, regardless of calcium in the diet.[21] Furthermore, hair analyses are of little or no value as a measure of calcium and phosphorus status, and may not be indicative of mineral deficiencies.[8,40] The only reliable indicator of nutritional status lies in proper ration formulation and accurate feeding management.

SUMMARY

Raising young horses that are sound and competitive in today's horse industry requires a carefully planned feeding and management program. Some horses inherit a propensity for skeletal defects, and such problems may appear when these horses are fed for rapid early development. In many cases, however, skeletal disorders are the result of nutrient imbalances which precipitate abnormal

bone metabolism. When such nutrient imbalances are combined with confinement and excessive, forced exercise in deep footing, skeletal problems may occur. There is no reason to expect that rapid early growth itself will cause skeletal disease and lameness if horses are free of genetic defects. Horse owners who give time and care to the feeding of properly balanced rations will be more successful growing young horses at a moderate or rapid rate and ensuring that they are sound at maturity.

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