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Digestive System of the Horse and Feeding Management

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Animals have different types of digestive systems based on where and how they digest components. Non-ruminant systems are characterized by enzymatic digestion of carbohydrates, proteins and fats in the foregut, with limited fiber digestion in the hindgut. Digestive systems of man, pigs and dogs are examples of this type of digestion. Ruminants, such as cows, sheep and deer, have more complex digestive systems which allow fiber digestion in the rumen, enzymatic digestion in the foregut and relatively minimal digestion of fiber in the hindgut. The horse's digestive system is somewhat intermediate between other nonruminants and ruminants in that high rates of enzymatic digestion occur in the foregut (mouth to ileum); plus, high rates of fermentive microbial digestion occur in the hindgut (cecum to rectum). The horse is classified as a nonruminant herbivore – a roughage eater.

Figure 1 shows the horse's digestive tract with approximate lengths and capacities of various compartments of the tract. Accessory organs that aid in digestion (not shown) include the teeth, salivary glands, liver and pancreas.

This diagram has been stretched out for demonstration purposes and thus is not anatomically correct. Figure 2 is a closeup of the major components of the horse digestive tract.

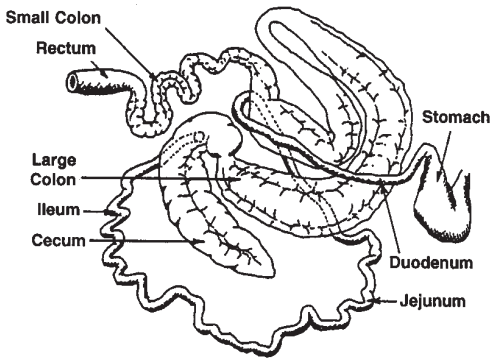

Figure 2.
Components of Horse Digestive Tract

The foregut includes the mouth, esophagus, stomach and small intestine. Digestion begins in the mouth where feeds are chewed and wetted with saliva. The chewing process cracks the outer shell of grains, reduces the particle size of feeds and increases the surface area of food particles.

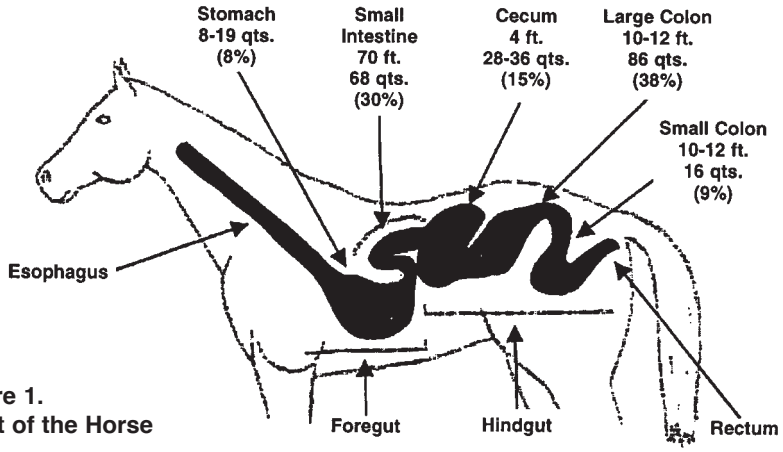

Figure 1.
Digestive Tract of the Horse

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The horse's stomach is small, relative to the total tract, and cannot accommodate large quantities of food at any one time, resulting in eating several times per day due to limited one-time capacity. Limited enzymatic digestion and some fermentive digestion from a small microbial population occurs in the stomach. Food remains in the stomach only about 15 minutes before it starts to pass into the small intestine. This limited capacity and any excess gas products in the stomach can cause the rupture of the stomach, other digestive upsets and death.

The small intestine is the site for a major portion of nutrient absorption. Here soluble carbohydrates are digested to simple sugars and absorbed for use as energy. Efficiency of carbohydrate digestion in the small intestine appears to be important to increase the energy available to the horse and decrease the potential for colic or founder caused by excessive carbohydrates reaching the hindgut. The small intestine appears to be the primary site for fat digestion and absorption. Diets containing 10 to 15 percent fat can be tolerated and used for energy. About 50 to 70 percent of the protein in grain-based diets is digested to amino acids and absorbed from the small intestine, but less than one-third of hay protein is absorbed from the upper tract. The fat soluble vitamins A, D, E and K are also absorbed in the small intestine along with B-vitamins, calcium and some phosphorus. Passage of feeds through the small intestine takes approximately 30 to 90 minutes.

The horse's hindgut includes the cecum, large colon, small colon and rectum. The cecum hangs against the right side of the abdominal cavity at the juncture of the horse's body trunk and hind leg. During or immediately after a horse eats, gut sounds, which are mixing activities of the cecum, can be heard normally by placing one's ear against the abdominal wall in the area of the cecum. Veterinarians routinely listen for these gut sounds when diagnosing digestive disturbances. Absence of gut sounds may indicate abnormal cecal activity.

The horse's hindgut contains an active population of bacteria and protozoa similar to that of the rumen in ruminants. Microbes break down fibrous feeds into short-chained volatile fatty acids. This microbial action allows the horse to efficiently utilize forages, either green or cured. Volatile fatty acids are an energy source for the horse, and the amount and proportion produced can be altered by composition of the diet. Starch that reaches the hindgut is fermented to volatile fatty acids plus lactic acid. Again, digestive disorders can occur when excessive amounts of soluble carbohydrate reach the hindgut, causing an excess of lactic acid to be produced. Therefore, maximizing starch digestion in the foregut is of the utmost importance to horsemen.

Microbes synthesize amino acids in the large intestine, but essential amino acids are not absorbed in any appreciable quantity from the hindgut. This means that, unlike the ruminant, the horse cannot eat low quality protein feeds and then convert this protein into higher quality protein for absorption and use in the body. Considerable amounts of B-vitamins are synthesized by the microbes in the hindgut and are absorbed. It appears that thiamine is not absorbed in sufficient quantities to meet the requirements of hard-working horses and, therefore, should be added to the rations of those horses that are classed as hard-working (e.g., jumping, roping, endurance riding, racing). Rate of passage through the cecum and large intestine is 36 to 72 hours.

Many factors can influence the digestibility of nutrients in the complex digestive tract of the horse. These include type of feedstuff, level of maturity of forage, method of processing feedstuffs, quantity fed, frequency of feeding, rate of passage and age and individual differences among horses.

Feeding Management Guidelines

Horses require different amounts of nutrients in their daily diets depending upon their nutritional class or status in life. Table 1 lists the nutritional requirements of horses as determined by the National Research Council. For this discussion, the classes are mature idle, working, growing and stage of reproduction. Dividing horses into classes relative to nutrient requirements is the first step in designing a workable feeding management program. This approach helps a horse owner meet each horse's nutrient requirements in the most manageable and economical fashion. The following suggestions should help in designing your feeding management program.

1. **Feed horses according to body weight**.

Table 2 shows recommended daily feed intakes by horses as a percent of body weight. The most accurate method of determining body weight is to weigh the horse on a scale. Where weighing is impractical, weight tapes or body measurement formulas can be used. Probably the most commonly used technique for determining body weight is the heart girth tape, which is available from feed dealers, veterinarians and livestock supply companies. Another method for estimating a horse's body weight is the body weight equation. One equation is:

$$W = \frac{HG^2 \times BL}{330}$$

where W = weight in pounds, HG = heart girth in inches and BL = body length in inches (point of shoulder to point of hip).

Table 1. Nutrient Concentrations in Total Diets for Horses and Ponies (90% dry matter basis)

	Digestible Energy[a]	Diet Proportions		Crude		Cal-	Phos-	Magne-	Potas-	Vitamin A	
	(Mcal/lb)	Conc. (%)	Hay (%)	Protein (%)	Lysine (%)	cium (%)	phorus (%)	sium (%)	sium (%)	(IU/kg)	(IU/lb)
Mature Horses											
Maintenance	0.80	0	100	7.2	0.25	0.21	0.15	0.08	0.27	1650	750
Stallions	1.00	30	70	8.6	0.30	0.26	0.19	0.10	0.33	2370	1080
Pregnant Mares											
9 months	0.90	20	80	8.9	0.31	0.39	0.29	0.10	0.32	3330	1510
10 months	0.90	20	80	9.0	0.32	0.39	0.30	0.10	0.33	3280	1490
11 months	1.00	30	70	9.5	0.33	0.41	0.31	0.10	0.35	3280	1490
Lactating Mares											
Foaling to 3 months	1.10	50	50	12.0	0.41	0.47	0.30	0.09	0.38	2480	1130
3 months to weaning	1.05	35	65	10.0	0.34	0.33	0.20	0.08	0.30	2720	1240
Working Horses											
Light work[b]	1.05	35	65	8.8	0.32	0.27	0.19	0.10	0.34	2420	1100
Moderate work[c]	1.10	50	50	9.4	0.35	0.28	0.22	0.22	0.36	2140	970
Intense work[d]	1.20	65	35	10.3	0.36	0.31	0.23	0.12	0.39	1760	800
Growing Horses											
Weanling, 4 months	1.25	70	30	13.1	0.54	0.62	0.34	0.07	0.27	1420	650
Weanling, 6 months											
Moderate growth	1.25	70	30	13.0	0.55	0.50	0.28	0.07	0.27	1680	760
Rapid growth	1.25	70	30	13.1	0.55	0.55	0.30	0.07	0.27	1470	670
Yearling, 12 months											
Moderate growth	1.15	60	40	11.3	0.48	0.39	0.21	0.07	0.27	1950	890
Rapid growth	1.15	60	40	11.3	0.48	0.40	0.22	0.07	0.27	1730	790
Long yearling, 18 mos.											
Not in training	1.05	45	55	10.1	0.43	0.31	0.17	0.07	0.27	2050	930
In training	1.10	50	50	10.8	0.45	0.32	0.18	0.08	0.27	1620	740
Two year old, 24 mos.											
Not in training	1.00	35	65	9.4	0.38	0.28	0.15	0.08	0.27	2380	1080
In training	1.10	50	50	10.1	0.41	0.31	0.17	0.09	0.29	1840	840

[a]Values assume a concentrate feed containing 3.3 Mcal/kg and hay containing 2.00 Mcal/kg of dry matter.
[b]Examples are horses used in Western and English pleasure, bridle path hack, equitation, etc.
[c]Examples are horses used in ranch work, roping, cutting, barrel racing, jumping, etc.
[d]Examples are race training, polo, etc.

Table 2. Recommended Daily Feed Intakes as Percent of Body Weights*

Class	Forage	Concentrate	Total
Mature Horses			
Maintenance	1.5-2.0	0-0.5	1.5-2.0
Working			
Light	1.0-2.0	0.5-1.0	1.5-2.5
Medium	1.0-2.0	0.75-1.5	1.75-2.5
Intense	0.75-1.5	1.0-2.0	2.0-3.0
Late Gestation	1.0-1.5	0.5-1.0	1.5-2.0
Lactating Mares	1.0-2.0	1.0-2.0	2.0-3.0
Young Horses			
Yearling foal (12 months)	1.0-1.5	1.0-2.0	2.0-3.0
Long yearling (18 months)	1.0-1.5	1.0-1.5	2.0-2.5
2-year-old (24 months)	1.0-1.5	1.0-1.5	1.75-2.5

Air dry feed, 90% dry matter
Source: NRC, 1989

2. **Feed horses according to condition scores**.

Feed adjustments should be made according to condition scores so they can be fed to optimal condition and subsequently achieve maximum reproductive and performance efficiency. Table 3 is a condition scorecard. The ideal condition score for most horses is 5 to 7.

3. **Feed adequate long stem forage**.

As a nonruminant herbivore, the horse innately has a need to forage or chew long roughage. A horse requires 1 percent of its body weight daily of long-stemmed roughage to allow for normal activity of the digestive tract.

4. **Provide feed by weight, not volume**.

Standard volumes of feedstuffs do not weigh the same due to their density differences. For example, a

Table 3. Condition Scorecard*

	Score	Back	Ribs (midbarrel)	Neck	Shoulder (forerib)	Withers	Tailhead
poor	1	very prominent vertebrae	very prominent	extremely thin	prominent	prominent	very prominent
very thin	2	prominent vertebrae	prominent	very thin	very thin	very thin	very thin
thin	3	vertebrae - fat half way up	see easily	thin	thin	thin	prominent
moderately thin	4	negative crease	see slight outline	moderately thin	moderately thin	moderately thin	some fat
moderate	5	level (no crease)	not see; easily feel	blend into shoulder	blend smoothly into body	rounded	moderate fat
moderately fleshy	6	slight crease	not see; feel	little fat	little fat	little fat	moderate fat
fleshy	7	average crease	barely feel	average fat	average fat	average fat	fleshy fat
fat	8	obvious crease	difficult to feel	fat	flush behind	fat filled	fat
extremely fat	9	very obvious crease	not feel (patchy fat)	bulging fat	bulging fat	bulging fat	bulging fat

*Adapted from NRC-Nutrient Requirements of Horses.

standard 3-pound coffee can containing 32 pounds per bushel oats will weigh 2½ pounds; 38 pounds per bushel oats will weigh 4 pounds; and the same can filled with corn will weigh 5 pounds. Hays will vary just as grains and concentrates. Always check feed weight per unit volume, especially when new or different feeds and hays are purchased.

5. **Never feed concentrates at a level more than 0.75 percent of body weight at any one feeding**.

For example, a 1,000-pound horse should never be fed more than 7.5 pounds of concentrate at any one feeding. If more than 7.5 pounds of concentrate is required by an individual horse, split the amount equally and feed two or more times per day. Space multiple feedings throughout the day and feed daily at set feeding times. Horses are creatures of habit and respond positively to a regular schedule.

6. **Avoid abrupt ration changes**.

Ration changes become necessary in the normal production cycle. Typically these changes are in amounts, types or forms of feedstuffs. When changing a ration, some changes can be made almost immediately, some require a few days and others will require a week or longer. For example, changing from one textured concentrate to another with equal energy densities is only a slight change and can be done in a few days. However, changing horses from a ration high in oats to one high in corn represents a significant change in energy and will require a week or more to safely make the transition. When changing horses from grass hay to lush pasture, turn horses out for only a few hours for two to three days, then half a day for two to three days and then out to the lush pasture continuously. If this gradual changeover is not feasible, fill the horses up on dry, bulky grass hay prior to turning them out on lush pasture. A similar management scheme should be followed when changing from grass hay to lush legumes.

Selecting the Correct Feed

For the majority of horse owners, the best way to feed horses is to choose the best available forage, either pasture or hay, and then purchase a complete, balanced commercial grain concentrate. Commercially prepared feeds are practical for feeding a small number of horses. Hay should be tested to determine the amount of essential nutrients it can provide.

Many of the commercially prepared feeds from reputable companies are balanced for protein, calcium, phosphorus; contain trace mineralized salt; and are fortified with vitamins. The nutrients provided in the commercial concentrate may be determined by reading the feed tag, with one exception. That exception is energy. It is not required by law to print the energy content of a feed on the tag. However, energy content may be estimated by its relationship to percent crude fiber (Table 4).

Owners with a large number of horses may find it more economical and practical to custom mix a ration and have it delivered in bulk. Those owners choosing to mix rations on the farm should take time to balance for protein, energy, minerals and vitamins. If individual grains are purchased for mixing, only the highest quality should be used. Some sample rations are included (Tables 5-10).

The horse is dependent upon its owner to provide the proper nutrients and management system for optimum health and performance. Knowledge of the horse's digestive system and nutrient requirements combined with a sound feeding management plan assures the horse owner that the horses in their care will be healthy and have the ability to reach maximum performance level.

Table 4. Relationship of Crude Fiber to Expected Digestible Energy in Conventional and Fat-Supplemented Grain Mixes

If the feed tag indicates crude fiber (%) of	Then, the digestible energy (Mcal/lb) of the feed will be approximately	But, if the feed also contains 4%-5% added fat (tag shows 7%-8% fat), then the digestible energy will be approximately
2	1.62	1.72
4	1.55	1.65
6	1.45	1.55
8	1.35	1.45
10	1.25	1.35
12	1.15	1.25
(and 3% to 3.75% fat)		

Table 5. Example Performance Horse Ration (designed to be fed with good quality grass hay or grazing)

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Cracked Corn	45.00	900	Crude Protein = 12.0%
Whole Oats	42.50	850	Digestible Energy = 1.39 Mcal/lb.
Soybean Meal	7.50	150	Crude Fiber = 6.0%
Molasses	3.25	65	Crude Fat = 3.7%
Calcium Carbonate	.75	15	Calcium = .36%
TM Salt	1.0	20	Phosphorus = .32%
Vitamin A	+	+	
Vitamin E	+	+	**Important**: See Table 2 on expected feed consumption and always introduce new grain feeds gradually. This ration contains approximately 6% more energy than straight oats, so smaller amounts of this ration will usually maintain similar body condition.

Table 6. Fat-Supplemented Performance Ration for Hard Working Horses (to be fed with grass hay)

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Cracked Corn	40.00	800	Crude Protein = 14.0%
Whole Oats	37.50	750	Digestible Energy = 1.50 Mcal/lb.
Animal Fat	5.00	100	Crude Fiber = 5.7%
Soybean Meal	12.25	245	Crude Fat = 8.25%
Molasses	2.00	40	Calcium = .42%
Calcium Carbonate	.75	15	Phosphorus = .38%
Dicalcium Phosphate	.25	5	
Brewer's Yeast	1.25	25	**Important**: See Table 2 on expected feed consumption and always introduce new grain feeds gradually. This ration contains 8% more energy than the ration shown in Table 5 and 13% more energy than straight oats, so smaller amounts of this ration will usually maintain similar body condition.
TM Salt	1.0	20	
Vitamin A	+	+	
Vitamin E	+	+	

Table 7. Brood Mare Ration to Be Fed with Good Quality Hay or Grazing During Late Pregnancy and Lactation

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Oats	40.00	800	Crude Protein = 14.8%
Cracked Corn	40.00	800	Digestible Energy = 1.4 Mcal/lb.
Soybean Meal	15.00	300	Crude Fat = 3.3%
Molasses	3.00	60	Calcium = .59%
Ground Limestone	.75	15	Phosphorus = .50%
Dicalcium Phosphate	.75	15	
TM Salt	.50	10	
Vitamin A	+	+	

Table 8. Fat-added Ration to Be Fed with Good Quality Hay or Grazing During Late Pregnancy and Lactation

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Oats	35.00	175.00	Crude Protein = 16.2%
Cracked Corn	35.00	175.00	Digestible Energy = 1.51 Mcal/lb.
Added Fat	5.00	25.00	Crude Fat = 8%
Soybean Meal	20.00	100.00	Calcium = .67%
Molasses	2.00	10.00	Phosphorus = .58%
Ground Limestone	.75	3.75	
Dicalcium Phosphate	1.25	6.25	
TM Salt	1.00	5.00	
Vitamin A	+	+	

Table 9. Yearling Ration (to be fed with grass hay)

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Cracked Corn	47.5	950	Crude Protein = 14.7%
Oats	30.0	600	Lysine = .66%
Soybean Meal	15.0	300	Digestible Energy = 1.42 Mcal/lb.
Molasses	5.0	100	Calcium = .66%
Calcium Carbonate	.5	10	Phosphorus = .63%
Dicalcium Phosphate	1.5	30	
TM Salt	.5	10	
Vitamin A	+	+	

Table 10. Creep Feed and Weanling Ration (weanling ration designed to be fed with good quality grass hay or grazing)

Ingredients	Percent	Pounds/Ton	Calculated Analyses
Cracked Corn	40.0	800	Crude Protein = 16.5%
Oats	32.5	650	Lysine = .80%
Soybean Meal	20.0	400	Digestible Energy = 1.39 Mcal/lb.
Molasses	5.0	100	Fat = 3.2%
Calcium Carbonate	1.0	20	Fiber = 5.5%
Dicalcium Phosphate	1.0	20	Calcium = .80%
TM Salt	.5	10	Phosphorus = .50%
Vitamin A	+	+	

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