Nutrition of the Aged Horse

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Ageing is defined as the "accumulation of changes in an organism or object over time" (Jarvis, 2009). Horses are living into their 30s, and the changes that occur to their bodies with the ageing process are highly individual. Horses that have been well cared for during their youth and middle age will have a better chance of survival and quality of life as they enter their golden years. Previous estimates of the number of aged horses in the United States were around 15% (Rich, 1989), but data from a survey in 2005 by the National Animal Health Monitoring System showed 7.6% of the United States equine population to be over 20 years and only 0.7% over 30 years (Anon, 2005). Currently, there are over 9 million horses in the United States, so the number of older horses could be well over half a million.

In the literature, several terms are used for horses that are long in the years—old, aged, senior, and geriatric are the most common. Which is the correct or preferred term is still up for debate. There tend to be negative connotations surrounding the use of "old," perhaps because it gives the impression that the animal is at the end of its life. The term "senior" is used when referring to the type of feed that is designed with the needs of older horses in mind. Perhaps the most commonly used term, "geriatric," is not appropriate because in human medicine it refers to someone suffering from disease. It therefore may not be appropriate when referring to a healthy older horse (Jarvis, 2009). It seems that "aged" is becoming the preferred term because it is all-encompassing and has a positive connotation (e.g., as fine wine is aged).

There is also no consensus on when a horse actually becomes aged. This threshold can be interpreted chronologically, physiologically, or demographically (Ireland, 2009). Chronological age is the number of years since birth, and 20 years is commonly considered the age at which the horse enters this stage of life. Physiological age compares an animal's functioning relative to a younger animal and is dependent on the use, genetics, management, and environmental factors as to how quickly an animal ages. Demographic age is a measure of survivorship in that an animal is old if, compared to the population, less than 75% of horses survive to that age. The very old would be when there is less than 25% of a population still surviving. Using physiological age makes the most sense when deciding to make changes in how the horse is to be maintained, and perhaps the most important aspect of this is nutrition.

Challenges Facing the Aged Horse

Aged horses that have no difficulty maintaining appropriate body condition and are free from disease and dental issues will be able to thrive on a diet similar to younger horses. The increasing number of healthy aged horses could be due to improved husbandry with greater owner awareness of advancements in nutrition, farrier care, and routine management, as well as improvements in veterinary care (Ireland, 2009). Elzinga et al. (2011) found no differences in digestive capacity between healthy aged and adult mares. Therefore, the requirements will be those of the regular maintenance horse, and no special adaptations or considerations will be needed. As long as a horse remains healthy in this program, there is no need to switch to alternative sources of forage or special concentrate for seniors.

Low body weight from decreased intake and reduced digestibility

A common problem seen in some aged horses is chronically low body condition. Some possible reasons for this may be decreased intake, reduced digestibility, and environmental factors that increase energy requirements (Siciliano, 2002). A progressive loss of muscle mass is a common characteristic of aged horses. Whether the loss is due to decreased activity level of the horse (retirement) or whether nutrition is involved is not totally clear (Hintz, 1995). Chronic parasitism can have a long-term effect on digestive function and affect the ability of the horse to maintain weight (Ralston, 1990). Other causes can be from dental, metabolic, endocrine or infectious disease.

Temperature and herd dynamics

Herd dynamics can have an effect on the ability of an older horse to ingest sufficient calories. When in a group-feeding situation, an aged horse may end up at the bottom of the pecking order or lose interest in fighting for its share of the food. Competition with new herdmates or loss of a companion may affect appetite or interest in food as well (Jarvis, 2009). All of these result in chronic weight loss if the horse is unable to consume adequate calories. If the horse has soundness or arthritis issues, it may not be willing to travel around to areas of more abundant forage. The older horse may also experience discomfort from extending the neck to graze in a pasture situation to get adequate grass (Siciliano, 2002).

Ambient temperature can have an effect on the ability of the horse to maintain weight. Cold tolerance can become a serious issue in the aged horse and can come from a lack of fat covering for insulation, unwillingness to fight for a spot in a shelter, or not consuming sufficient calories to generate enough internal heat (Cymbaluk et al., 1990). A decreased ability of an aged horse to adapt to environmental factors has been seen in blood values like red blood cell volume, mean cell hemoglobin concentrations, and absolute lymphocyte count (McFarlane et al., 1998).

Common diseases and disorders

The ageing process involves increased oxidation and free radical damage, which makes aged horses more susceptible to disease. Weight loss is one of the most obvious signs. It is advisable to have a complete blood chemistry done to rule out medical reasons for weight loss, such as chronic infection, neoplasia, renal dysfunction, or hepatic failure (Ralston, 2006). Aged horses tend to have mild microcytic anemia, but all other values should be within the normal range for adult horses (Ralston et al., 1988). Aged horses have also been found to have an increased number of lymphocytes in response to exercise (Williams et al., 2008), which would imply that aged animals are immune-compromised during exercise. Along with periodontal disease and tooth loss, there are a few diseases that commonly afflict geriatric horses, such as Cushing's disease, colic, laminitis, arthritis, and renal and hepatic problems.

Dental disease. While minor dental abnormalities do not usually cause weight loss or decrease digestibility of feedstuffs (Ralston et al., 2001), serious tooth loss or periodontal disease can have major consequences on the ability of the horse to maintain weight without extreme changes in diet (Roy, 2002). Horses evolved on a predominantly fibrous diet that is highly dependent on thorough mastication to prepare the feedstuffs for digestion. Due to the schedule of tooth eruption in horses, teeth are susceptible to loss starting at approximately 20 years of age because the roots are too shallow to hold them in place after sufficient surface has worn off from continual grinding. Clinical signs of a dental problem may include weight loss, quidding of partially chewed feed, choke, halitosis, feed packing in cheeks, and diarrhea. Periodontal disease can be quite painful, as can loose or

infected teeth, and the horse may be slow to finish feed or exhibit complete anorexia (Knottenbelt, 2003). When forages are not adequately masticated, evidence of long lengths of fiber in the feces can be observed (Jarvis, 2009).

Cushing's disease. Equine Cushing's disease, also known as pituitary pars intermedia dysfunction (PPID), is one of the most common endocrine disorders in aged horses and is caused by the loss of dopaminic inhibition on the pituitary gland from the pressure put on the hypothalamus from development of a tumor on the pituitary gland. The disease rarely occurs in horses under 15 years of age, with the median age around 20 (McGowen, 2009), and is clearly linked to the ageing process. Clinical signs are recurrent or chronic laminitis, insulin resistance, susceptibility to infections, weight gain or loss, polyuria/polydypsia, and most characteristically, hirsutism (Jarvis, 2009). Treatment with pergolide can control some of the consequences of the disease along with dietary changes targeted at controlling blood sugar.

Colic. Aside from being the leading cause of death in horses, colic is the most common health problem in aged horses. In a study in 2003 on United States referral hospital population (Brosnahan and Paradis, 2003), the most common health problem in equines over 20 was colic (39%), of which impaction and strangulating lipoma were most frequent. Grazing difficulty, lipomas and dental disease were the major predisposing causes. In an Auburn study of referral colics, the major causes were 88% impaction colic in older horses versus only 29% of colics from horses of all ages (Carson-Dunkerley et al., 1996). Choke is another problem commonly seen in aged horses. Problems with dentition are the obvious causes of such high incidence of impactions and choke in aged horses because of a lack of ability to properly prepare the feedstuffs for optimal digestion.

Laminitis. The causes of laminitis are many, but in the aged equine it is most likely linked to equine metabolic syndrome (EMS), which is characterized by chronic obesity, insulin resistance, and susceptibility to laminitis. The development of insulin resistance has been associated with increasing age in man and is likely in equines as well (McGowan, 2009). There is an indication of an association with chronic obesity and the development of EMS.

Arthritis. Repetitive use and localized deterioration over time of the joints in the horse may lead to the development of arthritis. Osteoarthritis is a chronic degenerative process that affects the articular cartilage in joints. There is a progressive deterioration caused by inflammation and clinical signs are joint effusion (swelling), lameness, and decreased range of movement. When a horse has osteoarthritis in the forelimbs, there may be increasing pain with grazing as all the weight is shifted forward as the head goes down. The stiffness in the joints may cause an aged equine to be reluctant to move around to graze adequate amounts of fresh forage (Jarvis, 2009). Pain from osteoarthritis may affect the appetite as well. Once osteoarthritis has developed, supportive therapies like feeding a joint supplement or acupuncture are options for improving quality of life.

Hepatic and renal disease. While chronic liver failure is uncommon in horses, the incidence has been found to be double in older horses. Liver failure causes weight loss, lethargy, jaundice, loss of appetite, and intolerance to fat and protein in the diet (Ralston, 2001). Horses that were exposed chronically to ragwort in either badly managed pastures or in poor-quality hay may suffer from cumulative effects of years of exposure causing pyrrolizidine alkaloid hepatotoxicosis (Jarvis, 2009). As the liver is responsible for processing fat and protein and performing gluconeogenesis, the main problems associated with liver failure include a reduced ability to process energy sources, mainly fat and protein. A decrease in energy is seen as a side effect of this reduced ability, in addition to decreased appetite and weight loss (Ralston, 2001).

Renal disease is also uncommon in horses, but it is progressive and irreversible, although some individuals live for months and even years if given the appropriate nutrition support (Schott et al., 1997). Typical signs of renal disease are weight loss, polyuria/polydipsia, ventral edema, and a decreased appetite. Reduced kidney function can result in renal and bladder calculi, weight loss, loss of appetite, and potentially death. Horses excrete a significant amount of excess dietary calcium in their urine. As a result, if kidney function is reduced, renal and bladder "stones" of calcium oxalate are more likely to occur as well as a potentially lethal increase in blood calcium (Ralston, 2001).

Nutrient Requirements for Aged Horses

Not much is known on the exact nutrient requirements of aged horses. While healthy aged horses may not have different requirements than other mature horses, the effects of disease and poor dentition have obvious consequences on energy and protein requirements, and perhaps less obvious effects on certain nutrients. In the absence of established requirements, careful observation of the body condition will assist in evaluating the adequacy of a ration and the health of the horse (Siciliano, 2002).

Control of the environment will aid the horse in overcoming some of the consequences of ageing. For intolerance to temperature extremes, access to adequate shelter in a paddock/pasture without competition for space from younger dominant horses, and blanketing when necessary will help. Continuous turnout with unlimited access to shelter is ideal because it allows free exercise to keep arthritic joints from stiffening up from lack of movement (Ralston, 2006). To ensure adequate nutrition, it is important to supply access to plentiful forage within easy reach without having to travel relatively long distances and uninhibited access to concentrates free from competition of other horses, if necessary (Pugh, 2007). While giving an aged horse a separate enclosure to consume a meal at whatever pace it chooses is ideal, some will have a better appetite if they have a companion (Jarvis, 2009).

Water

Water is the most important nutrient for the horse, regardless of age. Even if the aged horse has free access to plenty of clean, fresh, unfrozen water, there may be times when a horse does not drink adequate water. Keeping drinking water at a fairly constant temperature (not too hot or too cold) will at least eliminate one reason for water refusal, like the effect of cold on sore teeth. Complications from inadequate water intake could be dehydration, constipation, and possibly impaction problems. If the horse is not drinking well, 1 to 2 gallons of water can be poured over the horse's feed and served as a sloppy mash (Ralston, 2006). Adding 1 to 2 ounces of salt to the feed will stimulate the thirst response and encourage drinking, but the salt may deter the horse from eating the feed.

Protein

Protein has so many functions in the body that it makes up 80% of the body tissues (after the removal of fat and water), and it has a wide range of roles within the body. Daily intake of protein is important because of continual turnover of body proteins resulting from the processes of synthesis and degradation (Frape, 2010).

Whether the protein requirement for the aged horse actually differs from the mature horse has been subject to scrutiny. In 1989, Ralston and coworkers postulated an increase in protein requirement because in a study they found a decrease in digestibility of protein in 20-year-old horses. From there they suggested the protein requirement was between 14 and 16%, which is nearly double

the maintenance requirement. In a repeat of the study a few years later, they did not get the same results and found no decrease in digestibility of protein (Ralston, 2001). The conclusion was that the first group of horses had not been raised in the best of conditions and did not have a regular deworming program, so they were probably suffering from the ravages of parasitic damage in the intestinal tract that affected protein digestion. The second group had been raised with an effective deworming program, thus not suffering from the same damages to the digestive tract resulting in better protein digestion. Since then, another group, Elzinga et al. (2011), also found no difference in protein digestibility between aged and mature horses. It is probably safe to say that if an aged horse is healthy and holding its weight well, it will have the same protein requirement it had as a mature horse. However, if the horse had a questionable health program during its life or is currently suffering from health problems, the protein requirement may be much higher than that of the maintenance horse.

The quality of a protein is determined by its amino acid content. The only two essential amino acids known in the horse, lysine and threonine, are present in adequate quantities in common protein sources used in horse feeds such as soybean meal. A third amino acid that is considered very important in preventing loss of muscle mass, leucine, is found in reasonable amounts in alfalfa hay. For reasons of trying to prevent muscle mass loss, the use of alfalfa would be warranted (Siciliano, 2002).

Energy

A horse gets its dietary energy from multiple sources: digestible fiber, starches, sugars, and fats in the diet. Therefore, the energy requirement of the horse can be met with a variety of feedstuffs with different sources of energy. Most of the energy found in forages is in the form of fiber energy. The energy from fiber digestion may not be adequate to meet the requirements of the individual, so certain horses need to be supplemented with a concentrate that may have digestible fiber but may have some grain for starch energy, molasses for sugar energy, and maybe some added fat. The ability of a ration to maintain weight on a horse will be dependent on the total amount of energy and to a lesser extent the forms of energy found in the diet, as well as the energy requirement of that individual.

Fiber

What distinguishes the digestive capabilities of the horse from the human is the ability to digest fibrous carbohydrates like cellulose, hemicelluloses, and pectin, to yield energy in the form of volatile fatty acids like acetate, proprionate, and butyrate, which are absorbed into the bloodstream and metabolized efficiently for energy. A horse can subsist on a forage-only diet because of this and can derive nearly all of its energy from volatile fatty acids if needed. The biggest difference in energy sources for the horse is that fiber energy is the least dense of the calorie sources, which means there is bulk to it and a point where it may fill the horse up without supplying adequate calories to maintain weight. In the aged horse, if there has been damage to the digestive tract from parasites or poor-quality feed through its lifetime, the ability to gain sufficient calories from the breakdown of fiber may be difficult. In this case, the horse will be more dependent on additional energy-dense calorie sources like starches, sugars, and fats.

What can complicate the diet of aged horses, if they are to the point where they are inefficient at fiber digestion, is the need for fiber for other reasons. Fiber keeps the digestive tract functioning properly for several reasons: digestible fiber is essential for keeping a balance of good and pathogenic bacteria in the hindgut; indigestible fiber keeps the flow of digesta moving through the digestive tract to stimulate peristalsis; and presence of fiber in the gut aids in water balance by

stimulating water intake and serving as a reservoir of water and electrolytes. Without adequate fiber in the diet, the malfunctioning of the digestive tract will make the horse more susceptible to colic.

Getting adequate fiber into the aged horse can be challenging if the individual has lost many teeth and has trouble chewing forages, but there are alternative fiber sources for use in these circumstances like hay cubes, pellets, and beet pulp, which can all be served in a wet mash.

Minerals

The body has a very limited capacity to store minerals, so daily consumption is essential to prevent deficiency signs from occurring (McDowell, 1992). Minerals are needed for structural purposes (like calcium and phosphorus in bone), regulatory purposes (calcium in muscle contraction or nerve conduction), and energy generation (phosphorus in the adenosine triphosphate). Certain minerals are needed in larger quantities, such as the macrominerals (calcium, phosphorus, magnesium, potassium, sodium, chloride), and others are needed in much smaller amounts, such as the microminerals or trace minerals (iron, zinc, copper, selenium, iodine, etc.). Not only is the presence of minerals important but also the balance. If there is too much of one, it may interfere with the absorption of others. Very little research has been conducted on mineral nutrition and balance in aged horses, so little is known about the optimal requirements.

The ideal calcium-to-phosphorus ration would be between 1.5:1 and 2:1, even though a horse can tolerate easily a 3:1 ratio. Excessive intake of calcium should be avoided because it might interfere with phosphorus digestion, which is a particular concern in the aged horse because of a reduced phosphorus digestibility (Ralston et al, 1989). Diets with approximately 1% calcium and 0.45% to 0.6% phosphorus are recommended (Ralston, 2001). Keeping the calcium level at 1% in the diet appears to be important in the aged horse because the risk of an increased incidence of renal calculi. This, as well as an increased incidence of renal disease, would make it important to monitor the amount of calcium. Feeding straight alfalfa may not be a good idea as Ralston and coworkers (1996) reported a higher incidence of renal calculi in aged mares and geldings fed alfalfa hay.

For the aged horse that is still being used for riding or working, there may be an increased requirement for electrolytes over younger mature horses (Siciliano, 2002). Older horses work harder than younger horses at a given speed and may therefore sweat more at lesser intensities. This may increase their need for electrolyte replacement even at lower exercise intensities.

Vitamins

Vitamins can be categorized in two general groupings: fat-soluble and water-soluble. Vitamins have a wide variety of regulatory roles ranging from coenzymes to regulation of gene expression (McDowell, 1989). Some may need to be supplied in the diet while others are produced within the body by enzymes or microbial action. The fat-soluble vitamins (vitamins A, D, E, and K) use the same method of intestinal absorption in the body as dietary fat and depend on dietary fat to aid in absorption. Because of this, the body has the capability to store significant amounts of these vitamins. Presently, there is no indication that the requirement for vitamins A, D, and K are any different for the aged horse compared to the maintenance horse. Vitamins A, E, and K are abundant in green, growing forages (pasture), and vitamins D and K are abundant in preserved forages (hay). Vitamin D is also formed in the body with exposure of the skin to sunlight.

Aged horses may benefit from vitamin E supplementation, especially if they are consuming only preserved forages, but there has not been any definitive research on this yet. The benefits from vitamin E supplementation would be immune system support, because one consequence of ageing

is a depression of the immune system, and the protective effect as an antioxidant when feeding a high-fat diet, as added fat is commonly used in horses with poor body condition.

The water-soluble vitamins are the B vitamins (thiamin, riboflavin, niacin, biotin, etc.) and vitamin C. Because they are water-soluble, there is no significant capacity for storage of these vitamins in the body (McDowell, 1989). In general, there is no requirement for any of these vitamins (except thiamin and riboflavin), as they appear to be produced within the body in adequate amounts under normal circumstances. The microbial population is responsible for the production of B vitamins used by the horse, so if something affects the environment of the microbes in the hindgut it will also influence the production of B vitamins. Vitamin C (ascorbic acid) is produced from glucose in the liver of the horse, but the rate of production is limited by the amount of the enzyme responsible for the conversion.

Ralston et al. (1988) found lower plasma ascorbic acid concentration in aged horses compared to younger, healthier horses, and in a follow-up study found an increased antibody response to vaccination in aged horses receiving vitamin C supplementation, especially those with PPID (Ralston, 2001). The amounts recommended vary from 10 g to 25 g twice a day and are therapeutic levels well above the estimated required daily amount (Ralston, 2001; Vervuert et al., 2004). Vitamin C status may be affected by viral infection and endocrine disorders like PPID (Siciliano, 2002) and therefore supplementation has been suggested to be useful in horses with chronic infections (Ralston, 2001). Further, vitamin C status has been shown to affect immune function and attenuation of cartilage degradation, and reduce the risk of osteoarthritis progression (Siciliano, 2002) and is commonly found in joint supplements. When supplementing vitamin C, the ascorbyl palmitate form was found to be more effectively absorbed in the small intestine than ascorbic acid and is the preferred form (Snow et al., 1987).

Feeding Recommendations for the Aged Horse

Certain nutritional options should be taken into consideration when designing a suitable diet for the aged horse. The objective of the diet is to maintain healthy body condition while supplying all the nutrients needed to give the aged horse a good quality of life.

Forage and roughages

Forages like pasture and forms of hay as well as roughages like beet pulp and soy hulls should be the basis of the diet and should make up at least 50% of the diet. Typically a horse will eat an equivalent of 1.5 to 2% of its body weight in feed. If a horse is eating 1.5% of its body weight, it is important that at least 1% is forage and roughage. This is easy to keep track of when all the feed is measured but when a horse is on pasture it is more of a challenge.

The greatest obstacle to feeding the aged horse is often getting sufficient forage in the diet. When consuming conventional forages like pasture or hay are difficult for a horse, there are alternative forms of hay and roughages that will suffice but are more labor-intensive to provide. Often a combination of forage types ends up being the best option.

Pasture. Often an aged horse will be able to maintain its weight on pasture during the growing seasons but may lose weight in the winter when it is switched to conserved forages (Geor, 2005). The benefits of grazing for the aged horse are numerous, but there are circumstances when pasture may not be the best option. Grass is normally higher quality, is more digestible, and has a higher vitamin content than dried forages. It is generally soft and requires less chewing than dried forage for tooth-challenged individual. It has a high water content, which helps to keep the horse hydrated

and keeps a horse from choking or developing an impaction. Free-choice consumption allows the horse to be ingest adequate amounts, as long as there is plenty of forage available in the pasture. The omega-3 and omega-6 fatty acid balance in green grass is ideal for the horse. Other advantages of maintaining the aged horse on pasture are the freedom of movement for arthritic joints and the provision of companionship with an easy escape route when there is pressure or when there is competition for food. For horses with polyuria from PPID or renal and hepatic disease, the fresh air flow eliminates problems with ammonia production on the respiratory system that plague stalled horses.

Pasture may not supply adequate forage when the horse is too arthritic in the neck to drop its head to graze comfortably or too arthritic in the joints to want to move around much. Also, if the horse has lost the effectiveness of the incisors to bite off the forage or lost too many molars to be able to chew the grass, pasture may not supply adequate forage. Free-choice pasture may not be the best option for the horse that overeats and becomes obese, or the horse that cannot handle the sugar in the grass and risks developing laminitis. Further, an aged horse on pasture will need shelter of some sort to be able to get out of the heat or the cold wind and precipitation.

Hay. Baled hay really is only appropriate for the aged horse that has good enough teeth to be able to chew the hay into small enough pieces to prepare it for digestion. One advantage of baled hay is that it can be soaked easily to remove some of the sugar for the horses with insulin resistance or Cushing's. Grass hay can be low enough in calcium for the horse with renal disease or low enough in protein and fat for the horse with liver disease. Baled hay is easy to feed whether it is by flakes on the ground or in hay nets or hay bunks, and can be divided up into several places to control competition. Hay is, however, the form of forage with the most waste.

Haylage is grass that has undergone a fermentation process for preservation. It is cut at a higher moisture content and remains higher than baled hay, about 40 to 50% water. Traditionally, haylage has been the forage of choice for horses with respiratory problems and is softer and easier to chew than conventional dried hay. Haylage can be better quality than dried hay because it can be cut at a less mature stage and provides more calories than mature hays. Because of the higher moisture content, the energy content on a pound for pound basis is almost half of dried hay, so this will affect the feeding rate. If inadequate quantities are fed, the horse may not be able to maintain its weight.

Chopped forages are grass or alfalfa hay cut into shorter pieces and packaged. Sometimes a little molasses or oil is added to settle dust and improve palatability. The product is a little easier to chew but still requires some chewing, and mixes well with concentrate to slow consumption of a meal. Chopped hay can be fed wet or dry, but tends to be very dusty and not good for a horse with respiratory problems unless dampened. Because it needs to be fed in a bucket or feed pan, if fed in a group situation, competition can be a problem because of the slow rate of consumption. There is a report of chopped hay contributing to interdental feed packing and development of periodontal disease (Miles, 1990).

Hay cubes are made from hay that is chopped and then compressed into squares. They share some of the same advantages as chopped forage but are generally less dusty. The cube is very compact and a little hard to chew when fed dry and may be too difficult for some to chew without soaking or covering with water just before feeding. There is a risk of choking if the horse does not break up the layers within the cube before swallowing. Cubes are most commonly made of alfalfa, but are available in grass or grass and corn plant. Because of their compact nature, they can be fed on the ground as well. Alfalfa cubes are not appropriate for horses with kidney or liver disease for the same reason as alfalfa hay: too much protein and calcium.

Hay pellets are made of dehydrated ground hay that is formed into a pellet; they can be made of alfalfa, grass hay, or a mix. Because the hay is ground to a small particle size, it is easier to digest for individuals that cannot grind their own feed because of tooth loss. They can be fed wet as a mash or dry, but the risk of choke is higher when fed dry in the individual missing teeth. Hay pellets that are soaked make a nice mash with beet pulp and can be fed as soupy as needed by the horse. They can be mixed with concentrate to boost the fiber content of the diet and are an excellent addition to a diet if the forage intake is questionable. Hay pellets are of consistent quality and available year-round. Only grass hay pellets are appropriate for individuals with kidney or liver disease because they are lower in protein and calcium than alfalfa pellets. If switching a horse to an all-pelleted diet, the change should be gradual in order to allow time for the microbial population of the gastrointestinal tract to adapt to the type of forage.

Hay substitutes. There are roughage products that can be used to replace some of the forage in the diet but are not normally recommended as a total forage substitute. Forage stretchers are dehydrated beet pulp, soyhulls (pelleted alone or mixed), and commercial forage substitute pellets (usually made with alfalfa, soyhulls, wheat midds, or other roughage sources). They all are rich in highly digestible fiber and can add considerably to the energy and total fiber requirement of the horse. These sources lack the bulk of long-stem hay and should be fed with other forages unless the horse's teeth issues make it impossible to consume long-stem forages safely.

Beet pulp is best served soaked to aged horses, especially ones with dental problems, because it greatly reduces the risk of choke. Except for the newest flaked form, beet pulp will need time to reconstitute (30 minutes with hot water and longer with cold). It works well to start soaking the beet pulp when feeding the previous meal to keep a steady supply ready. For horses with issues with sugar in their diets, like insulin resistance or Cushing's disease, rinsing four times before setting it up to soak will get rid of the residual sugar (Pagan, 2005). Beet pulp works well when mixed with hay cubes or hay pellets to make a wet mash. Once the beet pulp is reconstituted, caution should be taken to maintain it in a temperature-controlled environment or it may freeze in the winter or spoil in the summer heat.

Concentrates and grains

If the aged horse cannot maintain a good body weight on forage alone, then energy-dense concentrates are designed to complement what is missing in the forages; whether it is calories, protein, minerals, etc. Depending on the needs of the horse, a 'senior' feed may or may not be necessary. Even if a horse is still maintaining well on grass, there are commercial concentrates (ration balancers) designed to meet what is missing nutrient-wise in an all-forage diet.

Straight grains. Traditional diets contain grass and/or hay and some type of straight grain, like oats or barley. This kind of diet will balance out for energy, but straight grains are low in vitamins and minerals (except phosphorus), and if fed with a low protein hay will not be able to compensate. They are palatable to the horse and are good for when the horse get picky about the feed.

Commercial feed forms. Commercial concentrates come in various forms and combinations of forms that basically all have the same purpose: to complement the forage in the diet. Some contain enough roughage products to be able to replace a good portion of the forage in the diet, and in extreme cases, all of the forage. Textured feeds are combinations of grains (corn, oats, barley, etc.) mixed with a fortification pellet (containing a protein source, vitamins, and minerals), molasses to hold it all together, and sometimes other ingredients like oil, beet pulp, or chopped forage. With pelleted feeds, all the ingredients are ground to a similar particle size and formed into a pellet. In

an extruded feed, all the ingredients are ground as well but the process that sticks them together is different than pelleting. The distinguishing characteristics between pelleted and extruded feeds are the amount of fat and the overall digestibility. Extruded feeds can have a higher fat content than pelleted (pellets over 12% fat will crumble and fall apart) but need higher starch than pellets in order to form. In both the pelleting and extruding processes, the starches in the mix are heated to a temperature that gelatinizes them and improves prececal digestibility significantly for corn and barley. In a study comparing weight gain in aged horses between a sweet feed (corn, oats, barley, and molasses) and a pelleted/extruded blend, the horses thrived better on the pelleted/extruded mixed feed (Ralston et al., 1989). This study sparked the evolution of "senior" feeds.

Senior feeds. Just about every horse feed company in the United States has a "senior" feed in its product line, which has certain characteristics that distinguish it from the other types of feeds. A senior feed is usually formulated to be a complete feed, which means it will include some type of roughage, like alfalfa meal, soy hulls, beet pulp, or ground hay, to help the horse that is not able to eat forages in their natural state. Because the feed is supposed to replace some of the forage in the diet, the recommended feeding rate will be higher than other concentrates. Also with the higher feeding rate the concentration of minerals will be lower, so the horse will need to eat more to get desired nutrients. For example, the recommended feeding rate on a senior feed may be 10 to16 lb per day while the average concentrate will be 5 to 8 lb. The protein will be higher (14 to 18%) because of the earlier research that found a decrease in protein digestibility in the aged horses. The higher protein may not be necessary according to more recent research unless the horse has had extensive parasite damage in the digestive tract. Senior feeds can be fed dry or wet as a mash.

Balancer pellets. One specific kind of pellet is useful as a balancer to forages or forage and straight grain diets called a "ration balancer." They are concentrated in vitamins and minerals, but the protein content will vary depending on which forage they are to be used with. They will have high protein if they are made for use with grass hay and lower protein for alfalfa. The pellets are low-calorie and have a low feeding rate (1 to 2 lb/day), which makes them ideal for overweight horses and those with EMS or PPID. If the horse is getting a forage mash of hay pellets, chopped hay, and/or beet pulp, the balancer pellets will work to complement the mix and balance the ration.

Feeding Recommendations

Meal size

Because of the limitations of the stomach size and the fact that horses are trickle feeders that eat small meals frequently, the size of each meal should not be more than 0.5% body weight (5 lb for a 1000-lb horse). This can be challenging when the horse is getting a good part of its forage in each meal in a bucket. In following, if a horse is receiving 1.5% of its body weight in feed, then the number of meals will have to be at least three in order to not go over the 0.5% guideline.

Feeding time

Even the most aggressive horse in its youth can become very submissive as it ages. Feeding time can be an exercise in frustration when an aged horse is housed in a group with younger horses. Typically, the horse that needs the most feed is the one that is least willing to fight for it. If the aged horse needs more feed than others in the herd, it is best to separate and give the horse adequate time to eat (Geor, 2005). If there is a problem with arthritis in the forehand and the horse is uncomfortable putting its head down to the ground to graze, it would be better to feed the horse all of

its meals at a height where the horse can reach everything without having to shift its weight to its forehand (Jarvis, 2009).

Mashes

Wet mashes are the best solution for the horse that cannot chew feed properly. They can be served with warm water if it makes it more appetizing for the horse. Warm mashes are especially beneficial in cold weather as they will help to warm the horse from the inside. Also, a horse with a sore mouth will tolerate warm water much better than cold. When wetting the feed or making a mash it is prudent to only make as much as the horse will eat in one feeding. In doing this, it may require more feedings in a day. Soaking can double the volume of a meal, depending on the ingredients, which needs to be taken into consideration when planning meal sizes and expected intakes.

Sudden changes in feed should be avoided with the geriatric horse, especially those with a history of laminitis, because they are even more sensitive to change and it could cause digestive upset or colic.

Choke

Choke or esophageal obstruction is more common in aged horses because of poor mastication of feed and a decrease of saliva production. Choke occurs when feed becomes lodged in the esophagus, but choke does not involve obstruction of the airway as happens in humans. Once a horse chokes, it is more susceptible to choking in the future. It can be avoided if the feed is fed as a watery gruel. Caution should be taken when feeding long-stem forages to a horse with chronic choke.

Manure

With the loss of teeth, it gets more difficult to masticate feed or forages adequately, and the result is the feedstuff going through the digestive tract relatively undigested. Careful inspection of the horse's manure will reveal whether there are larger pieces or major quantities of whole grains. Evidence of poor digestion warrants a change in feeds to those with small particle sizes, as in hay or alfalfa pellets and extruded or pelleted senior feed.

Feeding the aged horse presents challenges. Advances in our understanding of the issues affecting aged horses have made available many different forms of feedstuffs that provide adequate nutrition to these horses.

References

Anon. 2005. Part 1: Baseline reference of equine health and management, 2005. USDA/APHIS, Fort Collins (CO), National Animal Health Monitoring System, pp. 1-60.

Brosnahan, M.M., and M.R. Paradis, 2003. Demographic and clinical characteristics of geriatric horses: 467 cases (1989-1999). J. Am. Vet. Med. Ass. 223:93-98.

Carson-Dunkerley, S.A., R.R. Hanson. 1996. Survival from colic in aged horses. In: Proc. Amer. Assoc. Equine Practnr. 42:262–263.

Cymbaluk, N.F., G.I. Christison. 1990. Environmental effects on thermoregulation and nutrition of horses. Vet. Clin. N. Am.-Equine 6(2):355–372.

Elzinga, S., B. Nielsen, H. Schott, J.Rapson, C. Robinson, J. McCutcheon, P. Harris and R. Geor. 2011. Effect of age on digestibility of various feedstuffs in horses. J. Equine. Vet. Sci. 31:268-269.

Frape, D. 2010. Utilization of the products of dietary energy and protein. In: Equine Nutrition and Feeding, 4th edition. West Sussex, U.K.: Wiley-Blackwell p. 21–36.

Geor, R. 2005. Cushing's disease and other problems of the older horse. In: Advances in Equine Nutrition Vol. III. Nottingham Press Nottingham U.K., pp. 447–452.

Hintz, H.F. 1995. Nutrition of the geriatric horse. In: Proceedings of the Cornell Nutrition Conference for Feed Manufacturers, Rochester, NY, October 24–26, p. 195–197.

Ireland, J. 2009. The geriatric equine population: Demographics, health and disease. Proc. British Equine Vet. Assoc. Congress 48:141.

Jarvis, N.G. 2009. Nutrition of the aged horse. Vet. Clin. N. Am. Equine 25:155–166.

Knottenbelt, D.C. 2003. The systemic effects of dental disease. In: Equine dentistry (G. J. Baker and J. Easley, eds.). Philadelphia: W.B. Saunders. p. 127–138.

McDowell, L.R. 1989. Vitamins in animal nutrition. Gainesville: Academic Press.

McDowell, L.R. 1992. Minerals in animal and human nutrition. San Diego: Academic Press.

McFarlane, D., D.C. Sellon, D. Gaffney, V. Hedgpath, M. Papich, and S. Gibbs. 1998. Hematologic and serum biochemical variables and plasma corticotrophin concentrations in aged horses. Am. J. Vet. Res. 59:1247-1251.

McGowan, C. 2009. Endocrine disorders in the geriatric horse. Proc. British Equine Vet. Assoc. Congress 48:144.

Miles, A.E.W., C. Grigson. 1990. Colyer's variations and diseases of the teeth of animals. Cambridge: Cambridge University Press.

Pagan, J.D. 2005. Recent research developments from Kentucky Equine Research. In: Advances in Equine Nutrition Vol. III. Nottingham Press Nottingham U.K., p. 1–10.

Pugh, D.G. 2002. Feeding the geriatric horse. In: Proc. Amer. Assoc. Equine Practnr. 48:21-23.

Pugh, D.G. 2007. Feeding the geriatric horse. In: Proc. Amer. Assoc. Equine Practnr. 53:193-195.

Ralston, S.L. 1989. Digestive alterations in aged horses. J. Equine Vet. Sci. 9:203-205.

Ralston, S.L. 1990. Clinical nutrition in adult horses. Vet. Clin. N. Am.-Equine 6:351.

Ralston, S.L. 2001. Care for the older horse: Diet and health. In: IVIS Reviews in Veterinary Medicine R0111.1101

Ralston, S.L. 2001. Management of geriatric horses. In: Advances in Equine Nutrition Vol. II. Nottingham Press Nottingham U.K., p. 393–396.

Ralston, S.L. 2006. Nutrition of the geriatric horse. In: Equine Geriatric Medicine and Surgery. Elsevier Publishing, St. Louis, MO, pp.169-171.

Ralston, S.L., and L.H. Breuer. 1996. Field evaluation of feed formulated for geriatric horses. J. Equine Vet. Sci. 16:334–338.

Ralston, S.L., K. Malinowski, and R. Christensen. 2001. Digestion in the aged horse revisited. J. Equine Vet. Sci. 21:(7):310-311.

Ralston, S.L., C.F. Nockels, and E.L. Squires. 1988. Differences in diagnostic test results and hematologic data between aged and young horses. Am. J. Vet. Res. 49:1387-1392.

Ralston, S.L., E.L. Squires, C.F. Nockels. 1989. Digestion in the aged horse. Equine Vet. Sci. 9:203–205.

Rich, G.A. 1989. Nutritional and managerial considerations of the aged equine. In: Proc. Adv. Equine Management Short Course, Fort Collins, CO, pp. 121–130.

Roy, C. 2002. Dental problems in debilitated equines in Delhi. In: Proc. Int. Colloquium on Working Equines 4:94-98.

Schott, H.C., S.P. Kristi, and S.D. Fitzgerald. 1997. Chronic renal failure in 99 horses. In: Proc. Amer. Assoc. Equine Practnr. 43:345–347.

Siciliano, P.D. 2002. Nutrition and feeding of the geriatric horse. Vet. Clin. N. Am.-Equine 18:491-508.

Snow, D.H., and M Frigg. 1987. Oral administration of different formulations of ascorbic acid to the horse. In: Proc. Equine Nutr. and Physiol. Soc.10:617–623.

Vervuert, I., and M. Coenen. 2004. Nutritional management in horses: selected aspects to gastro-intestinal disturbances and geriatric horses. In: Proc. European Nutr. and Health Congress 2:20–30.

Williams, C. A., M. E. Gordon, C. L. Betros and K. H. McKeever. 2008. Apoptosis and antioxidant status are influenced by age and exercise training in horses. J Anim. Sci. 86:576-583