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ALFALFA INSIGHTS

VIRENXIA'S NEWSLETTER ON ALFALFA, THE QUEEN OF FORAGES

IT'S ALL ABOUT QUALITY!

UNDERSTANDING FORAGE QUALITY ESSENTIALS

Forage quality is critically important, especially for animals having high nutritional requirements, and the ultimate test of forage quality is animal performance. Forage quality is considered satisfactory when animals consuming it perform as desired.

Adequate animal nutrition is essential for high rates of gain, ample milk production, efficient reproduction, and adequate profits. However, forage quality varies greatly among and within forage crops, and nutritional needs vary among and within animal species and classes. Producing suitable quality forage for a given situation requires knowing the factors that affect forage quality, then exercising management accordingly. Analyzing forages for nutrient content can be used to determine whether quality is adequate and to guide proper ration supplementation.

In recent years, advances in plant and animal breeding, introduction of new products, and development of new management approaches have made it possible to increase animal performance. However, for this to be realized, there must be additional focus on forage quality.

Freshalfa
علف طازج

Freshalfa is a Virenxia's supreme quality Alfalfa produced with international standards by using Virenxia's proprietary Enzymic Natural Fertilizer. It has maximum protein content, high Dry Matter Intake (DMI) and palatability to Dairy cows, Beef animals and small ruminants.

This issue covers essential information about forage quality which can be used to increase animal performance and producer profits.

WHAT IS FORAGE QUALITY?

Forage quality is the production output of a given animal (e.g. milk yield by dairy cows, body weight gain for beef or sheep) in response to forage consumption and utilization of the available nutrients and energy. Forage quality is a function of the rate and level of intake, the rate and extent of digestion, and the efficiency with which nutrients and energy are utilized by the animal (Barnes and Marten 1979). Animal performance is a biological assessment of forage quality. ***Factors that influence forage quality include the following:***

01 *Palatability*

Will the animals eat the forage? Animals select one forage over another based on smell, feel, and taste. Palatability may therefore be influenced by texture, leafiness, fertilization, dung or urine patches, moisture content, pest infestation, or compounds that cause a forage to taste sweet, sour, or salty. High-quality forages are generally highly palatable.

02 *Intake*

How much will they eat? Animals must consume adequate quantities of forage to perform well. Typically, the higher the palatability and forage quality, the higher the intake.

03 *Digestibility*

How much of the forage will be digested? Digestibility (the extent to which forage is absorbed as it passes through an animal's digestive tract) varies greatly. Immature, leafy plant tissues may be 80 to 90% digested, while less than 50% of mature, stemmy material is digested.

04 Nutrient content

Once digested, will the forage provide an adequate level of nutrients? Living forage plants usually contain 70 to 90% water. To standardize analyses, forage yield and nutrient content are usually expressed on a dry matter (DM) basis. Forage dry matter can be divided into two main categories:

1) Cell contents (the non-structural parts of the plant tissue such as protein, sugar, and starch); and

2) Structural components of the cell wall (cellulose, hemicellulose, and lignin).

05 Anti-quality factors

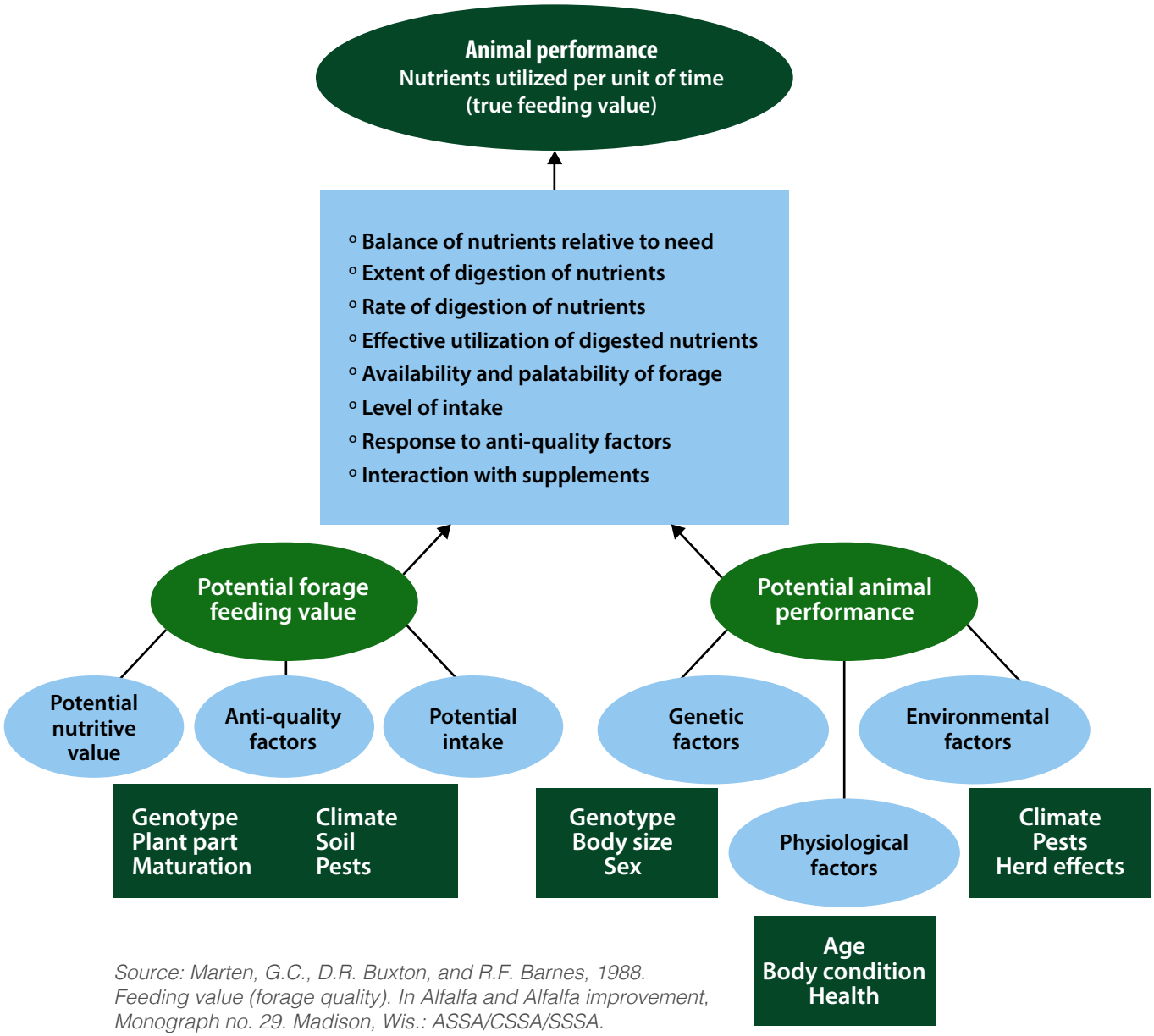
Various compounds may be present in forage that can lower animal performance, cause sickness, or even result in death. Such compounds include tannins, nitrates, alkaloids, cyanoglycosides, estrogens, and mycotoxins.
The presence and/or severity of these elements depend on the plant species present (including weeds), time of year, environmental conditions, and animal sensitivity. High-quality forages must not contain harmful levels of anti-quality components.

06

Animal performance

Is the ultimate test of forage quality, especially when forages are fed alone and free choice. Forage quality encompasses “nutritive value” (the potential for supplying nutrients, i.e., digestibility and nutrient content), how much animals will consume, and any anti-quality factors present. Animal performance can be influenced by any of several factors associated with either the plants or the animals (Figure 1.) Failure to give proper consideration to any of these factors may reduce an animal's performance level, which in turn reduces potential income.

Fig. 1: Factors that affect animal performance on forage.



Source: Marten, G.C., D.R. Buxton, and R.F. Barnes, 1988. Feeding value (forage quality). In Alfalfa and Alfalfa improvement, Monograph no. 29. Madison, Wis.: ASSA/CSSA/SSSA.

FACTORS AFFECTING FORAGE QUALITY

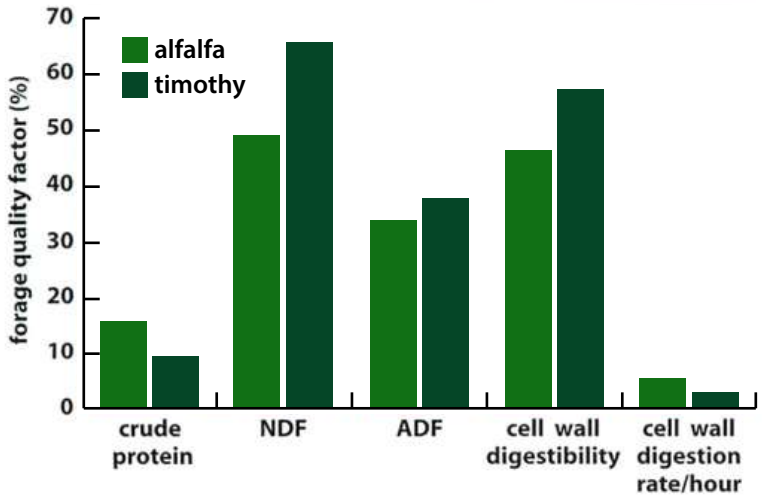
Many factors influence forage quality. The most important are forage species, stage of Maturity at harvest, and (for stored forages) harvesting and storage methods. Secondary factors include soil fertility and fertilization, temperatures during forage growth, and variety.

Species differences

Legumes vs. grasses

Legumes generally produce higher quality forage than grasses. This is because legumes usually have less fiber and favor higher intake than grasses. One of the most significant benefits of growing legumes with grasses is improvement of forage quality.

***Fig. 2:** Forage quality of alfalfa and timothy components of a mixture.



A comparison of timothy grass and alfalfa from the second cut of a mixed stand typical shows differences in quality. Alfalfa, at early bloom, had 16% crude protein (CP) compared with 9.5% in timothy grass.

In the same comparison, timothy grass had considerably higher levels of neutral detergent fiber (NDF) than alfalfa. Typically, higher NDF (total fiber) levels and a slower rate of fiber (cell wall) digestion for grass forages results in lower voluntary intake compared with legumes. Faster digestion allows more forage (and thus more nutrients) to be consumed.

**Source: Collins, M. 1988. Composition and fibre digestion in morphological components of an alfalfa-timothy award. Anim. Feed Sci. Tech. 19:135-143.*

Temperature

Plants grown at high temperatures generally produce lower quality forage than plants grown under cooler temperatures, and cool-season species grow most during the cooler months of the year. However, forage of any species tends to be lower in quality if produced in a warm region rather than a cool region.

Maturity stage

Maturity stage at harvest is the most important factor determining forage quality of a given species. Forage quality declines with advancing maturity. Maturity at harvest also influences forage consumption by animals. As plants mature and become more fibrous, forage intake drops dramatically.

Intake potential decreases and NDF concentration increases as plants age. This is because NDF is more difficult to digest than the non-fiber components of forage. Also, the rate at which fiber is digested slows as plants mature. Therefore, digestion slows dramatically as forage becomes more mature.

Daily fluctuations in forage quality

As early as the 1940s, changes in soluble carbohydrate levels in alfalfa were linked to time of day. Plants accumulate soluble carbohydrates during daylight and then use them overnight.

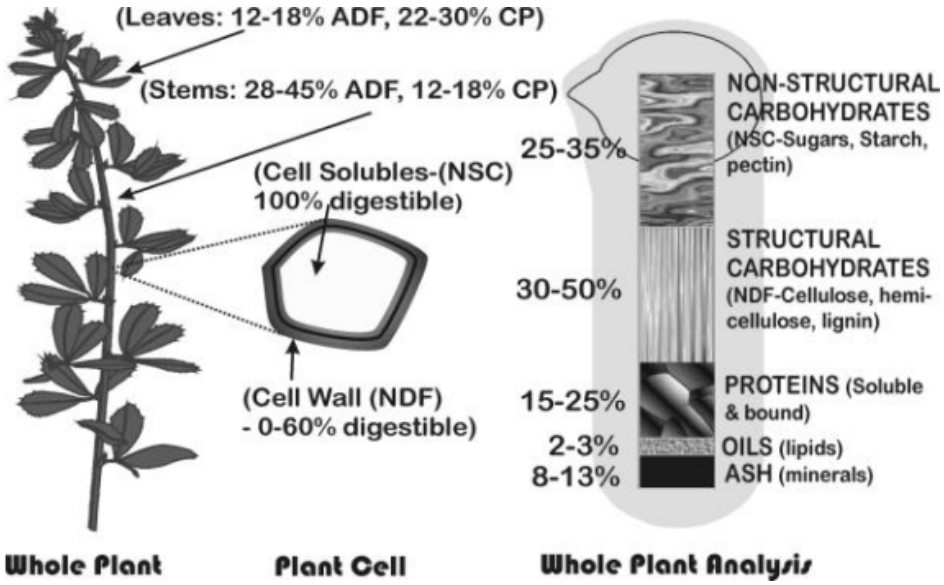
Thus, soluble sugars are lowest in the morning and highest after a day of bright sunshine. Recent studies in low rainfall climates have shown higher forage quality when alfalfa is harvested in the late afternoon rather than in the morning. It appears that the advantage of afternoon harvest is greatest on cool, sunny days and when the forage is highly conditioned to increase drying rates and minimize respiration in the windrow. However, afternoon harvests may not be advisable in high rainfall areas where every hour of good drying time is needed in curing hay.

In low rainfall climates, forage quality is higher when alfalfa is harvested in the late afternoon.

Leaf-to-stem ratio

Reduced leaf-to-stem ratio is a major cause of the decline in forage quality with maturity, and also the loss in quality that occurs under adverse hay curing conditions.
Leaves are higher in quality than stems, and the proportion of leaves in forage declines as the plant matures.

The oldest portion of alfalfa stems had less than 10% CP compared with 24% in alfalfa leaves. Stems had much higher fiber levels than leaves, but the older, lower alfalfa leaves were similar in quality to the upper, younger leaves. However, older alfalfa stem tissue was considerably lower in quality than young stem tissue.



Alfalfa forage consists of structural components that differ dramatically in forage quality. Leaves are much more digestible and lower in fiber than stems, and can have 2-3 times the protein. Within the cell, soluble components are 100% digestible whereas the cell wall is only partially digestible. Since the cell wall is the plant part most difficult to digest, it is the focus of chemical analysis. NDF approximates total cell wall and ADF approximates the most difficulty-digested portions of the cell: cellulose and lignin. Total plant quality is determined to a large extent by leaf-stem components, and development of the cell wall; both are affected by plant maturity.

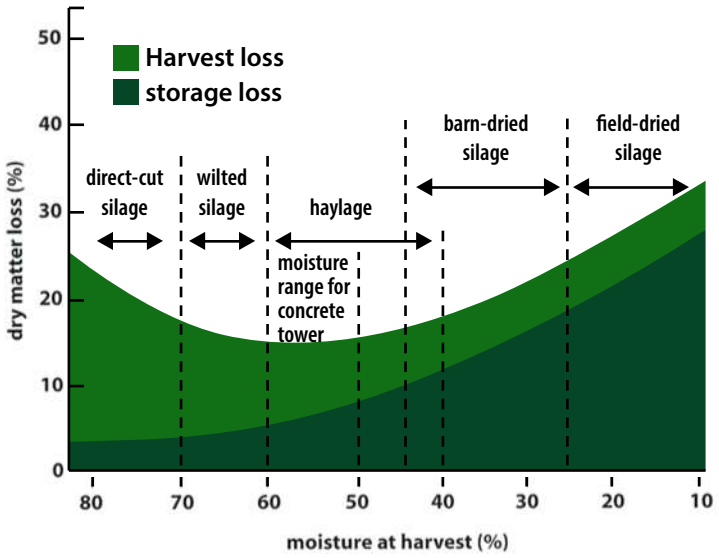
Harvesting and storage effects

Leaf shatter, plant respiration, and leaching by rainfall during field drying of hay can significantly reduce forage quality, particularly with legumes. Moderate rain damage reduced alfalfa CP levels slightly and digestibility dramatically, but NDF and ADF levels increased sharply. Rainfall during curing damages legume leaves most.
For alfalfa hay exposed to both drying and leaching losses, more than 60% of the total losses of dry matter, CP, ash, and digestible DM were associated with the leaves.
Rain during field drying has less impact on the forage quality of grasses than legumes.

In one study, alfalfa hay that received rain was 12 percentage units less digestible than fresh forage, compared with a difference of only 6 percentage units for grass hay produced under similar conditions. Damage from rain increases as forage becomes dryer, and is especially severe when rain occurs after it is ready to bale.

Quality losses also occur due to weathering, plant respiration, and microbial activity during storage. In high rainfall areas, losses can be large for round bales stored outside, due to weathering of the outer layers.

Fig. 6: Estimated dry matter loss during harvest and storage of hay-crop forage as various moisture levels.



Source: Michigan State University

Fertilization

Fertilizing alfalfa and other legumes with nitrogen to improve quality is not recommended. Fertilization usually has little or no effect on digestibility. Fertilization with phosphorus (P), potassium (K), or other nutrients that increase yield may actually slightly reduce forage quality when growth is rapid. Excessive levels of some elements such as potassium may in some cases decrease the availability of other elements such as magnesium (Mg) in the diet.

Sensory evalutation of hay

Much can be learned from a careful sensory examination of hay. First, the plant species present can be determined. Does the hay consist almost exclusively of a particular forage crop? Does the forage crop tend to be higher in quality than other forages? Does the hay contain weeds? If so, what percentage is weeds and how much nutritional benefit do they provide to livestock?

Could they be toxic?

The maturity of the hay, one of the main factors determining forage quality, can be visually assessed. The number and maturity of seed heads and blooms, and the stiffness and fibrousness of the stems are indicators of plant maturity.

Variety effects

The development of multifoliate alfalfa varieties (having more than three leaflets per leaf) is a strategy aimed at increasing forage quality, but some multifoliate varieties have no higher leaf percentage than traditional trifoliate varieties. Some trifoliate varieties exhibit superior quality, but care should be taken to assure that a “high-quality” variety is not substantially lower in yield.

Color

Helps sell hay to the average buyer. Color alone is not a good indicator of forage quality, but it can be an indicator of harvest and storage conditions. A bright green color suggests that hay was cured quickly and protected during storage. Slow curing prolongs plant respiration, which reduces forage quality. Hay that is rain damaged after being partially dried will lose color due to leaching. Mold growth on leaves and stems or exposure to sunlight will also bleach hay. Baling at moisture contents at or above 20 to 25% may cause high bale temperatures that result in tan to brown or black colors. A pleasant odor indicates hay was cured properly. Moldy, musty odors may occur in hay stored at moisture contents above 16 to 18% (above 14% for 1-ton square bales). Animals may respond to off-odors by going off feed.

Texture

Plants grown at high temperatures generally produce lower quality forage than plants grown under cooler temperatures, and cool-season species grow most during the cooler months of the year. However, forage of any species tends to be lower in quality if produced in a warm region rather than a cool region.

Dusty

Hay is usually the result of soil being thrown into the hay by rake teeth hitting the soil. The presence or absence of molds, dust, and odor are referred to as organoleptic qualities.

Visual inspection can also detect foreign matter (anything that has little or no feed value). Tools, sticks, rocks, wire, items of clothing, dead animals, and cow chips have all been found in hay and are obviously undesirable.

Leafiness

Is particularly important; the higher the leaf content, the higher the forage quality. Leafiness can be affected by plant species, by stage of maturity at harvest, and (especially in legume hays) by handling that results in leaf loss.

Source: American Farm Bureau Federation Publication

UNIQUE ATTRIBUTES FOR ALFALFA ON DAIRY COWS

It is likely that every nutritionist would have different unique attributes for alfalfa hay.
Alfalfa hay is an excellent source of digestible protein. The protein is rumen degradable protein (approximately 80% of the protein is degraded in the rumen) to support a robust microbial population (Getachew et al 2006). The rate and extent of alfalfa protein in the rumen is potentially something that could be a concern with respect to efficient utilization of the protein for retention in product (e.g. milk and meat) (Getachew et al. 2006).

Cows fed legume silages produced more milk and had higher feed intake.

Source: E.J. DePeters, Department of Animal Science, University of California, Davis

Alfalfa hay is consumed at high levels of intake. Legumes were often consumed in higher amounts than grasses (Van Soest 1995). The amount and digestibility of the NDF (neutral detergent fiber or the cell wall content) are factors that impact Dry Matter Intake (DMI) (Mertens 1987). Oba and Allen (1999) stated that “digestibility of NDF is an important parameter for forage quality”.

Within a forage family, high NDF digestibility was related to increased DMI and milk yield. For a range of forages, as the cell wall content increased, organic matter intake by sheep decreased (Van Soest 1994). Legumes such as alfalfa are in general lower in NDF content than grasses. Even though alfalfa contains more lignin content than most grasses, NDF digestion in the rumen is still better than grasses. As NDF content of the diet increased, DMI by the lactating cows decreased. Finally, diets based on alfalfa hay had higher whole tract digestibility of NDF compared with diets based on corn silage. The NDF of alfalfa also contains considerable pectin, which is a cell wall carbohydrate that has a high rate and extent of degradation in the rumen (Bourquin and Fahey 1994; Van Soest 1995). In a recent review of forage silages, cows fed legume silages produced more milk and had higher feed intake than cows fed grass silages further supporting the advantage of legumes (Steinshamn 2010).

WHEN IS THE BEST TIME TO CUT HAY

If you want to know if hay is high quality, who better to tell you than the animals themselves? It turns out that in a number of studies in arid climates, cows have demonstrated a clear choice: **They consistently selected the taste and smell of hay that was cut in the afternoon.**

In USDA research conducted in Idaho, animals were filmed selecting between hays. “They would just sort of back away from morning-harvested hay,” explains Dan Putnam, an Extension agronomist and forage specialist at the University of California, Davis. “Our field studies have confirmed that result: Higher-quality hay generally results from afternoon harvests, which can be observed in laboratory analyses.”

A Daily Cycle

Similar results have emerged from other studies in Western states across a variety of locations. The reasons why have to do with basic plant biology. Alfalfa and grasses, like all plants, feed themselves using photosynthesis, converting sunlight and carbon dioxide into sugars. These sugars are then broken down by plant cells into other useful materials through a process called respiration. It’s a two-step sequence that first produces and then removes the sugars—which are, in the end, what make for tasty, nutritious, high-dollar hay.

It’s also a sequence whose balance shifts throughout the day. “In the evening, when the sun goes down, respiration will continue but photosynthesis stops. Which means that at night, sugars are being consumed without being replaced. So, it’s in the late afternoon, after a full day of sunlight, that a plant’s sugar content is at its peak.

Unlike fibers, these simple carbohydrates are entirely digestible. That, of course, makes the forage more marketable. “We’ve seen differences in afternoon harvests of one or two points TDN [total digestible nutrients], or five to eight points of relative feed value,” Putnam says. “However, whether this advantage is maintained depends on what happens after swathing. It can be lost if the hay takes too long to dry and stabilize the quality.”

Source: Dan Putnam, an Extension agronomist and forage specialist at the University of California, Davis.

MYCOTOXIN IN ALFALFA

What Causes Mold to Grow on Hay?

Much hay has been rained on or left lying in the field for prolonged periods of time due to excessively wet and humid conditions. The long drying periods with high humidity can allow mold to grow on the hay in the field.

Rain and poor drying weather has caused some hay to be baled wetter than desired. With high humidity, normal drying in storage may not occur and hay can retain elevated levels of moisture allowing mold growth.

Mold and bacteria will grow on hay (without preservative added) at moisture levels above 14% to 15%. The mold growth produces heat, carbon dioxide and water, which further damages the hay. Moldy hay can result in dry matter and nutrient loss and produce spores and dust. Drying of stored hay is enhanced by increasing ventilation, creating air spaces between bales, reducing stack size, and stacking in alternating directions. Since moisture tends to move up and out the top of a stack of bales, ample headspace should be provided above a stack in a barn, allowing moisture to evaporate.

Mycotoxins are toxic secondary metabolites produced by fungi (molds). The most prominent mycotoxin, aflatoxin, belongs to a group of difuranocoumarins that is produced by certain molds of the genus Aspergillus, particularly Aspergillus flavus, Aspergillus parasiticus and Aspergillus nomius (Fink-Gremmels, 2008; Park, Ayala, Guzman-Perez, LopezGarcia, & Trujillo, 2000). Eighteen different aflatoxins have been identified, but the major aflatoxins are found in animal feedstuffs, including aflatoxin B1 (AFB1), B2, G1 and G2 (Coppock & Christian, 2007).

The most prevalent and potent natural carcinogen amongst these aflatoxins is AFB1 (Gourama & Bullerman, 1995). Lactating mammals that ingest AFB1 deposit the 4-hydroxylated metabolite, aflatoxin M1 (AFM1), in their milk. The maximum accepted levels for animal feed (5 µg kg−1) in Iran and the European Commission.

Beef and sheep have microbes in their rumen that act to naturally detoxify mycotoxins. This ability makes these animals somewhat tolerant to these toxins.

Mycotic diseases may not be immediately identified in cattle. Several mycotoxins even suppress immunity.

However, high producing animals have an increased rumen passage rate; this faster processing of contaminated feed may overwhelm the rumen microflora, and they will not be able to denature all the toxins.

Mycotic (caused by mycotoxins) diseases may not be immediately identified in cattle. They are not transmissible from one animal to another, and treatment with drugs or antibiotics has little effect on the disease. Outbreaks may be seen seasonally because the weather will influence fungal growth and toxin production. When mold is seen, it does not necessarily mean that mycotoxin production has occurred.

Several mycotoxins suppress immunity, which may allow viruses, bacteria or parasites to create a secondary disease that is more obvious than the primary mycotic infection.

Stressed animals are more susceptible to mycotoxins. Sources of animal stress would include:

- ***poor health***
- ***less than ideal feeding***
- ***overcrowding***
- ***high production***

The rapid growth of molds can cause heating of feed, which reduces the energy as well as the vitamins A, D3, E, K and thiamine available to the animal. In addition, moldy feeds tend to be dusty, which reduces their palatability.

After initial feedings of mycotoxin-infected feed, relatively minor problems may develop in the animal; however, within days or weeks of continued feeding, the effects become more obvious.

There may be a decrease in dry matter intake, and therefore nutrient intake and weight gain. In fact, overall performance may be reduced by 5 to 10 per cent. Animals may go off feed, experience ketosis, displaced abomasums, diarrhea or signs of hemorrhaging.
The reproductive performance of cattle may remain unaffected by feeding moldy rations, but the incidences of reduced fertility or high rates of abortion may occur.

Aflatoxins and Milk:

Aflatoxins are a major food safety concern particularly in developing countries.
If lactating cows ingest aflatoxins through contaminated feed, they can excrete aflatoxin metabolites in their milk. Human consumption of aflatoxins including in contaminated cereals and milk can lead to liver cancer and may increase the risk of child hood stunting.

Source: Hay and Forage News, USA

ALFALFA INNOVATIONS

ALFALFA FOR DOGS

Alfalfa (Medicago sativa) is an inexpensive herb that is easy to find, and it has useful applications. In the Middle East, alfalfa is known as the father of all herbs. Alfalfa is a member of the leguminous family and has been used in herbal medicine for nearly 1500 years. It might be best to purchase your alfalfa from a certified organic source. If you grow it yourself, cut alfalfa before it comes into bloom and dry it out of the sunlight in a moisture-free area.

Rich in nutrients

Alfalfa is a nutritive herb that contains considerable amounts of protein. It is also one of the richest sources of vitamins and trace minerals, such as calcium, magnesium, potassium, betacarotene, vitamins A, B12, C, D, E and K. It is also high in the antioxidant chlorophyll. Its nutritional value makes alfalfa a commonly used dietary herb for many animals.

Arthritis relief

Alfalfa is quite effective in fighting arthritis. Clinical research shows that as many as 20% of people who take alfalfa report a marked decrease in painful symptoms and similar results have been reported in animals. Daily supplementation can deliver long-term relief for pets suffering from any inflammatory joint disease, especially if given alongside dandelion, yucca and licorice root.

The leaves were used to treat disorders of the digestive tract and the kidneys.

Kidneys and more

In early Traditional Chinese Medicine, young alfalfa leaves were used to treat disorders of the digestive tract and the kidneys. Herbalists also like alfalfa for its ability to act as a diuretic and to treat overly-acidic urine which may lead to bladder irritation and cyst formation.

Alfalfa contains saponins which help with the absorption of fat soluble nutrients in the small intestine, and can be useful for animals who need to gain weight or adjust to a new diet.

Cancer prevention

Alfalfa also contains cancer fighting agents which are believed to inactivate carcinogens in the liver and small intestine, effectively reducing the risk of cancerous growths.

How to use

Dried alfalfa can be sprinkled over your dog's food using a pinch per 10 lbs once a day, or about 1 tsp for a 50 lb dog. If you buy capsules or tinctures sold for humans, assume the recommended dose is for a 150 lb person and adjust for your dog's weight. You can also make a tea by boiling 1 quart of water and adding 4 tsp dried alfalfa; steep for 10 – 20 minutes, strain and allow to cool.

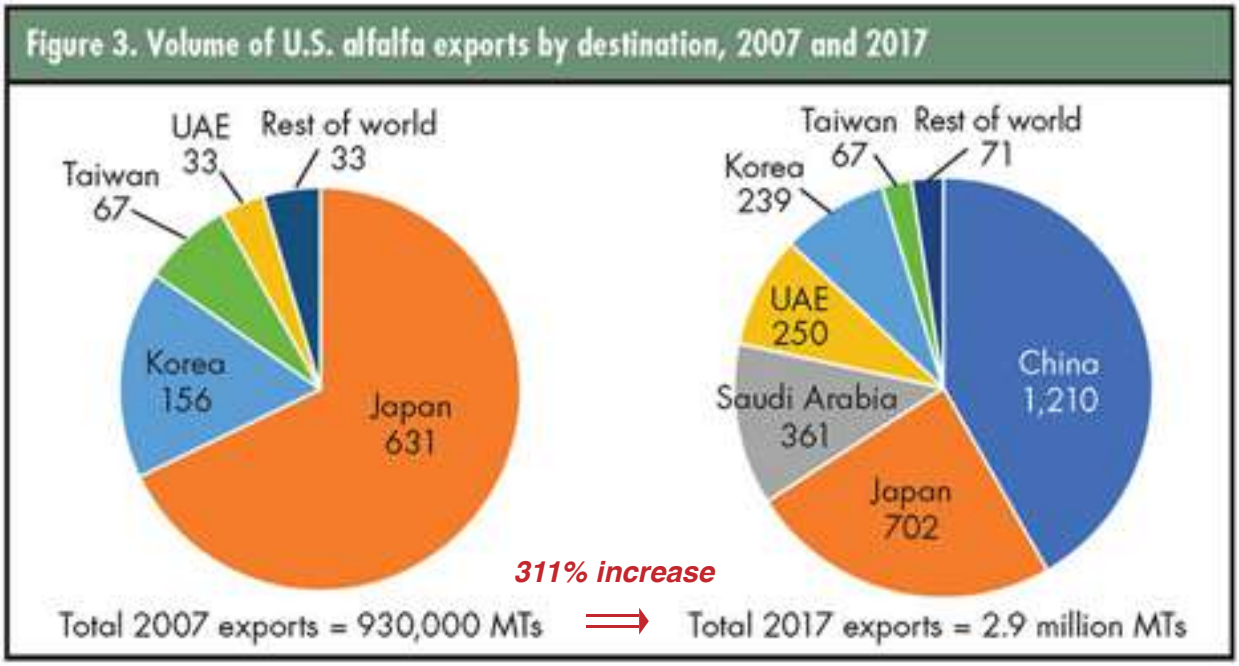
You can then add tea to your dog's food or water, about 1/4 cup per 10 lbs. The tea will keep for a few days in the refrigerator.

Source: Dana Scott, Founder and CEO of Dogs Naturally Magazine

Whichever method you choose, it's best to start out slowly and feed for a month before assessing your dog's reaction to the herb.

Shifting Hay Markets

The major demand for imported forage crops is in Asia, led by Japan, China, and Korea, and followed by Middle Eastern countries. These countries have expanded or improved their dairy and beef production and do not have adequate space or water resources for much good pasture or hay production. An important development in the past decade has been the emergence of the Chinese and Middle Eastern markets, ballooning from negligible amounts in 2007 to millions of MT per year in 2017. This growth was driven primarily by rapid expansion of modern dairy farms in China and Korea, and limitations of water resources in Saudi Arabia and the United Arab Emirates (UAE).



While the percentage of the national U.S. crop exported remains below 6 percent for alfalfa and below 3 percent for grass hays, the equivalent percentage of production exported from the seven Western states exceeded 17 percent for alfalfa and 41 percent for grass in 2017. This rapid rise in export demand has been welcomed by cash hay growers but is regarded as a negative by domestic dairy and other livestock hay buyers, who have had to compete for forage supplies with foreign buyers.

GMO's are not allowed

Sensitivity to genetically engineered (GE) traits has been another important issue for exporters and growers for export markets, primarily for China. While some GE alfalfa has been exported to Japan and other countries, alfalfa exports to China must not contain a GE trait (primarily Roundup Ready), even in a very small amount.

Export companies in the U.S. routinely test export hay for low level presence (LLP) of the Roundup Ready trait and will reject hay with even a small amount of LLP (for example, 0.1 percent). This may change in the future if China approves these traits. Other countries either allow a trait to be imported (as with Japan), require a statement of "non-GMO," or do not routinely test.

Some importing companies reject GE hay due to the sensitivity of their customers who do not want GE traits even if they are permitted by import regulations. Recent discussions with U.S. Foreign Agricultural Service personnel indicate that approval of Roundup Ready trait for importation to China is a top priority, which would change the market sensitivity for Western alfalfa growers.

Alfalfa exports to China must not contain any genetically engineered trait.

While exports of hay are a minor issue for many U.S. alfalfa and grass hay growers, they are a key market for growers in the seven Western-most states. Worldwide, interest in the trade in forages has also risen substantially, with the most important markets in Asia and the Middle East. The U.S. is the lead hay exporter, but a number of countries (Canada, Spain, Sudan, Italy, Australia, and Argentina) have shown growing interest in these markets.

Export markets demand high-quality forages, whether alfalfa or grass hay types, which favor exporting production regions with good haymaking weather, technology, and the infrastructure for long-distance shipping. Improvements in hay packaging, inexpensive ocean transport systems, resource limitations, and the imbalance of world trade (for example, empty returning cargo containers) have been major components driving this trend.

Source: Dan Putnam, Extension forage specialist, University of California-Davis.

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