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Diet Mixing: Increasing Intake of Unpalatable Plants

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The cows at Ray Banister's ranch readily eat plants that cows don't normally eat, such as sagebrush and snowberry. Banister uses a management style he calls boom-bust grazing. It involves short, intensive periods of grazing followed by two growing seasons of rest. He monitors the least palatable plants and moves his cows only after they've eaten most of these species reducing the competitive advantage unpalatable plants normally have over more palatable species. As a result, his ranch has some of the greatest biodiversity and highest plant cover in eastern Montana.

Implementing the new system came with a cost. It took Banister's cows 3 years to adapt to boom-bust grazing. During that time his calves' weaning weights plunged from over 500 pounds to 350 pounds, then rebounded to over 500 pounds. Initially when cows first entered a pasture, they ate only the most palatable species before eating the unpalatable plants. Today, cattle eat both palatable and unpalatable species as soon as they enter a new pasture.

Research at Utah State University demonstrates that animals can learn to eat unpalatable plants and to mix palatable and unpalatable plants in their diets. Furthermore, the nutritional composition of an animal's diet affects how much of these unpalatable plants animals can eat.

Do Unpalatable Plants Taste Bad?

Many people believe unpalatable plants taste bad but that's not the case. Many unpalatable plants contain toxins that often limit intake. In one experiment, lambs were offered a palatable ground food. While they ate, terpenes (the toxins found in sagebrush) were slowly infused into their blood stream. These lambs stopped eating 30 minutes sooner than lambs fed the same food but not infused with terpenes. Thus, when animals eat sagebrush, the increasing level of terpenes in the blood stream, not the flavor of the terpenes, causes them to stop eating (Dziba et al., 2006).

Experience Affects Intake

Experience eating foods high in toxins increases the likelihood animals will eat substantially more high-toxin foods both voluntarily and when encouraged. When two groups of sheep had free access to ground alfalfa and a 50:50 alfalfa-barley ration, sheep experienced with toxins ate 11 times more of the high-toxin foods (three rations containing either oxalate, terpene or tannin) compared with sheep with no experience with toxins. When ground alfalfa and alfalfa-barley were severely limited, experienced sheep ate 2.5 times more of the high-toxin foods compared with sheep with no experience with toxins (Figure 1). Sheep with no experience with toxins also ate almost none of the ration high in terpenes. Throughout the study, sheep

showed no ill effects from eating diets with toxins (Villalba et al., 2004).

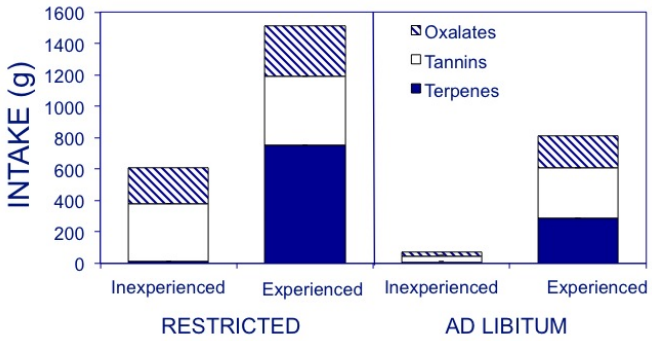

Figure 1. Intake of foods containing different toxins by lambs with restricted and unrestricted access to alfalfa and an alfalfa barley mixture.

Feeding Pattern

To prevent toxicity, herbivores may change their feeding patterns to limit intake of toxins. Lambs were offered one of four diets with different levels of terpenes (0%, 1.5%, 3.1%, 4.6%) for 6 hours each day. Food intake was lower when terpene levels were high and lambs stopped eating once they had eaten 28 g of terpenes in 6 hours. Lambs offered the control, and low-terpene diets, ate a large proportion of their food during the first hour. Lambs on the medium- and high-terpene diet ate many small meals frequently throughout the day. Terpenes limited food intake and caused lambs to change their feeding patterns to reduce the possibility of ingesting toxic quantities of terpenes (Dziba and Provenza, 2008).

First Impressions Matter

Animals are more likely to continue to eat plants high in toxins if their first experience with the plant is positive. Sheep first exposed to a toxin in a high-nutrient diet ate more of the toxin-containing food than sheep first exposed to the toxin in low-nutrient diets. In addition, nutrients and toxins don't have to be in the same food to improve intake. Feeding animals a high-quality diet before and after eating an unfamiliar food high in toxins, also increases intake of the unfamiliar high-toxin food. In one study, lambs were either fed an alfalfa-grain ration immediately before and after eating an unfamiliar, poor-quality, high-toxin food or they were fed the alfalfa-grain ration and the unfamiliar poor-quality high-toxin food at different times of the day. During the trial, lambs fed the high-quality diet and high-toxin food closely in time, ate more of the toxin-containing food and spent less time searching for other foods than lambs introduced to the two diets at different times of the day (Baraza et al., 2005). In addition, lambs consuming a tannin-containing food and a high-quality food in the same meal showed greater preference for the tannin-containing food than animals that ate the two foods in separate meals (Villalba et al., 2006a).

Supplements Help

It may seem counterintuitive, but supplementing ruminants with moderate amounts of protein and energy increases their intake of foods containing toxins such as terpenes, oxaltes, lithium chloride and tannins because nutrients enable animals to detoxify toxic compounds in plants (Villalba et al., 2002). Sheep and goats receiving supplemental nutrients nearly doubled their intake of chopped sagebrush (Figure 2). In a grazing study, sheep receiving supplemental protein and energy for 15 min/day spent 12% more time feeding on sagebrush than sheep that didn't receive the supplement. Supplemented sheep continued to increase intake of sagebrush throughout the study while sheep without supplements decreased intake of sagebrush near the end of the study (Dziba et al., 2007).

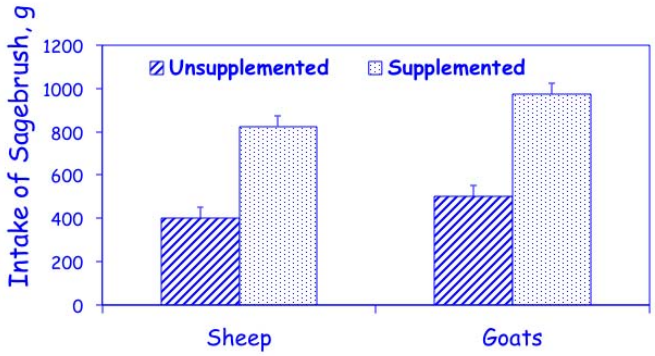

Figure 2. Intake of sagebrush by sheep and goats with and without supplement.

Herbivores must have access to the proper mix of nutrients, not just more nutrients, to enable them to eat toxin-containing foods. For example, sheep and goats fed a supplement high in protein ate more sagebrush and foods high-tannin than those offered a diet high in energy and low in protein. Ratio of energy/protein and the degradability of nutrients

(how quickly they are broken down in the rumen) are also important when formulating a supplement to increase intake of unpalatable plants. When the correct supplement is unknown, provide animals with a choice of high-protein and high-energy foods for a limited time each day until it becomes clear which proportions of foods they prefer when eating particular plants (Villalba et al., 2006b).

Availability of Alternatives

In some cases, managers can affect the likelihood that herbivores will eat unpalatable plants on rangelands by limiting alternative foods. Sheep in good body condition are more likely to eat more high-toxin foods, especially those containing terpenes, as the amount food without toxins becomes more limiting. In fact, when the amount of food without toxins was severely limited, sheep initially inexperienced with toxin-containing foods (oxalate, terpenes, or tannins) ate more food and gained more weight than when the amount of food without toxins was only moderately limited (Shaw et al., 2006a). In an experiment with sagebrush, as the stocking rate and density of sheep increased, the likelihood they would readily eat sagebrush also increased (Shaw et al., 2006b).

These results support the idea that animals are more likely to try new foods, especially those with strong flavors, by limiting alternative foods. However, these results do not support the idea that sheep are more likely to eat foods high in toxins if they have no alternative foods. During the trials above, lambs were fed limited amounts of high quality foods each day in conjunction with foods high in toxins. Providing animals with adequate nutrients each day is essential if they are to eat and detoxify plants high in toxins.

Once animals begin to include unpalatable plants in their diet, people are often tempted to force animals into areas that contain the unpalatable species with very limited amounts of alternative forages. Unfortunately, forcing animals to eat a diet too high in toxins with few alternatives often results in animals forming an aversion to the plant. This is especially true if the food high in toxins is also a new food. Once animals are eating unpalatable species, they must have food choices to keep from ingesting too much toxin and to provide nutrients to detoxify toxic compounds in plants that contain toxins.

Teaching Cows to Eat Sagebrush

In Nevada, Chuck Petersen conducted a study to teach cows to eat big sagebrush. In fall, cows with calves were turned onto small pastures of Wyoming and basin big sagebrush with an understory of grasses and forbs. Cows were supplemented with meadow hay and grain to help them detoxify terpenes in sagebrush. When cows first entered the pasture, they ate the understory and left the sagebrush. After 10 to 14 days, most of the cows were readily eating sagebrush. When they entered a new pasture, they readily ate sagebrush along with forages in the understory. The change in behavior maybe due to experience alone or it may be that rumen microbes needed time to adapt to eating forages high in terpenes, like sagebrush.

Mat Carter, an Oregon rancher, also taught his cattle to use sagebrush as winter-feed. The first winter, he corralled 150 cow-calf pairs with electric fence on 5 to10 acres and fed them 15 to 20 lbs/hd/d of meadow hay. His pastures are a mix of low and big sagebrush, gray and green rabbitbrush, and bitterbrush with an understory of grasses. Mat moved his cattle every 3 days to a new strip of pasture. As the winter progressed, he noticed when his cattle were first moved onto a new strip of pasture some ate grass, others bitterbrush and others sagebrush. Grazing decreased the amount of brush and increased grasses and new shrub seedlings the following spring. Several years later, Mat trained a new group of cattle to eat sagebrush in winter. Snow was deep so only sagebrush was available. He started feeding 20 lbs of hay and over a 2-week period he reduced hay to 6 lbs/hd/d. Cattle remained in good condition throughout the winter.

Conclusion

Livestock can consume substantially more toxins than once believed. Providing animals with positive experiences with unpalatable species, adequate nutrients to detoxify toxins, and in some cases limiting alternative foods are key to helping animals learn to eat unpalatable plants. These suggestions only apply to plants that are unpalatable due to the toxin content of the plant. Livestock should never be encouraged to eat poisonous plants that are acutely toxic or can cause chronic health problems and death.

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