Conditioning cattle to graze broom snakeweed (Gutierrezia sarothrae)

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ABSTRACT: Broom snakeweed (*Gutierrezia sarothrae*) is the most widespread range weed in North America. We attempted to positively condition cattle to graze broom snakeweed to create a biological tool to decrease the competitive ability of snakeweed in a plant community. Fifteen yearling heifers were divided into three treatment groups receiving different supplements: 1) cornstarch, 2) starch with ground snakeweed, and 3) a control (no supplements). Heifers were fed fresh snakeweed, and then were gavaged with the respective supplements to provide positive feedback to enhance their acceptance of snakeweed. The starch group consumed more snakeweed in the pen conditioning trial (*P* = 0.02). The starch and control groups were then taken to the field for two grazing trials. In the spring grazing trial, there was no snakeweed consumed in the free-ranging part of the trial; however, when the pasture size was decreased, the heifers started to consume snakeweed as alternative forages became less abundant. In the second small pasture trial, heifers in the positively conditioned group consumed more snakeweed than those in the control group (16 vs. 5% of bites, *P* < 0.001). In the fall grazing trial, little snakeweed was consumed in the free-ranging part of the trial. When the pasture size was decreased, both positively conditioned and control groups increased snakeweed consumption up to 35% of bites. In the small pastures of both the spring and fall grazing trials, 36 to 59% of snakeweed plants were grazed. Cattle can be forced to graze snakeweed in a short-duration, high-intensity grazing strategy.

Key Words: Broom Snakeweed, Diet Training, *Gutierrezia sarothrae*, Positive Conditioning, Short-Duration Grazing

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Introduction

Broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby) is the most widespread range weed in North America. Early investigations associated the increase of broom snakeweed with overgrazing, which decreased desirable vegetation and allowed broom snakeweed to increase where it already existed and to invade deeper soils and more productive sites (reviewed by McDaniel and Torrell, 1987). However, snakeweed has even increased in healthy plant communities in the absence of grazing (Chew, 1982; Hennessy et al., 1983). Other disturbances (such as fire, drought, and chaining) can also cause an increase in snakeweed density (USFS, 1937; Parker, 1939; Arnold et al., 1964). Broom snakeweed is very competitive with desirable grasses and greatly suppresses forage production (Ueckert, 1979; McDaniel et al., 1982). It is not palatable to most large ungulates (Pieper, 1989) and is toxic to livestock, causing abortions (Dollahite and Anthony, 1957). Platt (1959) ranked this range weed as one of the most undesirable plants in the various regions of the West.

Part of the problem of rangeland degradation has been the role of selective livestock grazing, which can suppress desirable species in the plant community and free up resources for undesirable weedy species. To counteract this, differential grazing habits, preferences, and selective abilities of livestock species may allow them to exert selective grazing pressure against some weeds that would result in effective control (Brock, 1988). Furthermore, livestock may be positively conditioned to graze weeds (Quimby et al., 1991). The diet selection theory of Provenza (1995) states that animals learn which plants to eat or to avoid based on postdigestive consequences. Foods that provide adequate nutrients are preferred, whereas those that cause nausea or illness are avoided. The objective of this experiment was to determine whether cattle could be positively conditioned to graze broom snakeweed by dosing them with cornstarch to provide positive energy feedback.

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Materials and Methods

Effects of Starch on Ruminal pH

The objective of this preliminary trial was to determine the amount of starch that could be fed without causing acidosis. Clinical signs of acidosis start to occur when ruminal pH falls below 5.5 (the normal range of ruminal pH is 6.5 to 7.0; Huntington, 1998). Two ruminally cannulated Holstein steers (981 kg) were fed a maintenance diet of chopped alfalfa (17.6% CP, 1.14 Mcal/kg NE\textsubscript{m}, as-fed basis) and then dosed with increasing amounts of starch through the ruminal cannula (0 to 25% NE\textsubscript{m} requirements). Starch was mixed with tap water in 5% increments of NE\textsubscript{m} requirements (0, 155, 310, 619, 929, 1,239, 1,450 g), and steers were dosed with a higher rate each day for 7 d. Ruminal fluid was siphoned through a tube in the cannula, and ruminal pH was measured before dosing and subsequently at 1, 2, 4, 6, and 8 h after dosing. The daily ration of hay was fed following dosing with starch, and intake was monitored as an indication of illness caused by acidosis.

Conditioning Trial

Fifteen Angus and Hereford × Angus heifers that had no previous exposure to snakeweed were stratified into three weight groups (333, 363, and 380 kg; BCS = 5.6), and the NE\textsubscript{m} was calculated for each group (6.0, 6.4, and 6.6 Mcal/d; NRC, 2000). Within each weight group, heifers were allocated randomly to three treatment groups to receive the supplemental energy: 1) starch, 2) starch plus ground snakeweed, or 3) control that received no supplements. For the second treatment, ground snakeweed the first day, then 200 g thereafter. The heifers were allocated randomly to three treatment groups to receive the supplemental energy: 1) starch, 2) starch plus ground snakeweed, or 3) control that received no supplements. The starch was dissolved in 2 L of tap water and pumped through the stomach tube in the starch and starch plus snakeweed treatments. In the starch plus snakeweed treatment, dry snakeweed was finely ground and mixed with 4 L of water and pumped into the rumen. Heifers were given 100 g of the ground snakeweed the first day, then 200 g thereafter. Controls received 2 L of tap water. The starch dose increased daily from 5% of the NE\textsubscript{m} requirement the first day, to 10%, then 15% for 3 d, and 20% for 3 d. Following the 8-d conditioning phase, acceptability was tested on d 10 in a single-choice trial. Acceptability of snakeweed was tested again on d 32 and 33 following the spring field grazing trail and again on d 94 before the fall grazing trial. The quantity of snakeweed consumed was a measure of its palatability.

Spring Grazing Trial

The starch (positive condition) and control groups were taken to snakeweed-infested rangeland for field grazing trials. The first study site was in the Howell Valley, 15 km west of Tremonton, UT (long 41.724°N, lat 112.408°W). It was a degraded sagebrush site dominated by snakeweed, Sandberg bluegrass (Poa sandbergii), and cheatgrass (Bromus tectorum). Cheatgrass had matured and dried up, and Sandberg bluegrass was senescent. Remnant perennial bunchgrasses, such as needle-and-thread (Stipa comata) and crested wheatgrass (Agropyron cristatum) were still green. Scarlet globemallow (Sphaeralcea coccinea) was the principal green forb, and red-stem filaree (Erodium cicutarium) was mature. Snakeweed stems were fully extended but still vegetative.

A 5.4-ha field was divided into two pastures with electric fencing. The two groups of heifers were randomly allocated to a pasture, and then the pastures were switched each day to minimize pasture bias. Diets were estimated by a bite count technique (Lehner, 1987). Each heifer was observed for 5-min periods and the number of bites of the following forage classes was recorded: perennial bunchgrasses that were still green, dry annual grasses, forbs, and snakeweed. Observations were made during the early morning and late evening grazing periods. Three to seven observations were made on each heifer daily. The positive conditioned group received 0.5 kg/heifer of steamflaked corn each morning and night to enhance the metabolism and excretion of terpenes. Green grass was present at the beginning of the trial to provide adequate protein. Adequate energy and protein are required for detoxification and excretion of terpenes (Foley et al., 1995). The study was conducted from June 9 to 24.

After 8 d and no snakeweed consumption, the pasture sizes were decreased to 0.4 ha in an attempt to quickly utilize the available forage and force the cattle to graze snakeweed. There was enough herbaceous forage exclusive of snakeweed to last the heifers for 4 d. A second set of small pastures (0.4 ha each) was fenced to repeat
the forced grazing trial. During these intensive grazing trials, both groups received 0.5 kg-heifer$^{-1}$-d$^{-1}$ of steam-flaked corn each morning and were offered a Crystalyx 14% (Ridley Block Operations, Mankato, MN) CP/molasses supplement to enhance digestion (Cook and Harris, 1968) and detoxification (Foley et al., 1995) of snakeweed. The Crystalyx tub was weighed before and after the trial and the difference was divided by the number of days and heifers in each group to estimate daily consumption. Crystalyx consumption averaged 0.5 kg-heifer$^{-1}$-d$^{-1}$.

**Fall Grazing Trial**

The trial was conducted near Bothwell, 10 km northwest of Tremonton, UT (long 41.744°483′N, lat 112.248°698′W). The site was a degraded big sagebrush site (5% canopy cover) dominated by dry cheatgrass, jointed goatgrass (*Aegilops cylindrica*), and medusahead (*Taeniatherum caput-medusae*). Purple threeawn (*Aristida purpurea*) occurred on a ridge in the center of the pastures and its regrowth was the only green forage.

The pasture design was similar to the spring grazing trial. A 5.1-ha area was divided into two pastures. The same heifer groups were allocated randomly to a pasture, after which the pastures were switched each day to decrease pasture bias. Diets were quantified by bite counts. After 4 d, there was limited consumption of snakeweed, so the pasture size was decreased to 0.85 ha to create a forced grazing trial. There was only enough herbaceous forage for 4 d to try to force the heifers to graze snakeweed. A second small-pasture forced-grazing trial (0.85 ha each pasture) was started on d 8 and lasted 4 d. Both groups of heifers were offered 0.5 kg of corn each morning and had access to the Crystalyx protein supplement. The heifers consumed 0.9 kg-heifer$^{-1}$-d$^{-1}$ of the 14% CP molasses supplement described previously.

**Standing Crop, Snakeweed Density, and Nutrient Content**

Standing crop was estimated in each of the large pastures at the beginning of both the spring and fall trials, and in each of the small pastures at the end of the trials. Ten 0.125 m$^2$ × 0.5 m quadrats were systematically placed through each pasture at 10-m intervals. The following forage classes were clipped at ground level: green grass, dry grass, forb, snakeweed, and litter. Samples were dried in a forced air oven at 60°C for 48 h, weighed and analyzed for CP by means of total N (Leco model FP-528; Leco Corp., St. Joseph, MI), and NDF (Ankom200 fiber analyzer; Ankom, Fairport, NY).

Snakeweed density was estimated at the end of each seasonal trial. Twenty 1-m$^2$ quadrats were systematically placed at 10-m intervals along paced transects throughout the pastures, the number of snakeweed plants grazed and ungrazed was counted in each quadrat, and the percentage of grazed plants was calculated.

**Statistical Analyses**

In the preliminary starch trial, individual steers were the experimental units. Ruminal pH was compared among the starch doses over the time after dosing by a repeated-measures mixed ANOVA using compound symmetry covariance structure (SAS Version 8e; SAS Inst., Inc., Cary NC). The difference between treatment doses was determined by linear contrasts. In the pen conditioning and field grazing trials, individual heifers were the experimental units. Snakeweed consumption during the 8-d pen conditioning trial was compared among the three supplement groups with repeated-measures mixed ANOVA using compound symmetry covariance structure. Differences among supplement treatments were determined by linear contrasts. Snakeweed intake during each of the subsequent preference tests on d 10, 32 and 33, and 94 was compared among groups by mixed model ANOVA. Snakeweed consumption of the treatment groups in the grazing trials was analyzed by repeated-measures mixed ANOVA comparing locations, treatment groups, and their interaction. The location × group interaction was significant (P < 0.001); therefore, the model was reduced and the locations were analyzed separately by comparing treatment groups and periods in a repeated-measures ANOVA over days within the periods. The periods were 1) large pasture with unlimited grass, 2) small pasture with limited grass, and 3) small pasture with limited grass. Standing crop of forage classes was analyzed using a mixed model ANOVA comparing locations and pastures within locations. Standing crop at the beginning and end of the studies was compared by linear contrasts. Density of snakeweed plants was compared between the locations and among pastures within locations by mixed model ANOVA. The number and percentage of grazed snakeweed plants in the small intensively grazed pastures were compared between locations and treatment groups by mixed-model ANOVA.

**Results**

**Preliminary Starch Trial**

There was a general decline in ruminal pH during the day (P < 0.001), indicating a buildup of VFA as the hay digested (Figure 1). There was no difference in pH between the starch rates until the 20% NE$_{m}$ level was reached. Only the high doses of 20 and 25% NE$_{m}$ differed from the other rates (P = 0.03). However, even when the pH dropped to 6.2 to 6.4 at these high rates, the steers did not decrease hay intake or show any signs of acidosis. Because the starch levels gradually increased at 5% increments, the ruminal microbes seemingly adjusted without causing illness.

**Pen Conditioning Trial**

The starch group consumed more snakeweed (182 ± 25 g compared with 93 ± 27 g for the control group and
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74 ± 30 g for the starch plus ground snakeweed group; $P = 0.02$). There was also a day effect ($P < 0.001$), indicating that all groups increased snakeweed consumption over time. However, the increase was not continuous (Figure 2). Following an increase in snakeweed consumption one day, intake would drop the next. No differences were detected for acceptance of snakeweed on test d 10 after conditioning, on d 32 or 33 after the grazing trial, or on d 94 before the fall grazing trial.

Standing Crop and Snakeweed Density in the Field Grazing Trials

There was no difference in total standing crop between the two locations at the beginning of the studies (Table 1). However, snakeweed standing crop was greater at Bothwell ($P = 0.02$), and dry grass was greater at Howell ($P = 0.01$; Table 1). There was a difference in standing crop of all forage classes between the beginning and end of each study ($P < 0.02$), but no differences were detected in standing crop between the pastures at the end of the small pasture trials in Period 2 and 3.

Snakeweed density was three times greater at Bothwell than at Howell (10.4 vs. 3.2 plants/m²; $P < 0.001$). The number of snakeweed plants grazed was also greater at Bothwell (3.8 vs. 1.85/m²; $P < 0.001$); however, the percentage of plants grazed was greater at Howell (59 vs. 36%) because of the greater density at Bothwell. There was no difference between the treatment groups in the number or percentage of snakeweed plants grazed.

Spring Grazing Trial

During Period 1 in the larger pastures, there was little snakeweed consumed (Figure 3). The heifers preferred the limited amount of bunchgrasses that were still green (22% of bites) and the forbs (14% of bites), but dry cheatgrass and sandberg bluegrass dominated the diets (64% of bites; Table 2).

In Period 2, when the pasture size was decreased, heifers increased consumption of snakeweed as the other forage diminished (Figure 3), but there was no difference between treatment groups (7% of bites).

There was a difference in snakeweed consumption between treatment groups in Period 3 ($P < 0.004$). The positively conditioned group consumed snakeweed for an average of 16% of bites compared with the control group at 5% of bites. There was also a group × day interaction ($P = 0.001$). The positively conditioned group increased snakeweed consumption over time (up to 34% of bites), whereas the control group varied their consumption between days without any distinct trend.

Fall Grazing Trial

In the large pasture grazing trial in Period 1, the positively conditioned group consumed more snakeweed than the control group (5 vs. 1% of bites, $P = 0.03$). There was also a group × date interaction ($P = 0.02$), indicating that the positively conditioned group increased snakeweed consumption over time, whereas the control group ate very little over the 4-d trial (Figure 4). In the two small intensively grazed trials in Periods 2 and 3, there were no differences in snakeweed consumption between groups. However, snakeweed consumption increased in both groups over time as alternative forages were depleted, and peak consumption reached 35% of bites. Dry cheatgrass averaged 82% of diets.
Table 1. Standing crop of forage classes at the beginning and end of grazing at two locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Green grass</th>
<th>Dry grass</th>
<th>Forb</th>
<th>Snakeweed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg/ha</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Howell</td>
<td>Begin</td>
<td>76 ± 25</td>
<td>389 ± 51a</td>
<td>43 ± 17</td>
<td>308 ± 79b</td>
<td>815 ± 115a</td>
</tr>
<tr>
<td></td>
<td>End</td>
<td>0**</td>
<td>141 ± 21**</td>
<td>0</td>
<td>112 ± 29**</td>
<td>254 ± 31**</td>
</tr>
<tr>
<td>Bothwell</td>
<td>Begin</td>
<td>0</td>
<td>235 ± 28b</td>
<td>0</td>
<td>612 ± 96a</td>
<td>847 ± 112a</td>
</tr>
<tr>
<td></td>
<td>End</td>
<td>0</td>
<td>181 ± 11**</td>
<td>0</td>
<td>237 ± 31**</td>
<td>519 ± 35**</td>
</tr>
</tbody>
</table>

**Standing crop of all forage classes differed from beginning to end of the trials ($P < 0.01$).

a,bWithin a forage class column, standing crop values at the beginning of each trial that do not have a common superscript letter differ ($P < 0.01$).

Nutritional Content of Forage

Snakeweed averaged 40% DM during the pen conditioning trial. During the spring grazing trial, snakeweed averaged 8.6% CP and 48% NDF (DM basis). Green grasses averaged 8.3% CP and 69% NDF, and the dry grasses averaged 5.6% CP and 73% NDF. Snakeweed was comparable to green grass in CP, but was lower in fiber. In the fall grazing trial, CP content of snakeweed was 6.9% and NDF was 53% compared with dry cheatgrass (4.8% CP and 70% NDF). Snakeweed was higher in nutrient quality than the poor quality cheatgrass, but its secondary compounds seemingly rendered it unpalatable.

Discussion

Heifers were positively conditioned to increase consumption of snakeweed in the pen conditioning trial. However, consumption of snakeweed was cyclic, following an increase in snakeweed consumption one day, intake would decrease the next. All three groups exhibited this trend, although not all on the same days. Perhaps the heifers were experiencing negative feedback from the snakeweed when it was consumed at high levels.

The ground snakeweed added along with starch in Treatment 2 did not increase acceptance of snakeweed. This group was gavaged with 100 g of ground snakeweed the first day, and then 200 g each day thereafter. The DM content of the fresh picked snakeweed was 40%, so this group would have received a total of 230 g of air-dried snakeweed. In comparison, the starch group consumed an equivalent of 120 g of air-dried snakeweed at its peak. It seems that the deleterious effects of snakeweed overcame the positive effects of starch in the starch plus ground snakeweed group and may have contributed to the cyclic consumption patterns in the other groups.

Individual terpenes in tarbush (Estell et al., 2002) and sagebrush (Dziba, 2004) reduced or stopped feed intake in sheep. Diterpene acids in ponderosa pine, which are similar to snakeweed (Gardner et al., 1999), adversely affect ruminal microbial populations (Weidmeier et al.,...
Table 2. Forage classes in cattle diets with different seasons and pasture sizes at two locations

<table>
<thead>
<tr>
<th>Location/season</th>
<th>Period/pasture size</th>
<th>Group</th>
<th>Green grass</th>
<th>Dry grass</th>
<th>Forb</th>
<th>Snakeweed</th>
<th>Litter</th>
<th>% of bites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howell Spring</td>
<td>1/Large Positive</td>
<td>22 ± 1.9</td>
<td>65 ± 2.2</td>
<td>12 ± 1.3</td>
<td>1 ± 0.3</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>21 ± 2.5</td>
<td>64 ± 2.7</td>
<td>14 ± 1.8</td>
<td>0</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2/Small Positive</td>
<td>11 ± 1.6</td>
<td>77 ± 1.9</td>
<td>5 ± 1.0</td>
<td>7 ± 1.3</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>7 ± 1.0</td>
<td>79 ± 2.3</td>
<td>6 ± 1.3</td>
<td>8 ± 1.7</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/Small Positive</td>
<td>2 ± 0.4</td>
<td>76 ± 2.1</td>
<td>6 ± 1.0</td>
<td>16 ± 2.1a</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>9 ± 20</td>
<td>80 ± 2.3</td>
<td>4 ± 0.8</td>
<td>5 ± 1.2b</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bothwell Fall</td>
<td>1/Large Positive</td>
<td>6 ± 2.5</td>
<td>89 ± 2.7</td>
<td>—</td>
<td>5 ± 1.4b</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3 ± 1.9</td>
<td>96 ± 1.9</td>
<td>—</td>
<td>1 ± 0.2b</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2/Small Positive</td>
<td>—</td>
<td>75 ± 3.7</td>
<td>—</td>
<td>17 ± 3.4</td>
<td>8 ± 1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>—</td>
<td>65 ± 5.2</td>
<td>—</td>
<td>22 ± 4.5</td>
<td>12 ± 3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/Small Positive</td>
<td>—</td>
<td>80 ± 3.0</td>
<td>—</td>
<td>16 ± 2.7</td>
<td>4 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>—</td>
<td>85 ± 2.5</td>
<td>—</td>
<td>9 ± 1.7</td>
<td>6 ± 1.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a,b: Within a column and period, means that do not have a common superscript letter differ (P < 0.001).

1992) and N intake and digestibility (Pfister et al., 1992). Secondary compounds in snakeweed may act directly by decreasing palatability, reduce ruminal microbial populations and digestibility, or physiologically reduce intake.

Although the starch group consumed more snakeweed during the pen conditioning trial, there was no difference in snakeweed intake between the groups in the subsequent test days. In fact, snakeweed intake decreased over time. Without the positive reinforcement from the starch treatments at the time snakeweed was consumed, its palatability or acceptance decreased.

Our results suggest that energy from starch supplements enhanced the initial acceptance of snakeweed in the pen, but did not result in long-term preference for it when the heifers were taken to snakeweed-infested rangeland. When other forage was available in the field grazing trials, the heifers selected grasses and forbs in preference to the snakeweed. The positively conditioned group consumed more snakeweed than the control group in Period 3 of the small intensively grazed trial at Howell, and in the larger pasture in Period 1 at Bothwell. However, the lack of consistency makes it difficult to conclude that positively conditioning with starch will reliably increase consumption of snakeweed, even under high grazing pressures. Other studies have conditioned preferences for unpalatable foods under controlled conditions in pens using energy sources such as glucose (Burritt and Provenza, 1992; Ralphs et al., 1995), propionate (Villalba and Provenza, 1996, 1997a), starch (Villalba and Provenza, 1997b), and supplemental N (Villalba and Provenza, 1997c). However, this test of positive conditioning under field grazing conditions was not successful.

Grazing pressure was the overriding factor that forced our heifers to graze snakeweed in the small intensively grazed pastures. Other studies reported that increasing stock density with an accompanying increase in grazing pressure increased use of less palatable shrubs such as shadscale, black sage (Pieper et al., 1959), big sagebrush, and rabbitbrush (Cook et al., 1962) on Utah’s western desert. Heavy fall grazing by sheep decreased big sagebrush production by 20% and increased grass and forb production 30% in Idaho (Laycock, 1967). In the live oak savanna of west Texas, Taylor et al. (1980) reported that heifers heavily browsed mesquite, live oak, sacahuista, and prickly pear at the end of 21-d grazing periods in a high-intensity, low-frequency grazing system. At the same location, a short-duration grazing system using 3-d grazing periods caused cattle and sheep to heavily graze sacahuista and prickly pear (Ralphs et al., 1990), which decreased the size and production of sacahuista by 40% after 5 yr. On shortgrass prairies of Colorado, heavy grazing intensity eliminated half shrubs, such as broom snakeweed, fringed sagewort, and slender eriogonum (Hart, and Ashby, 1998).

Snakeweed contains a variety of diterpene acids, flavones, and saponins (Dollahite et al., 1962; Roitman et al., 1994). However, there were no clinical signs of intoxication in the intensive grazing trials, even though our heifers consumed snakeweed for up to 35% of their bites. The relatively large amount of snakeweed consumed in the intensive grazing trials contrasts with the relatively small amount that apparently limited intake in the pen conditioning trial and tests. Perhaps the dry grass consumed along with snakeweed and the extended grazing time allowed for dilution of the secondary compounds. The supplemental energy and protein also might have enhanced detoxification.

Implications

Cattle increased consumption of snakeweed when it was paired with supplemental energy from starch in a pen conditioning trial. However, when taken to snakeweed-infested rangeland, they refused to graze snakeweed under free-ranging conditions. This finding suggests that supplemental energy can enhance acceptance of snakeweed when no other choices are available, but preference for snakeweed was not maintained in the field when alternative forages were available. When the pasture size was decreased and alternative forages were depleted, heifers were forced to graze snakeweed. Short-
duration grazing using high stock density to create high grazing pressure may be used to quickly graze all forage, including snakeweed, and then move off to allow the desirable forage to recover.

Literature Cited


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