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Pine needle consumption by cattle during winter in South Dakota

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Abstract

Pregnant cattle that consume ponderosa pine (*Pinus ponderosa* Lawson) needles often abort. The objectives of these studies were to: 1) determine needle consumption by grazing cattle; 2) relate consumption in pen-fed and grazing cattle to weather variables; and 3) determine if needle temperature influenced consumption in pen-fed cattle. Trial 1 was conducted from 3 Dec. 1991 to 12 Feb. 1992 near Custer, S. Dak. Eight mature cows grazed a 9-ha pasture. Needle consumption was measured using bite counts and fecal analysis. The winter was mild, and cattle consumed few needles (< 2% of bites). Trial 2 was conducted in the same location from 5 January to 2 March 1993, using 6 pregnant cows kept in pens and 5 open cows grazing the pasture. The pen-fed cows were offered 1 kg of fresh pine needles daily; methods for grazing cattle were the same as in the previous trial. Further, the pen-fed cows were offered warm or cold green needles in 2 acceptability trials. Grazing cattle consumed an average of 20% of bites as pine needles. As snow depth increased, pine needle consumption increased, particularly from short (< 2 m tall) trees ($P < 0.01$). The percent of bites of green needles was related ($r^2 = 0.69$) to minimum temperature and snow depth, with greater consumption at colder temperatures and at deeper snow depths. As snow depth increased, cattle reduced daily grazing time ($P < 0.01$); at colder temperatures, cattle also reduced grazing time ($P < 0.05$). Pen-fed cows ate 483 g pine needles/day (fresh weight), with no abortions occurring. Cattle preferred cold needles to warm needles ($P < 0.05$) in January, despite tree size; whereas, the opposite result was noted in February. We conclude that snow depth, reduced amounts of grazable forage, and cold ambient temperatures are crucial factors in consumption of ponderosa pine needles by grazing cattle.

Key Words: *Pinus ponderosa*, cattle diets, diet selection, poisonous plants, grazing behavior

Ponderosa pine (*Pinus ponderosa* Lawson) forests in western North America range from southern Canada to northern Mexico. When pregnant cattle eat pine needles, abortion or premature birth of calves often results (James et al. 1989). The economic losses from dead or weak calves and from retained fetal membranes in the dam can be devastating to livestock producers (Lacey et al. 1988). The abortifacient compound in pine needles has been identified as isocupressic acid (ICA), a diterpene resin acid (Gardner et al. 1994, Gardner et al. 1996).

The Black Hills of western South Dakota and eastern Wyoming have a history of serious abortion problems from ponderosa pine needles (Lacey et al. 1988). Calf losses from pine needle abortion were reported by nearly 75% of 173 producers queried in 7 Black Hills counties (Cogswell 1974). We have observed that most abortions occur during winter, and there are apparently 2 reasons for this. First, most cattle are bred to calve during early spring, and cows become more susceptible to pine needle abortion as gestation progresses (Panter et al. 1990, Short et al. 1992). Second, cattle probably eat more pine needles during cold weather when grazing in pine-tree infested areas (Pfister and Adams 1993). Uresk and Paintner (1985) reported that summer diets of cattle in the Black Hills consisted of about 7% pine needles. No studies have been conducted to determine winter consumption of pine needles by cattle in the Black Hills.

The objectives of these studies were to (1) determine the amount of pine needles eaten by grazing and pen-fed cattle, and relate consumption to weather variables; (2) determine if grazing time was related to weather conditions and pine needle consumption; and (3) determine if pine needle temperature influenced acceptability to penned cows. We hypothesized that grazing and pen-fed cattle would consume more pine needles at lower ambient temperatures, and that colder needles would be more acceptable to pen-fed cattle compared to warmer needles.

Methods

Trial 1: 1991–1992

The study was conducted from 3 December 1991 to 12 February 1992 on the Spring Valley ranch about 20 km west of Pringle, S. Dak. A 9-ha pasture was encompassed with electric fence. Dominant dormant species on the pasture, besides pine trees, included skunkbrush (*Rhus trilobata* (Nutt.) Gray), western wheatgrass (*Agropyron smithii* Rydb.), sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), little bluestem (*Schizachyrium scoparium* (Michx.) Nash in Small) and fringed sage (*Artemisia frigida* Willd.).

The forage standing crop and the amount of available pine litter were estimated at the beginning of the study using thirty, 0.5 m^2 plots; standing dead grasses were clipped, whereas pine needle

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litter was removed from the ground. Plots were placed at predetermined intervals along 3 pace transects that quadrisected the pasture. Plant material was dried to a constant weight in a forced-air oven and weighed.

Density of pine trees was determined when the study began by randomly placing twenty, 10 × 20 m plots and by enumerating pine trees within these plots. Pine trees were divided into 2 size classes: short (< 2 m tall) and tall (> 2 m tall). We used these size classes because all needles on trees < 2 m in height were available for browsing by cows; whereas, all needles on trees > 2 m tall were not available for grazing. We were also interested in whether short (presumably young) trees were differentially browsed compared to taller (older) trees. No attempt was made to determine the biomass of pine needles on trees, as needles were abundant on nearly all trees.

Eight multiparous cows weighing about 500 kg were verified to be pregnant by rectal palpation. Cows had grazed the ranch property for several years, including many pine-tree infested pastures, but had no known history of abortions. Cows were penned each evening at 1630 hours to ensure that cattle would not eat pine needles during the night; cows were released to graze at 0730 hours each morning. These grazing hours roughly correspond to daylight hours when it was possible to make behavioral observations. No fixed amount of grass hay was fed daily; the arbitrary amount depended upon the amount of snow cover on the ground, and during warmer weather, no hay was given. The average amount of grass hay fed daily to the 8-cow group was 4.2 kg (SD = 8.8, range = 0 to 45 kg). Six cows were fitted with vibracorders (Argo Instruments, Winchester, Virg.) to measure grazing time; the 8-day charts were changed weekly.

A computer-controlled weather station (Campbell Scientific, Logan, Ut.) was installed next to the pasture. Wind speed (maximum, minimum, average), wind direction (average), air temperature (maximum, minimum, average), relative humidity (maximum, minimum, average), and barometric pressure (average) were continuously monitored, and recorded every 15 min. Total precipitation was recorded hourly (excluding snow). A 1 × 1 m board placed in an open area of the pasture was used to determine snowfall.

Diets were quantified using bite counts and focal animal sampling. Each cow was focally sampled (Altmann 1974) for several 5-min periods during active grazing periods. Bites were recorded for 3 categories of pine needles: pine needle litter, needles from trees < 2 m tall, and needles from trees > 2 m tall; other categories were other browse and other plants (i.e., mostly dormant grasses). The observer made sequential observations of cows during active grazing periods throughout daylight hours. Snow depth was measured at the cow's location (i.e., where front feet were placed) when the 5-min bite count was finished, and we calculated the average daily snow depth associated with each cow's grazing locations.

We used bite counts because we wished to relate pine needle consumption to specific dates and weather variables. To supplement the bite count data, we collected fecal samples from a herd of free-grazing cattle kept in a pine-tree infested pasture near Custer, S. Dak. Multiple (≥ 5) freshly deposited fecal patties were sampled at midday on a weekly basis from mid-December, 1991 to mid-February, 1992. Each weekly collection was composited into a single sample. Diet composition (pine needles, grasses, and other plants) was determined using the microhistological technique as outlined by Pfister and Adams (1993). Observer accuracy was determined in blind trials to be ± 3% for percentage of pine needles in feces.

Trial 2: 1993

Grazing and Pen Feeding Study

The study was conducted in the same location as Trial 1 from 5 January to 2 March, 1993. The pasture was about the same size, had about the same amount of residual forage, and pine tree density had not changed from the previous year. Six pregnant and 5 open multiparous cows weighing about 500 kg from the producer's herd were used. The 6 pregnant cows were penned individually and offered 1,000 g/day (fresh weight) of freshly harvested pine needles. Needles were harvested each morning at 0700 hours from trees in a nearby 2 ha section of forest and offered each day to the cows from 1500 to 1600 hours. Between harvest and feeding the needles were kept at ambient temperature in a shaded location. The pen-fed cows were each given 11 kg (as-fed basis) of grass hay at 1630 hours.

Bite counts were done with the open cows as noted for the previous trial, and all wore vibracorders. We used open cows to avoid interference from the sequelae of retained fetal membranes, which may cause morbidity in cows after an abortion (K. Panter, personal observation). The amount of hay fed each day was determined as previously noted for Trial 1. The average amount of grass hay fed to the 5-cow group was 29.9 kg/day (SD = 10.3, range = 0 to 68 kg/day).

Snowfall and weather were monitored as noted for the previous trial. The cows were not penned at night, and fecal samples were collected twice weekly on Wednesday and Sunday. An observer collected a morning fecal sample when each cow defecated. Each fecal sample was placed in a plastic bag and frozen until processed later at the laboratory. Each sample was thawed, dried in a forced-air oven at 40° C, and ground to pass a 1-mm screen in a Wiley mill. Microhistological techniques were used to determine fecal composition. Fecal composition on each sampling date was adjusted for the grass hay fed 2 days earlier.

Pine Needle Acceptability Trials

We hypothesized that pine needle temperature would affect acceptability to cattle, with warmer needles being less acceptable. Many secondary compounds within pine needles are volatilized at warmer temperatures, hence the pungent odor when brought indoors. We assume that these freshly-released compounds may serve as feeding deterrents. Two pen trials were conducted using 3 of the pregnant cows kept in pens. The cows were trained to eat small quantities of grain from feed boxes attached to the fence, and the cows learned to move from box to box to eat the material. Bulk collections of pine needles from short (< 2 m tall) and tall (> 2 m tall) trees were made in early January and early February, and the needles were frozen. Pine needles were divided into 4 treatment groups: tall-warm, short-warm, tall-cold, and short-cold. Warm needles were heated immediately before offering to cows; cold needles were kept frozen at −15° C until offered to cows for 5 min each day. Pine needle choices were offered simultaneously in 4 different positions within a pen over 4 days on 12 to 15 January and 2 to 5 February. A digital thermometer with sensing probe was used to record needle temperatures. During the January trial, the average warm and cold needle temperature was 15.1 (range 10.9 to 17.0) °C and −6.0 (range −9.4 to −4.2) °C, respectively when the 5-min trial ended. The average ambient temperature during the afternoon tests was −2.5° C. During the February trial, the average warm and cold needle temperature was 4.0 (range 1.0 to 7.6) °C and −8.2 (range −10.1 to −5.4) °C,

Table 1. Mean values for various weather variables during winter grazing studies in South Dakota.

				1993								
				Period [b]								
	1991/92			1			2			3		
Variable	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Min temperature	-30.6	-2.1	-9.7	-27.1	-14.7	-20.4	-17.2	-3.4	-9.3	-30.6	-7.2	-17.8
Max temperature	-6.6	18.2	6.0	-14.5	2.3	-9.0	-2.5	15.7	6.2	-15.7	11.2	-2.5
Avg. temperature	-14.1	5.1	-2.4	-19.2	-8.2	-14.6	-10.4	2.9	-2.2	-24.2	0.1	-10.3
Avg wind speed	0.4	2.7	0.8	0.7	3.3	1.6	0.6	2.1	1.2	0.6	2.0	1.3
Avg barometric pressure	674.3	689.0	681.5	698.4	703.8	701.2	698.4	706.3	702.8	695.0	703.9	701.2
Avg relative humidity	33.4	96.2	62.3	74.1	89.8	82.2	26.6	100.0	67.8	30.7	95.7	70.0

[a]Min = minimum; max = maximum; avg=average. Units are: temperature in °C, wind speed in m/sec, barometric pressure in mm Hg (uncorrected for elevation), and relative humidity in %.
[b]Period 1: 7 to 14 Jan.; Period 2:15 Jan. to 9 Feb.; Period 3: 10 Feb. to 1 Mar..

respectively, at the end of the 5-min trial. The average ambient temperature during the 4 afternoon periods was 5.8° C

Statistical Analysis

Grazing time data were analyzed using analysis of variance procedures, with a model that included cows as blocks, periods as treatments, snow depth as a main effect (< 25, 25–150, > 150 mm), and minimum daily temperature (MDT) and average wind speed (AWS) as covariates (Pfister and Adams 1993). The animal × period interaction was used to test period effects. The same model was used to test for differences in diets. We anticipated using several major colder or warmer weather patterns to differentiate periods, but during Trial 1 the unusually mild winter precluded this approach, and we present only descriptive statistics. During Trial 2, major weather patterns were apparent, and the trial was divided into 3 differing periods for analysis. Table 1 provides weather data and other pertinent details for the designated periods in Trials 1 and 2. Furthermore, stepwise multiple regression was used to evaluate the relationships between grazing time or pine needle consumption and various weather parameters. The composition of fecal samples for 3 periods was compared using ANOVA procedures during Trial 2; after a significant ($P < 0.05$) F-test, means were separated using the PDIFF procedure of SAS (1988). Consumption of pine needles by pen-fed cows was evaluated by ANOVA with a model that included cows as blocks, days, and the day × cow interaction. A multiple latin square design was used to test cold and warm pine needle acceptability during both pen trials. The factors for the latin square model included: cow (i.e., square), 4 positions within the pen, 4 days, and 4 pine needle groups.

Results

Trial 1: 1991-1992

Grazing Study

The standing crop consisted of dried grasses (463 ± 146 kg/ha) and pine litter (420 ± 109 kg/ha). Short and tall tree densities were 535 ± 185 and 380 ± 105 trees/ha, respectively.

The winter of 1991–1992 was relatively mild with an average ambient temperature of –2.4° C. The maximum daily temperature was below freezing for only 3 days during the trial and averaged 6.0° C.

Cattle averaged < 0.5% of their bites as pine needles during the trial. Grazing cattle selected primarily dormant grasses (data not shown). Most of the pine needles consumed were from small trees, as cattle ate almost no pine litter or green needles from larger trees. Maximum daily consumption was about 2% of bites. Complimentary fecal analysis from the grazing herd also showed that pine needle consumption was low, averaging <1 % of cattle diets (data not shown). Regression analysis showed that weather variables were poor indicators of pine needle consumption, with minimum daily temperature the best single predictor variable ($r^2 = 0.18$), with cattle eating more pine needles at colder temperatures.

Cattle averaged 343 min (SD = 59) of daily grazing time. There was a quadratic relationship ($P < 0.05$) between maximum daily temperature and daily grazing time ($r^2 = 0.33$; Fig. 1). Generally, cattle grazed longer as maximum daily temperature increased above freezing.

Trial 2: 1993

Grazing Study

Grazing cattle consumed 20.1% of bites as pine needles during the trial. There were distinct period effects ($P < 0.05$), with cattle taking over > 35% of grazing bites as pine needles during periods 1 (7 to 14 January) and 3 (10 February to 1 March) and about 8% during period 2 (15 January to 9 February) (Table 2). Cattle ate little pine litter during the trial, instead, selecting green pine needles from both large and small trees (Table 2). Pine needle composition of feces was affected by period ($P < 0.01$), with highest levels noted during periods 1 and 3 (Table 2).

Snow depth influenced bites of total pine needles and green needles from both short and tall trees. As snow depth increased, pine needle consumption increased, particularly from short trees (Table 3). Deeper snow was a factor in increased browsing on other shrubs by cattle; whereas, reduced snow depth was related to increased grass use by grazing cattle.

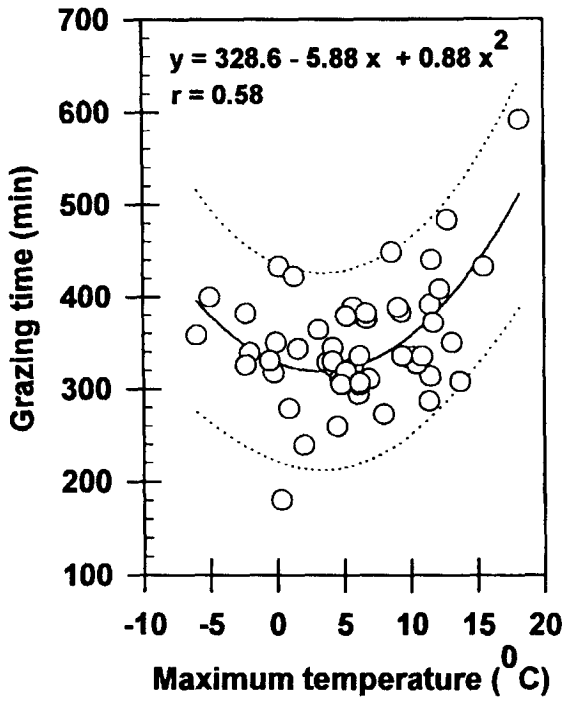

Fig. 1. Daily grazing time (min) for cows grazing ponderosa pine ranges at different air temperatures in western South Dakota during winter, 1991/92. The dashed line indicates the 95% confidence interval.

Total pine needle consumption by grazing cattle (% of bites) was negatively related ($r^2 = 0.52$ for 2-variable model) to average temperature and barometric pressure. The percent of bites of green needles eaten from short trees was negatively related to minimum daily temperature and snow depth ($r^2 = 0.69$ for 2-variable model); whereas, bites of needles from tall trees and pine litter were poorly ($r^2 < 0.3$) related to any combination of weather variables.

Time spent grazing was influenced by snow depth ($P < 0.01$) and minimum temperature ($P < 0.01$) but not by period or wind speed ($P > 0.1$). As snow depth increased, cattle reduced grazing time (Table 3); at colder temperatures (i.e., lower minimum temperature), cattle also decreased grazing time. Most (> 60%) grazing was noted during the afternoon (1200 to 1800 hours). Grazing time was positively related to maximum temperature and negatively related to average relative humidity ($r^2 = 0.49$ for 2-variable model).

Pen feeding study

Consumption of pine needles by pen-fed cows averaged 438 g/day (fresh weight). Periods were different ($P < 0.01$); cows ate more needles during period 1 (mean 684 g) compared to periods 2 and 3 (means 415 and 383 g, respectively). No weather variables were related to consumption of pine needles by pen-fed cows ($r^2 < 0.1$). No abortions occurred in the pregnant pen-fed cows.

Pine needle acceptability trials

In the January trial, cattle preferred ($P < 0.05$) the cold needles over the warm despite the tree size from which they were collected (Table 4). The opposite result was found during the February trial, with cattle preferring ($P < 0.05$) the warm pine needles over the cold (Table 4), despite tree size.

Discussion

We found in a previous 2-year study in Montana that cattle ate substantial quantities of pine needles during a normal (i.e., cold) winter but ate essentially no needles during a mild winter (Pfister and Adams 1993). The present study strongly supports that conclusion. Cattle ate virtually no needles in the Black Hills during the winter of 1991/92, a response we attribute to the mild winter weather and abundant forage availability. In contrast, during the next normal (i.e., cold) winter, cattle selected green pine needles for a large portion of their grazing diets. Interestingly, cattle ate

Table 2. Composition of grazing cattle diets (% of bites; % in fecal material) and grazing time (min/day) during winter, 1993 in western South Dakota.

	Period [a]											
	1				2				3			
Item	Min[b]	Max[b]	Mean	SE	Min	Max	Mean	SE	Min	Max	Mean	SE
Pine needle litter	0.0	0.0	0.0	—	0.0	23.7	0.5	0.2	0.0	17.3	0.5	0.3
Green needles (trees<2 m tall)	0.0	83.3	25.2	3.6	0.0	39.6	3.4	0.6	0.0	59.7	11.8	2.0
Green needles (trees>2 m tall)	0.0	69.7	17.1	3.4	0.0	63.7	3.7	0.8	0.0	100	22.9	4.1
Total pine needles	0.0	97.4	42.3	4.0	0.0	72.9	7.7	1.1	0.0	100	35.3	3.9
Browse	0.0	72.7	33.5	3.9	0.0	94.8	2.1	0.9	0.0	5.4	0.2	0.1
Grasses	0.0	69.2	24.2	4.5	0.0	100	90.1	1.6	0.0	100	64.6	3.9
	(% of feces)											
Total pine needles	24.0	75.0	46.6	6.2	2.1	40.0	14.3	1.2	17.1	88.0	47.1	2.9
	(min/day)											
Total grazing time	76	349	182	9.9	15	547	291	11.0	99	536	267	10.4

[a]Period were(1) 7 to 14 Jan.; (2) 15 Jan. to 9 Feb; (3) 10 Feb. to 1 Mar.
[b]Min = minimum; max = maximum. Denotes minimum or maximum value on any day for any cow during the period, depending on the variable (i.e., % of bites, % of feces, min/day)

Table 3. Effect of snow depth on cattle grazing diets (% of bites) and grazing time (min/day) during winter, 1993, in western South Dakota.

Item	Snow depth (mm) <25	25–150	>150	MSE[a]	P[b]
	(% of bites)				
Green needles (trees < 2 m tall)	2.1	6.3	24.6	10.3	0.01
Green needles (trees > 2 m tall)	1.4	14.8	17.0	20.4	0.17
Pine needle litter	0.3	0.8	0.0	2.1	0.69
Total pine needles	3.9	21.8	41.5	19.9	0.01
Browse	0.1	0.2	27.4	9.6	0.01
Grasses	96.1	77.9	31.1	20.4	0.01
	(min/day)				
Total grazing time	305	254	200	73.6	0.01

[a] MSE = root mean square error
[b] P = probability of a greater F value

Table 4. Consumption of warm or cold pine needles by cattle in 2 acceptability trials during Jan. and Feb. 1993, in western South Dakota.

Trial/Needle treatment[a]	Sum	Mean	SE
January	(g)		
Tall/warm	8.0	0.7[b]	0.6
Short/warm	180.5	15.0[cb]	10.1
Tall/cold	627.2	52.3[c]	27.7
Short/cold	452.0	37.7[cb]	17.9
February			
Tall/warm	1241.3	103.4[c]	30.6
Short/warm	1446.1	120.5[c]	25.9
Tall/cold	127.3	10.6[b]	8.2
Short/cold	7.9	0.6[b]	0.6

[a] Pine needles were collected from either tall (2>m) or short (< 2m) trees and frozen. During the trials, needles were either kept cold, or warmed to test for effects of needle temperature on acceptance by cattle (see text for details).
[b] Within trials means without a common superscript differ (P<0.05).

mostly green needles and relatively little pine litter in South Dakota as compared to the Montana study where most of the needles eaten were weathered litter.

We earlier reported (Pfister and Adams 1993) that both snow depth and forage availability may influence consumption of pine needles. Snow depth was positively related to pine needle consumption during winter, 1993, and in our Montana study. Pine needle consumption increased as snow depth increased; more snow on the ground also resulted in more browsing on other shrubs, and less snow resulted in cattle eating more grass. Unfortunately, both snow depth and amount of forage that could be easily grazed under the snow were confounded with general winter weather patterns. During the cold winter, snow depth impaired grazing by cattle of low-growing vegetation on many sites within the pasture; whereas, the mild winter resulted in no substantial, long-lasting snow cover in the pasture, and cattle had easy access to dormant forage.

Pine needle consumption by grazing cattle was negatively related to temperature, a result similar to our Montana study (Pfister and Adams 1993). Ambient temperature and snow depth were also negatively related, again emphasizing the interrelationship of cold temperatures, amount of snow on the ground, and pine needle consumption. It seems unlikely that cattle are simply eating more total forage (including needles) during colder periods. Forage intake of confined cattle is often increased by colder temperatures (NRC 1987); whereas, grazing cattle often decrease forage intake as temperatures decrease (Adams et al. 1986, Adams 1987). We do not believe that cattle eat pine needles from only hunger, because we have observed cattle leaving hay on the ground to browse on pine trees. Similarly, MacDonald (1952) reported that pine needles were palatable to range cattle and were eaten even when animals were well fed. No studies have determined if hungry cattle will eat more pine needles than well-fed animals although we suspect they would; Pfister and Adams (1993) examined the influence of rumen fill, but cattle ate no pine needles during that winter. Short et al. (1994) determined that high levels of protein intake will increase consumption of pine needles by pen-fed cows but other dietary interventions (e.g., straw and mineral supplementation) did not affect consumption.

We speculated earlier (Pfister and Adams 1993) that cattle may eat more needles during colder weather because of weather-induced chemistry changes in needles. We did not, however, find any relationship between weather variables and pine needle consumption by pen-fed cattle when needles were fed for > 50 days. Thus, we failed to accept our hypothesis that pen-fed animals eat more pine needles at colder ambient temperatures. Furthermore, our 2 latin square acceptability trials gave inconsistent results concerning pine needle temperature. Cattle avoided warm needles during the first acceptability trial, and then avidly selected warm needles and avoided cold needles in the second trial. Cattle ate much greater quantities of warm needles during the second trial compared to cold needles during the first trial. The "warm" needles in the 2 trials were not the same temperature, and cattle apparently preferred the needles that were thawed to just above freezing (4° C) over the "very warm" (15° C) needles in the first trial. We did not intend to compare the 2 trials directly, but perhaps they were confounded by warm needle temperature, time (i.e., month), ambient temperature, or other unknown factors. Some unknown degree of learning from the first trial may have contaminated the second trial. We could smell the pungent odor of the "warm" needles in both trials but had no way of measuring release of volatile compounds. We also found little evidence of differences in acceptability between green needles from older (tall) and younger trees. We did not measure concentrations of the abortifacient compound, ICA, and we doubt if ICA concentrations in pine needles have any influence on consumption by cattle because ICA is only 1 of at least 6 different resin acids in pine needles (Gardner et al. 1994).

Cattle reduced grazing time in response to both deeper snow and colder temperatures (Malechek and Smith 1976, Adams et al. 1986, Pfister and Adams 1993). Conversely, cattle grazed longer as maximum daily temperature increased above freezing. Several studies have shown that cattle respond to colder temperatures by reducing grazing time (Adams 1987). During the winter of 1993, cattle sometimes grazed very little, apparently because grazing negatively affected net energy balance when snow was relatively deep and forage was difficult to prehend. When cattle did graze, green pine needles were readily available, and snow depth may account for green needles being eaten by cattle. Cattle did not often push beneath snow to eat pine litter, unlike cattle during our earlier Montana grazing study (Pfister and Adams 1993). In that study, cattle ate substantial (but declining) amounts of pine litter even when litter was covered by > 150 mm of snow.

Our results show that ambient temperature and snow depth (or conversely amount of grazable forage) are major factors influencing pine needle consumption by grazing cattle. Although grazing time may decrease in response to colder weather, cattle are more likely to eat pine needles during periods of colder weather. We suggest that producers with pine-tree infested ranges pay close attention to weather patterns. As pregnant cattle get closer to parturition, they are at greater risk of aborting from ingesting needles, and should be kept away from pine trees. Our experience suggests that pine needle consumption may be most problematic when grazing cattle are confronted with colder temperatures and reduced amounts of grazable forage, either from earlier heavy grazing and(or) from snow cover.

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