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The effect of western juniper on the estrous cycle in beef cattle

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ABSTRACT

Numerous evergreen trees and shrubs contain labdane acids, including isocupressic acid, which can cause late-term abortions in cattle. Recent research has shown that the bark from western juniper trees can also cause late-term abortions in cattle. Additionally, ranchers have observed that cattle in western juniper-infested rangelands tend to have decreased conception rates. The objective of this study was to determine if western juniper alters the estrous cycle of cattle. Fourteen heifers (10 treated and 4 control) were monitored for 74 days for signs of normal estrous behavior, with a 21 day feeding trial with western juniper bark from days 28–48, after which the cattle were bred naturally with a bull. The cattle were checked for pregnancy 30 days after all cattle had been bred. The data from this study indicate that exposure to western juniper bark does not affect normal estrus, estrous cycle or conception rates of cattle.

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Needles from ponderosa pine (*Pinus ponderosa*) trees are known to cause late-term abortions in cattle (Gardner et al., 1999; James et al., 1989, 1994). Isocupressic acid (ICA), a labdane resin acid in the needles of ponderosa pine, was identified as the abortifacient agent (Gardner et al., 1994). In addition to ICA, pine trees also contain other labdane acids including imbricataloic acid (IMB), agathic acid (AA) and dihydroagathic acid (DHAA). The bark of Utah juniper (*Juniperus osteosperma*), which contains a high concentration of AA (1.5% by dry weight) but no ICA, will induce abortions in cattle, demonstrating that AA is also abortifacient in cattle (Gardner et al., 2010).

There have been several reports of abortion rates of 10–15%, within cattle herds in Oregon, after cattle were pastured in areas with an abundance of western juniper trees (*Juniperus occidentalis*; Cory Parsons, personal communications). In each of these instances, there was no ponderosa pine, or other trees known to contain ICA, found in these areas. There was clear visual evidence that cattle had consumed the bark and needles from the western juniper trees. The reported losses occurred most often after a significant weather incident, such as high winds that knocked limbs onto the ground or heavy snow fall that covered available forage, which can result in cattle eating large amounts of needles and/or juniper bark in a short period of time. Ranchers also reported cattle consuming large amounts of juniper from slash piles or riparian projects where western juniper trees were used for restoration. Analysis of the bark, needles, and berries from western juniper trees determined that all contain labdane acids similar to those found in ponderosa pine needles, albeit in lower concentrations (Welch et al., 2011). Additionally, feeding western juniper bark to late-term pregnant cattle demonstrated that the bark from western juniper trees could induce abortions in cattle (Welch et al., 2011). Analyses of samples of bark, needles, and berries from western juniper trees collected across the state of Oregon, determined that there is considerable variation in the concentration of the abortifacient compounds in western juniper trees (Welch et al., 2013). However, in general, most western juniper trees have the potential to cause late term abortions in cattle.

Several livestock producers in Oregon have also reported irregular estrous cycles and lower reproductive rates in cattle that utilize juniper-infested summer rangelands (Cory Parsons, personal communications). There are numerous plants that are known to adversely affect the estrous cycle of cattle including several phytoestrogen containing plants (soybeans and clovers) and locoweeds (Evans, 2012; Panter et al., 1999). Consequently, exposure to these plants during the breeding season could effectively prevent the cattle from becoming pregnant, delaying pregnancy, or resulting in an inability to maintain pregnancy. Therefore, the objective of this study was to determine if consumption of western juniper alters the estrous cycle of beef cows and therefore could extend the calving interval or reduce conception rates.

For this study, bark from western juniper trees (*J. occidentalis*) was collected in August of 2012 from trees that had been cut down 1–2 years previously near Durkee and Brothers, Oregon. Comparisons of the labdane acid profiles in bark from live trees versus trees

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that have been cut down previously demonstrate no significant differences (data not shown). The bark was allowed to dry at ambient temperature. The dried bark was ground to pass a 2 mm screen using a Gehl Mix-All model 55 (Gehl Company, West Bend, WI, USA) and stored in a plastic bag in an enclosed, non-heated, un-insulated building at ambient temperature. The concentration of labdane acids in the bark was measured by gas chromatography following previously published methods (Gardner and James, 1999). The composite collection of bark contained 0.09% ICA, 0.42% IMB, 0.15% DHAA, 0.52% AA, and 1.19% total labdane acids, on a dry weight basis.

Fourteen Black Angus heifers were evaluated via rectal palpation and ultrasound imaging to determine reproductive status i.e. active reproductive tract, stage of estrous cycle, normal tone and size of the uterus, and ovarian parameters. The estrous cycle of all 14 heifers was synchronized by administering 5 ml of Lutalyse (Pfizer, New York, NY, USA) intramuscularly followed by a second 5 ml injection 10 days later. Heifers were then observed and handled for 28 days prior to dosing with juniper. Ten heifers were dosed via oral gavage with western juniper bark (35 mg of total labdane acid/kg BW/day; half in the morning and half in the evening) for 21 days. Four control heifers were handled the same as the treatment heifers except ground barley straw was substituted for the juniper bark. Daily blood samples were collected from 3 of the treated heifers for the duration of the study, 74 days, to evaluate serum progesterone profiles as a physiological indication of their estrous cycle. Serum progesterone concentrations were determined using a commercial direct solid-phase radioimmunoassay kit (Siemens Healthcare Diagnostics, Duluth, MN, USA). Validation of the human kit for bovine serum was performed according to previously published methods (Panter et al., 1995). Inter- and intra-assay coefficients of variation were 5.1% and 6.6%, respectively.

All cattle were observed daily for standing estrus and their reproductive tracts were evaluated by rectal palpation and ultrasound imaging prior to the start and immediately following the feeding trial. The size of each ovary was determined by measuring the vertical and horizontal diameter of each ovary via ultrasound imaging techniques. One month after the end of the feeding trial, heat detection patches were placed on all heifers, and they were introduced into a pen with a Red Angus bull. Cattle were monitored daily for evidence of breeding and the date the heat detection patch changed color was noted as the breed date. A new heat detection patch was placed on each heifer after breeding and they were monitored for an additional 30 days for repeat breeding. All heifers were evaluated for pregnancy by rectal palpation and ultrasound imaging approximately 30 days after the last heifer was bred. All animal work was done under veterinary supervision with the approval and supervision of the Utah State University Institutional Animal Care and Use Committee.

In this study, all animals appeared healthy and normal throughout the study. There was no change in feed intake or any clinical signs of poisoning observed in the cattle. The cattle were evaluated by rectal palpation and ultrasound imaging 11 days after the second injection of Lutalyse. They were all found to have a prominent corpus luteum (CL) present on one of their ovaries, indicating that they were each exhibiting a normal estrous cycle. There was no difference in the size of the ovaries between the control and treated cows, either before or after juniper treatment (Table 1), suggesting the juniper treatment did not affect ovarian function. Juniper treatment had no effect on serum progesterone concentrations, as the cows had a normal 21 day cycle before treatment, during treatment, and immediately after treatment (Fig. 1). There was no difference in the average time it took for the control and treated heifers to be bred by the bull (Table 1); however, there were two of the treated heifers that rebred (Table 1), suggesting that they did not conceive the first time they were bred. However, there was not a statistically significant difference (P = 1.0) between the control and treated groups. Finally, all the cattle were evaluated for pregnancy by rectal palpation and ultrasound imaging approximately 30 days after the last cows had been bred. All of the cattle were found to be pregnant (Table 1). The data presented in this study indicate that exposure of cattle to western juniper, at the dose administered in this study, will not adversely affect estrus or the estrous cycle in cattle, their ability to become pregnant, or their ability to maintain pregnancy during the first trimester. However, cattle producers should still be cognizant of the potential of western juniper trees to cause late-term abortions in cattle.

Table 1
The effect of western juniper on several reproductive parameters.

Group		Control		Treated	
n		4		10	
Ovary size (cm^2)		AVG	SD	AVG	SD
Day −11[a]	Left	4.3	1.8	3.5	0.7
	Right	2.9	1.3	4.3	1.5
Day 22[b]	Left	6.3	4.0	6.7	3.6
	Right	10.0	4.4	8.4	4.1
Day 57[c]	Left	5.0	2.9	5.3	2.2
	Right	8.0	2.7	6.5	2.5
# days to breed[d]		14	0	9	5
# repeat breeders[e]		0		2	
% pregnant[f]		100%		100%	

[a] 11 days prior to start of the feeding trial.
[b] 1 day after end of the feeding trial.
[c] 36 days after end of the feeding trial.
[d] # of days after introduction to bull before confirmation of breeding.
[e] # of animals who bred more than once.
[f] % of animals in each group that were pregnant 50 days after the last positive breeding date.

Due to the small sample size of this study, these results may not be a true reflection of the total population. Consequently, there is still a possibility that western juniper could adversely affect the normal estrous cycle of some cattle. However, encroachment of western juniper is known to adversely affect grass productivity as well as soil hydrologic and nutrient cycles (Bates and Svejcar, 2009; Miller et al., 2000; Roberts and Allen Jones, 2000). Therefore, it is possible that cattle grazed in juniper-infested rangelands may suffer

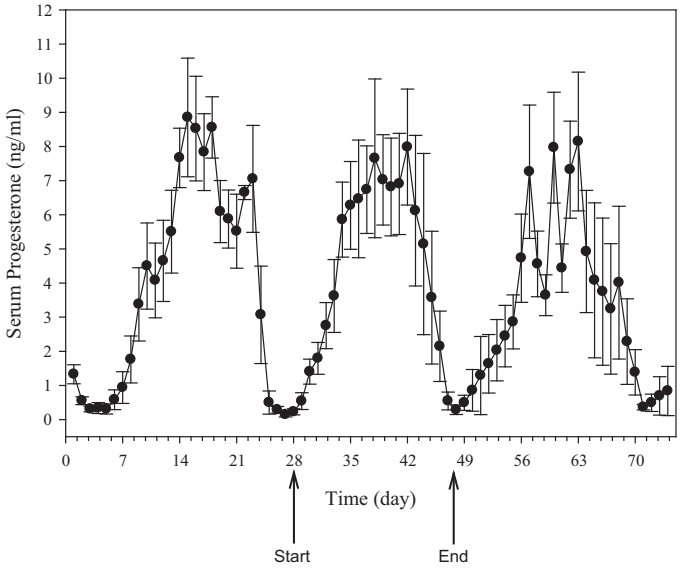

Fig. 1. Cows fed western juniper have normal progesterone profiles. Blood was collected from three cows for 28 days prior to the juniper treatment, during the 21 days of the treatment, and for 26 days after the treatment for analysis of serum progesterone concentrations. Data represent the average and standard deviation.

from slight nutritional deficiency, which could impact their overall mineral status including copper, selenium and other trace minerals that are vital for normal reproductive efficiency. Therefore, the reports of increased numbers of open cows observed when cattle graze western juniper-infested rangelands may more likely be due to poor nutritional status or mineral deficiencies. It is well known that deficiencies in key minerals in cattle will adversely affect the ability of cattle to either become pregnant and/or maintain pregnancy (Jainudeen and Hafez, 1993). Additionally, if the cattle are nutritionally deficient, they may eat more juniper bark and needles, as research has shown that cattle in lower body condition eat more pine needles than cattle in better body condition (Pfister et al., 2008). Consequently, future experiments will evaluate the nutritional and mineral status of cattle grazing in western juniper-infested rangelands.

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References

Bates, J.D., Svejcar, T.J., 2009. Herbaceous succession after burning of cut western juniper trees. Western North American Naturalist 69, 9–25.

Evans, T.J., 2012. Reproductive toxicity and endocrine disruption. In: Gupta, R.C. (Ed.), Veterinary Toxicology Basic and Clinical Principles, second ed. Academic Press, New York, New York, pp. 287–318.

Gardner, D.R., James, L.F., 1999. Pine needle abortion in cattle: analysis of isocupressic acid in North American gymnosperms. Phytochemical Analysis 10, 132–136.

Gardner, D.R., Molyneux, R.J., James, L.F., Panter, K.E., Stegelmeier, B.L., 1994. Ponderosa pine needle-induced abortion in beef cattle: identification of isocupressic acid as the principal active compound. Journal of Agricultural and Food Chemistry 42, 756–761.

Gardner, D.R., James, L.F., Panter, K.E., Pfister, J.A., Ralphs, M.H., Stegelmeier, B.L., 1999. Ponderosa pine and broom snakeweed: poisonous plants that affect livestock. Journal of Natural Toxins 8, 27–34.

Gardner, D.R., Panter, K.E., Stegelmeier, B.L., 2010. Implication of agathic acid from Utah juniper bark as an abortifacient compound in cattle. Journal of Applied Toxicology 30, 115–119.

Jainudeen, M.R., Hafez, E.S.E., 1993. Reproductive failure in females. In: Hafez, E.S.E. (Ed.), Reproduction in Farm Animals, sixth ed. Williams & Wilkins, Media, PA, pp. 261–287.

James, L.F., Short, R.E., Panter, K.E., Molyneux, R.J., Stuart, L.D., Bellows, R.A., 1989. Pine needle abortion in cattle: a review and report of 1973–1984 research. The Cornell Veterinarian 79, 39–52.

James, L.F., Molyneux, R.J., Panter, K.E., Gardner, D.R., Stegelmeier, B.L., 1994. Effect of feeding ponderosa pine needle extracts and their residues to pregnant cattle. The Cornell Veterinarian 84, 33–39.

Miller, R.F., Svejcar, T.J., Rose, J.A., 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53, 574–585.

Panter, K.E., James, L.F., Mayland, H.F., 1995. Reproductive response of ewes fed alfalfa pellets containing sodium selenate or *Astragalus bisulcatus* as a selenium source. Veterinary and Human Toxicology 37, 30–32.

Panter, K.E., James, L.F., Stegelmeier, B.L., Ralphs, M.H., Pfister, J.A., 1999. Locoweeds: effects on reproduction in livestock. Journal of Natural Toxins 8, 53–62.

Pfister, J.A., Panter, K.E., Gardner, D.R., Cook, D., Welch, K.D., 2008. Effect of body condition on consumption of pine needles (*Pinus ponderosa*) by beef cows. Journal of Animal Science 86, 3608–3616.

Roberts, C., Allen Jones, J., 2000. Soil patchiness in juniper-sagebrush-grass communities of central Oregon. Plant and Soil 223, 47–61.

Welch, K.D., Gardner, D.R., Panter, K.E., Stegelmeier, B.L., Parsons, C., Pfister, J.A., et al., 2011. Western juniper-induced abortions in beef cattle. International Journal of Poisonous Plant Research 1, 72–79.

Welch, K.D., Cook, D., Gardner, D.R., Parsons, C., Pfister, J.A., Panter, K.E., 2013. A comparison of the abortifacient risk of western juniper trees in Oregon. Rangelands 35, 40–44.