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Evaluation of the Seasonal and Annual Abortifacient Risk of Western Juniper Trees on Oregon Rangelands

By Kevin D. Welch, Cory Parsons, Dale R. Gardner, Tim Deboodt, Peter Schreder, Daniel Cook, James A. Pfister, and Kip E. Panter

On the Ground

- Western juniper trees can cause late term abortions in cattle, similar to ponderosa pine trees.
- Results from this study demonstrate that there is no difference in the labdane acid (the abortifacient compounds) content of western juniper trees throughout the year, or from year to year.
- Consequently the abortifacient risk of western juniper trees should not vary throughout the year, or from year to year.
- Producers who winter cattle in rangelands with western juniper trees should take similar precautions to prevent late term abortions as they would with ponderosa pine trees.

Keywords: cattle, abortions, western juniper trees, isocupressic acid, labdane acids.

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Several trees, including ponderosa pine (*Pinus ponderosa*) trees, are known to cause late-term abortions when eaten by pregnant cattle.[1,2] Isocupressic acid (ICA), a labdane resin acid in the needles of ponderosa pine, was identified as the abortifacient (abortion-causing) agent.[3] In addition to ICA, pine trees may also contain additional labdane acids that may also be abortifacient, including imbricataloic acid (IMB), agathic acid (AA), and dihydroagathic acid (DHAA).[4] Research has demonstrated that other species of trees also contain ICA and/or metabolites of ICA.[5] For example, 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.[6] Current management recommendations indicate that any plant material with a concentration greater than 0.5% ICA (on a dry weight basis) poses a risk for inducing abortions in late-term pregnant cattle and that ICA concentrations over 1% pose a much higher risk.

Western juniper trees (*Juniperus occidentalis*) are found throughout the state of Oregon and in parts of Washington, Idaho, Nevada, and California (Fig. 1). The bark, needles, and berries from western juniper trees contain labdane acids as in ponderosa pine needles, albeit in lower concentrations.[7,8] Some concern has been expressed by cattle producers, veterinarians, and extension agents in these areas that western juniper trees can adversely affect the reproductive efficiency in cattle, including increased abortions and open cows. Recent research has demonstrated that western juniper trees can induce late-term abortions in cattle.[7] However, another study concluded that exposure to western juniper trees does not adversely affect the estrous cycle of cattle.[9]

In order to further characterize the abortifacient risk of western juniper trees, the labdane acid concentrations in western juniper trees across the state of Oregon were evaluated.[8] There was considerable variation in the abortifacient risk of western juniper trees among the 35 locations surveyed. However, in general, all western juniper trees were considered to be a risk to induce late-term abortions in cattle.[8] The objective of this study was to determine if there is a seasonal or annual variation in the abortifacient compounds in western juniper trees. Previous research demonstrated that there is difference in the ICA concentration in the needles of ponderosa pine trees at some locations, whereas there was no difference at other locations.[10] The information obtained in this study will increase knowledge regarding the abortifacient risk of western juniper trees and help better understand the variation in potential abortion risk throughout the year and from year to year.

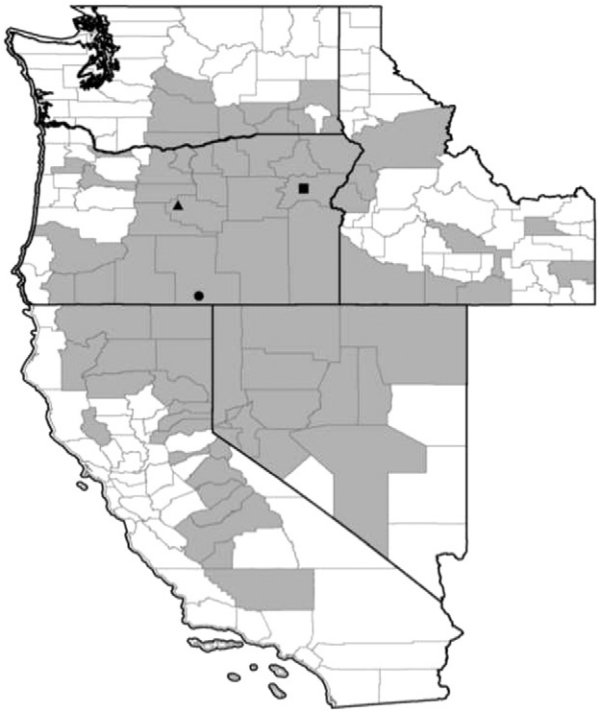

Figure 1. Map of the distribution (gray-shaded areas) of western juniper trees. The three collection sites for this study were in Baker County (■), Crook County (▲), and Lake County (●), Oregon.

Methods

We collected samples of needles and bark from western juniper trees every other month from June 2012 through June 2014 from three locations (8–10 trees per location), including Baker County (near Baker City), Crook County (near Prineville), and Lake County (near Lakeview), Oregon (see Fig. 1). Trees at each location were marked with a numbered identifier so that samples were collected from the same trees at each collection. By numbering the trees, the labdane acid content of individual trees could be monitored over time. We collected samples from live trees by walking around the tree and randomly taking grab samples of bark and needles from a minimum of four sites on the tree, from parts of the tree that could be accessed by grazing cattle. We placed the samples into paper bags and allowed them to dry at ambient temperature and then analyzed them for labdane acid concentrations. Dried samples were ground to pass through a 1- to 2-mm mesh using a Wiley Mill. After processing, the ground plant material was placed in plastic bags and stored at −80°C until analysis. The concentration of labdane acids in the plant materials were measured by gas chromatography as previously described.[11] Data are expressed as mean ± SD. Statistical comparisons of labdane acid concentrations between multiple samples were made by using a one-way analysis of variance (ANOVA) with a Bonferroni post hoc test. Comparisons between two samples were made using the Student's t test. Differences were considered significant at $P < .05$.

Results and Discussion

In an effort to better characterize the abortifacient risk of western juniper trees and to determine if there is a seasonal or annual variation in the labdane acid content of western juniper trees, we collected samples of needles and bark from western juniper trees from three locations in Oregon, including Baker County, Crook County, and Lake County (see Fig. 1). In order to provide a more conservative estimate of the abortifacient risk of western juniper trees, we report the total labdane acid content of the samples, which is the sum of all the individual labdane acids. The results from this study indicate that there is no discernible pattern of seasonal or annual variation in the total labdane acid content of bark and needles from trees at the three different locations (Fig. 2). Based solely on plant chemistry, these results suggest that the relative risk of abortion, or other reproductive problems in cattle, is similar throughout the year, and from year to year. However, other important factors can influence the abortion risk, including the stage of pregnancy, weather, and body condition. Any aspect of management that increases the risk of cattle eating western juniper bark and needles will likely increase their risk and influence their response to that exposure.[12,13]

In addition to measuring the total labdane acid content, we also determined the concentration of the individual labdane acids. Overall, we found no significant changes in the concentration of any of the individual labdane acids in the needles of western juniper trees throughout the course of the study (Fig. 3). We found very similar results in the bark (data not shown), with the exception that the rank order of the abundance of individual labdane acids was different between the bark and the needles. In the needles, DHAA was the most abundant labdane acid followed by IMB, ICA, and AA, whereas in the bark, AA was the most abundant, followed by ICA, IMB, and DHAA.

In a previous study,[8] we found no statistical difference in total labdane acid content in western juniper trees in any of the 35 locations evaluated. However, there was considerable variation among individual trees at a given location. Similarly, in this study, there was no clear difference in the total labdane acid content among the three locations, but, again, we found a significant difference among individual trees at a given location (Fig. 4). Importantly, in trees that contained high concentrations of labdane acids, the concentrations were always high, whereas in trees that were low in labdane acids, the concentrations always remained low (see Fig. 4). Given this variation, some individual trees, if consumed, may pose a much higher risk for causing late-term abortions than the general population at a given location. These data may also help explain the lower incidence of western juniper–induced abortions compared with ponderosa pine needle–induced abortions. Overall the labdane acid concentration in western juniper trees is lower than that in ponderosa pine needles, and thus western juniper trees pose a lower abortifacient risk. However, if cattle consume the needles and/or bark from specific western juniper trees that do have a higher labdane acid content, abortions may occur.

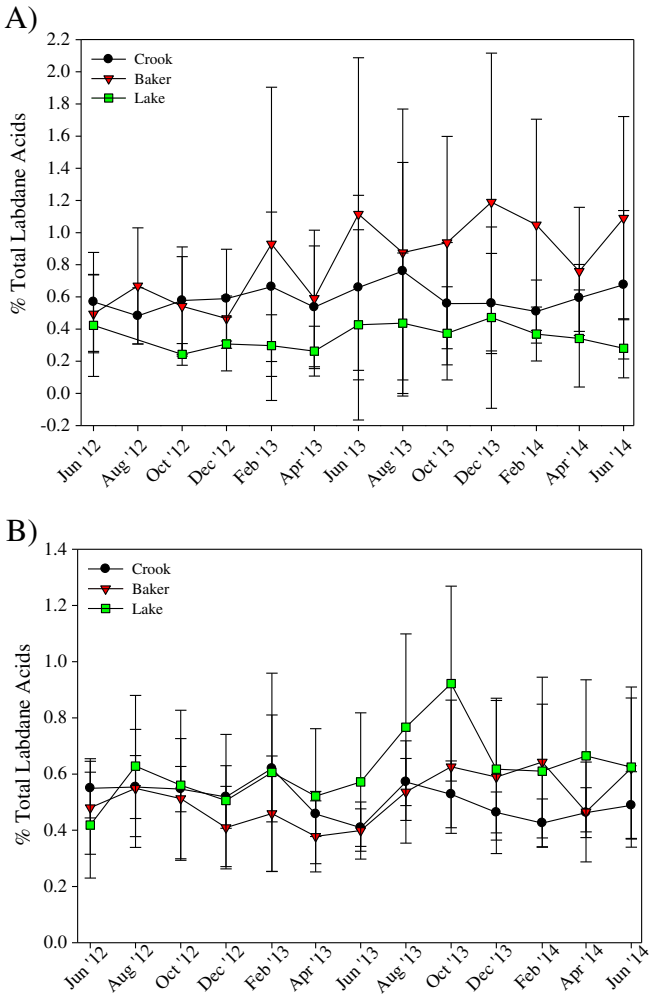

Figure 2. Total labdane acid concentrations in bark and needles from western juniper trees. Samples of bark (**A**) and needles (**B**) were collected every 2 months from June 2012 to June 2014 from Baker County, Crook County, and Lake County, Oregon. The data represent the sum of all the labdane acids in each sample. The data are reported as the mean ˘ SD from 810 trees. Data are presented as a percentage of dry weight plant material.

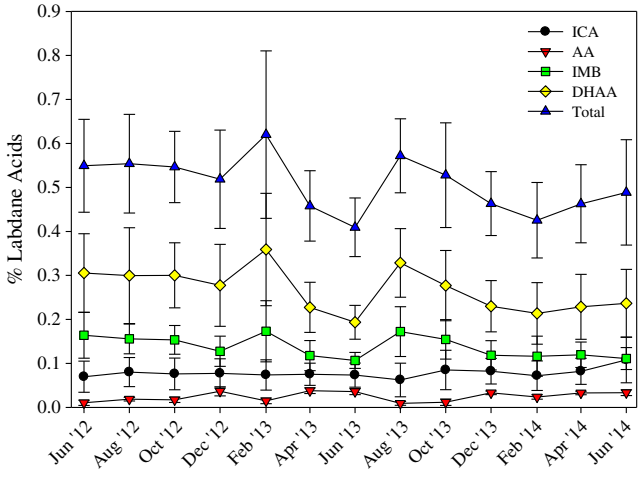

Figure 3. Comparison of individual labdane acid concentrations in western juniper needles. Samples of needles were collected every 2 months from June 2012 to June 2014 from Crook County, Oregon. Data represent the labdane acids isocupressic acid (ICA), imbricataloic acid (IMB), dihydroagathic acid (DHAA), agathic acid (AA), and their sum (Total). Data represent the mean ˘ SD from 10 trees. Data are presented as a percentage of dry weight plant material.

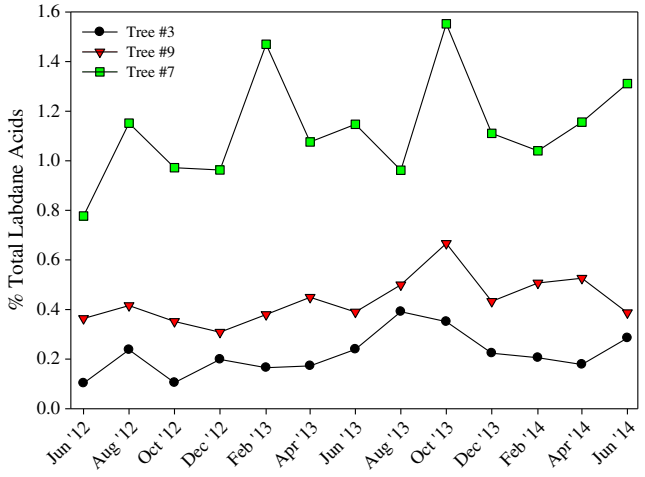

Figure 4. Comparison of the total labdane acid concentrations in western juniper needles among three trees at one location. Samples of needles were collected every 2 months from June 2012 to June 2014 from Lake County, Oregon. The data represent the sum of all the labdane acids in each sample. Data are presented as a percentage of dry weight plant material.

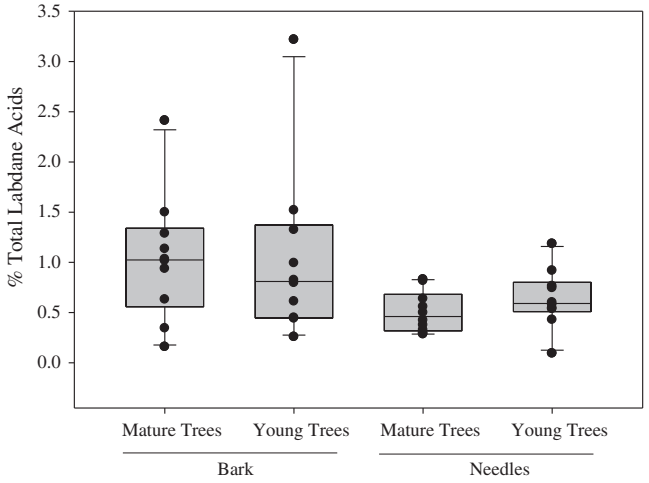

Figure 5. Comparison of the total labdane acid concentrations in juvenile versus mature western juniper trees. Samples of needles and bark were collected from both juvenile trees as well as older mature trees in April 2014 from Baker County, Oregon. The data represent the sum of all the labdane acids in each sample. The data are reported as the mean ˘ SD from 10 mature trees and 10 juvenile trees. Data are presented as a percentage of dry weight plant material.

Finally, we also compared the total labdane acid concentration in juvenile trees with that in mature trees in order to determine if there is a change, or difference, in labdane acid profiles or concentrations as trees age. Again, we found a large variation in the labdane acid content of all trees, juvenile or mature. However, overall there was no difference in the total labdane acid content in the needles or bark from juvenile trees versus mature western juniper trees (Fig. 5), suggesting that regardless of the maturity, western juniper trees, if eaten in sufficient quantities, pose a risk of abortions in late-term pregnant cattle.

Management Recommendations

Controlled grazing studies have not been performed to specifically determine the factors that influence the consumption of western juniper trees by cattle. However, after conversations with several ranchers who have experienced problems, it appears that western juniper-induced abortions are similar to pine needle–induced abortions (personal communications). Consequently, the following recommendations are based upon both studies on ponderosa pine needles and conversations with ranchers regarding western juniper–induced abortions.

Cattle appear to eat more juniper bark and needles from recently downed trees, either from trees found in slash piles or from debris after strong wind storms. Increased snow depth and lower daily temperatures can result in increased consumption.[13,14] Additionally, cattle in poor body condition may consume more juniper than cows in adequate body condition.[13]

There are no known methods to prevent juniper-induced abortions, however, some basic recommendations may minimize the potential impact. First, pregnant cattle should be denied access to juniper trees during the third trimester of pregnancy, as this is when they are most susceptible. Second, adequate feed and shelter should be provided, as this will help minimize juniper consumption. Third, pregnant cattle should be maintained in good body condition, which will also help reduce juniper consumption. Fourth, if significant problems continue, the calving schedules should be changed to late spring or fall to minimize the chances of extreme weather conditions driving cattle to trees for shelter, which can lead to increased juniper consumption. Finally, if abortions do occur, it is advisable to seek veterinary care for associated complications, such as retained placenta and endometritis. Also, late-term calves might survive, but they typically need extra care as they are usually weak and thus might not receive adequate colostrum or suckle normally.

Conclusions

Previous research has shown that western juniper trees can cause late-term abortions in cattle, as is the case with ponderosa pine trees. Previous analyses of over 400 western juniper trees from 35 locations across the state of Oregon suggested that western juniper trees in all areas present an abortion risk in pregnant cattle. The abortifacient compounds are found in the bark, needles, and berries, with the bark posing the most significant risk. There is substantial tree-to-tree variation, with some trees having extremely high concentrations of abortifacient compounds and thus posing a greater risk of abortions in cattle. Additionally, results from this study demonstrate that there is no difference in the abortifacient risk of western juniper trees throughout the year or from year to year. Cattle producers who winter cattle in rangelands with western juniper trees should take similar precautions as they would with ponderosa pine trees in order to prevent late-term abortions.

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