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EXTENSION
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Beef

July 2005

All the following articles are taken from: 7th International Symposium on Poisonous Plants, Program & Abstracts (Held June 6-10, 2005 at USU.)

Several new toxic plants or modes of toxicity are included. A website with plant photos is listed for each plant. (CVB)

The Atlas of the Vascular Plants of Utah (shows sites of documented occurrence): http://www.nr.usu.edu/Geography-Department/utgeog/utvatlas/index.html

PHEASANT'S EYE (*ADONIS AESTAVALIS*) TOXICITY IN LIVESTOCK AND RODENTS

http://hortiplex.gardenweb.com/plants/p1/gw1000675.html

Adonis aestavalis (pheasant eye) is an introduced species from Europe that has escaped cultivation in many parts of North America. Pheasant's eye contains several cardenolides including adonitoxin, cymarin, K-strophanthin, and vernadigin and has historically been used medicininally for its cardiac enhancing effects. These cardenolides are reported to be more potent than digitoxin and they induce positive inotropic effects by inhibiting membrane bound Na-K ATPase. Since pheasant's eye is not highly palatable, most poisonings are caused by contaminated hay. *Adonis* has been associated with poisoning in both horses and cows. Tissues from several steers were examined histologically. These animals had extensive gastroenteritis with congestion and intestinal hemorrhage. Myocardial lesions were not evident histologically. The purpose of this study was to verify *Adonis* toxicity in a rodent model and document the histoligc and ultrastructural lesions of poisoning.

Four of 4 horses repeatedly developed anorexia, sweating and diarrhea when fed hay contaminated with *Adonis aestavalis.* Four of twenty yearling steers died suddenly when fed contaminated hay. Two steers were necropsied and the tissues were examined for histologic lesions. To experimentally reproduce the disease, *Adonis aestavalis* was collected, frozen, freeze dried, finely ground, and dosed to 3 groups of 10 Syrian hamsters at a rate of 0, 100 and 200mg/kg QID for 7 days. Control animals (0 mg/kg *Adonis)* were dosed with similar amounts of ground alfalfa.

No myocardial lesions were detected in the clinical cases. In the experimental study the high dose hamsters developed diarrhea, anorexia and became reluctant to move. Histologically the myocardial lesions were subtle with focal myocyte swelling. There was no evidence of necrosis or coagulation of sarcoplasmic proteins. Ultrastructurally there were early lesions of mitochondrial swelling and myofiber disruption.

These findings indicated the *Adonis aestavalis* is extremely toxic; however, in many cases the myocardial lesions that have been historically associated with cardioglycoside poisoning may not be evident histologically. The lack of myocardial lesions may be due to the toxic *Adonis* cardioglycosides that kill the animals before morphologic lesions develop. The production of the classical cardioglycoside-associated myocardial lesions is variable and it is probably related to dose, duration, and recovery time.

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CUTLEAF NIGHTSHADE (SOLANUM TRIFLORUM NUTT.) TOXICITY IN HORSES AND HAMSTERS

http://montana.plant-life.org/species/sola_triflo.htm

Solanum triflorum Nutt. (cutleaf nightshade) ingestion has been associated with gastroenteritis and neurologic disease in horses, cattle and rodents. Reproducing poisoning has been difficult. We have investigated several incidents of possible nightshade poisoning in horses that developed signs of cholinergic stimulation. Affected horses had severe salivation, frequent urination, diarrhea and colic. In all cases the horses recovered with no detectable permanent sequelae of poisoning. The purpose of this study was to develop a small animal model of poisoning and if possible, identify the neurotoxin.

Thirty Syrian hamsters were randomly divided into 5 groups and dosed with 0, 50, 100, 150 and 200 mg of plant suspended in 2 ml of water four times a day for 8 days. After dosing, the animals were euthanized, blood was collected and the hamsters were necropsied. Tissues were collected, fixed and prepared for histologic studies. During the study, the hamsters were monitored four times each day and pupil diameters were measured. Serum was collected analyzed for electrolyte and biochemical changes.

None of the treated hamsters developed cholinergic-related clinical signs and there were no significant differences in pupil diameter between the groups. After several days of dosing, several high dose hamsters developed diarrhea and small labial ulcerations. These animals had significant biochemical changes consistent with electrolyte loss and lip mobilization. Segmental portions of intestine and stomach were dilated with gas and mucoid exudates in all of the high dose animals. The adjacent mucosa was red and edematous. Histologically these animals had focally extensive hemorrhagic and necrotizing gastroenteritis. No other histologic lesions were identified.

These findings suggest that in rodents, cutleaf nightshade toxicity is due to the direct toxic effects of *Solanum* glycoalkaloids. Additional studies are needed to determine if cutleaf nightshade cholinergic toxins only effect horses or if they are specific to plant phenotype.

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SWITCHGRASS (*PANICUM VIRGATUM*) TOXICITY IN RODENTS, SHEEP, GOATS, AND HORSES

http://www.floridata.com/ref/p/pani_vir.cfm

Switchgrass (Panicum virgatum) has been reported to cause toxicity similar to Kleingrass poisoning in livestock. Widespread use of switchgrass in pastures and as CRP cover has exposed many animals to this potentially toxic grass. Though we have found saponins in switchgrass that are similar to those reported to be toxic in Kleingrass, switchgrass toxicity has been difficult to reproduce experimentally. Most work suggests that switchgrass does not have saponins at concentrations high enough to be toxic to livestock. The purpose of this study is to establish a model for switchgrass toxicity, identify switchgrass toxins and determine their toxicity, document the clinical and histologic lesions of switchgrass poisoning, and predict when and under what conditions switchgrass is toxic to livestock.

Syrian hamsters, sheep, goats and horses were fed or dosed orally with fresh switchgrass, switchgrass hay or ground switchgrass. Feeding trials varied from 30 to 180 days. Ground switchgrass was analyzed for glycosisidic steroidal alkaloids.

Diosgenin (1) was identified as the major sapogenin with smaller amounts of yarmogenin (2). Switchgrass was about 11.5% protein with low digestibility. Most animals fed switchgrass lost weight and body condition, but did not develop photosensitivity. No crystalline lesions were detected in the livers of these animals or in the hamsters that were gavaged with swithgrass. However, some goats fed green switchgrass with green alfalfa developed hepatocellular swelling, choleangitis and ghosts of canilicular crystalline inclusions. These animals had skin lesions consistent with phylloerythrin-associated photosensitivity. Further examination of the switchgrass hay from several field outbreaks of photosensitivity and liver disease in horses found that it was moldy with relatively little good forage remaining (<25%). Surveys of saponin concentration in various switchgrass collections in different phenotypes are ongoing.

These findings suggest that switchgrass can be toxic under certain conditions. Goats may be most susceptible to poisoning. Green switchgrass fed with other chlorophyll-rich forage is likely to be the most toxic. Minimal crystalline hepatopathy is produced, but hepatocellular swelling and subsequent inflammation suggest toxicity is due to more than just crystalline disruption of the biliary system. Other hepatoxins, such as alfatoxin, may exacerbate switchgrass toxicity. However, though it is comparatively poor forage, most sun-dried switchgrass hay is relatively non-toxic.

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LUPINE RESEARCH AT THE POISONOUS PLANT RESEARCH LABORATORY: PAST, PRESENT AND FUTURE

http://www.pprl.ars.usda.gov/lupine.htm

Past: In the late 1800's and early 1900's lupine poisoning was common in many bands of sheep in the western U.S. Large losses from ingesting lupines were quickly linked to grazing of seed pods in late summer or ingesting lupine hay harvested with significant seed pods. While the lupine alkaloids had not yet been described, it was clear that the seed pods were "rich in the poison". Death losses were occasionally reported in cattle and horses but were often associated with overgrazing and lack of other more desirable forage. In the late 1950's a condition in cattle was described in which calves were born with skeletal defects of the limbs, neck and spine. These skeletal defects were linked to lupines by Wagnon in 1960 and Binns and James in 1961 and the name "crooked calf disease" was assigned to the condition. Cleft palate was also linked to the disease. From 1960 to the mid 1980's research at the poisonous plant lab focused on describing the condition, identifying the teratogenic alkaloids and developing management methods to reduce losses. The condition was wide spread throughout the western U.S. especially the northwestern U.S. and western Canada.

Present: Research from the late 1980's to present confirmed the teratogenic alkaloid as anagyrine and identified the mechanism of action. In addition to anagyrine, 3 other alkaloids were determined to cause “crooked calf disease.” These were piperidine alkaloids and found in relatively few lupines compared to anagyrine. A goat model was developed to study the mechanism of action and ultrasound techniques were used to monitor fetotoxicity. It was determined that the alkaloids prevented fetal movement during the critical time in fetal growth and development resulting in multiple congenital contractures (MCC). The cleft palate malformation was determined to be the result of mechanical interference of the tongue during early fetal development (35-41 days in goat; and 40-50 in cattle) and also associated with the lack of fetal movement.

Future: Future research will focus on understanding when and why cattle graze lupines. Lupines are good forage with protein levels of 12-18% in the vegetative growth phase to 35-40 % protein in seed-containing pods. Secondly, we plan to determine what the absorption, distribution and elimination profiles of the teratogenic alkaloids are in the fetal compartment, realizing that intermittent grazing of lupine may allow the fetus to regain activity during the susceptible stages of pregnancy. Finally, we know that the fetal effects are dose and time dependant and that some cows are more sensitive than others while sheep are more resistant to the teratogenic effects. Therefore, we believe very sensitive animals can be identified and either culled from the herd or managed to prevent lupine grazing.

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CONGENITAL GOITER IN GOATS ASSOCIATED WITH THE CONSUMPTION OF FLIXWEED (DESCURAINIA SOPHIA)

http://www.missouriplants.com/Yellowalt/Descurainia_sophia_page.html

Contaminated alfalfa and orchard grass hay was fed to 28 pregnant Boer goats during the first 2 months of pregnancy. These goats were located in central California, and were raised in a drylotlpasture where they normally received an alfalfalorchard grass hay along with a free choice, non-iodine containing mineral supplement. Of the 59 kids born to the 26 does (2 does did not kid), 40.7% (17ma1es, 7 females) were either born dead, or died shortly after birth. The affected kids showed hypothyroidism characterized by absence of hair, goiter (6 male and 5 female), and abnormally large birth weights (7.0 -7.5kg).

Ten of the 28 does produced hypothyroid kids and showed normal mammary development prior to parturition, however all does required assistance during kidding. Two kids submitted for diagnostic purposes revealed no evidence of infectious causes of abortion. Histopathological examination of the enlarged thyroid glands from 5 of the kids showed severe, uniformly diffuse thyroid follicular hyperplasia, and follicular cells lined by tall columnar cells with an absence of colloid.

The contaminated hay fed to these goats consisted predominantly of alfalfa (*Medicago sativa*) and orchard grass (*Dactylis glomerata*), with 5-1 0% flixweed (*Descurainiasophia*) as the contaminant. Flixweed is a common annual weed of the Brassicaceae (*Cruciferae*) family that has not been previously associated with neonatal goiter in goats. Stems, seed heads, and the seed of flixweed present in the contaminated hay was submitted for a glucosinolate analysis profile, and was found to contain 3-butenyl glucosinolate (whole seed 27.64 umoles/g, stemsseed heads 10.59 umoles/g) using standard gas chromatography methods.

Although iodine levels were not determined in these goats, there appears to be an association between congenital goiter in the kids and feeding of the flixweed contaminated hay. Especially, since the goat's management, location and diet remained unchanged since previous years. However, further studies are required to elucidate the association of 3-butenyl glucosinolate found in the flixweed (*Descurainia sophia*) with hypothyroidism.

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FUNGAL ENDOPHYTES OF LOCOWEED: AN OVERVIEW

http://www.pprl.ars.usda.gov/locoweed.htm

Consumption of locoweeds is known to cause poisoning of grazing animals. Locoism, as the toxicity is termed, has long been attributed to the production of swainsonine, an alpha-mannosidase inhibitor, by the locoweed plants. Our work has shown that fungal endophytes of the locoweeds produce swainsonine in culture and play an important role in locoism. Feeding rats with the fungal endophytes alone induces the same vacuolization of organs as consumption of locoweed plants.

Based on spore morphology and nucleotide sequence analyses of the ITS, b-tubulin, and gyceraldehyde phosphate dehydrogenase encoding regions, the endophytes are thought to be composed of at least two new species of the genus Embellisia. These fungi form a distinct clade with the genus. Genetic comparisons using RAPD and nucleotide sequences have shown that the endophyte isolates from Oxytropis locoweeds are highly similar genetically, independent of the location from which they were collected. Fungal isolates from *Oxyfropis lambertii* collected from Arizona, Utah, and New Mexico were genetically identical. In contrast, endophytes isolated from Astragalus locoweed species were highly genetically diverse and varied even within a farm. Interestingly, work done in Dr. Tracy Sterling's laboratory at NMSU has shown, that the genetic diversity between Oxytropis species is very small and that diversity within varieties of Astragalus mollissimus is much greater.

All Embellisia isolates from locoweeds produce swainsonine. These endophytic fungi grow very slowly and sporulate sporadically on agar plates. Several studies have correlated endophyte presence with high swainsonine levels. We have shown that removal of the locoweed seed coat prior to germination produces a plant that does not contain swainsonine, and from which the fungus can not be isolated. These non-toxic plants look similar to toxic plants when grown in tissue culture. Fungus can be cultured from the removed seed coat and microscopy on the seed coat has localized the fungus in the aleurone and parenchyma layers.

Recent work has shown that swainsonine production is tightly linked to the fungal endophyte and its environment. When fungus was grown in drought-stressed or low pH (pH 4.5) media, the amount of swainsonine produced per gram dry weight greatly increased. When toxic plants were grown in the same drought-stressed or low pH conditions, the level of swainsonine also increased. Growing the infected plants or fungus in high temperatures or on high pH, nitrogen deficient, phosphorus deficient, or potassium deficient media did not cause an increase in swainsonine production. Interestingly, the plant grown under drought-stressed conditions grew taller and wider than the controls and produced higher dry weights, and the fungus alone had lower dry weights.

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EFFECT OF FUNGICIDE ON SWAINSONINE PRODUCTION IN WHITE LOCOWEED (OXYTROPIS SERICEA)

http://www.pprl.ars.usda.gov/locoweed.htm

White locoweed is an important species in the western rangelands of the United States because of its wide distribution, and its injurious effects due to the alkaloid swainsonine when grazed by livestock. Swainsonine production inside the plant is attributed to the presence of the endophytic fungi *Embellisia* sp.

To determine the effects of *Embellisia* sp. on swainsonine production, white locoweed seeds and leaves were treated with the fungicide Cleary's 3336 (ethyl-thiophenate). A set of scarified seeds of white locoweed was grown in PVC pots. The plants received four fungicide treatments between seed stage and 24 weeks after germination. In group one only treated seeds were tested, a second group was only treated with a foliar application, a third group was treated with both seed and foliar application, and a fourth group remained untreated (Controls). Twenty-four weeks after germination, the plants were measured and leaves were clipped to determine plant growth and swainsonine concentration differences between fungicide treatments.

The plants that received seed and seedlfoliar fungicide had lower (t=2.17 =0.03778) biomass (1.469 SE ± 0.119 and 1.479 SE ±0.283) than the controls (2.239 SE ±0.302) and the foliar treated plants (2.159 SE ±0.244). In addition, plants treated with foliar fungicide application had greater (t=2.92 P=0.0065) swainsonine content (0.1 50% SE ±0.017) than the plants that received seed and seedlfoliar fungicide application (0.044% SE ±0.027 and 0.084% SE ±0.035). These results indicate that seed fungicide treatment can reduce endophytic growth in white locoweed. Although the use of a fungicide is not economically feasible because of white locoweed's large seed bank, and the risk of eliminating beneficial fungi, this study may contribute to the development of biologically harmless methods to reduce the endophyte infection, and therefore control swainsonine livestock intoxication in white locoweed infested areas.

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THE COMPARATIVE PATHOLOGY OF LOCOWEED POISONING IN LIVESTOCK, WILDLIFE AND RODENTS

http://www.pprl.ars.usda.gov/locoweed.htm

Locoweeds are Astragalus and Oxytropis plants that contain an indolizidine alkaloid swainsonine, a potent inhibitor of lysosomal a-mannosidase and Golgi mannosidase II. All animal species are susceptible to locoweed poisoning; however, there are remarkable variations in locoweed-induced clinical signs, lesion distribution and the extent of histologic lesions.

Clinically, locoweed poisoning has an insidious onset, with signs of poisoning becoming

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apparent after the animal has grazed the plant for several weeks. In livestock, the intoxication is initially characterized by depression, anorexia and weight loss. With continued intoxication, the clinical signs become more severe with additional proprioceptive deficits, intention tremors, mild seizures, and nervousness (especially when stressed). Chronically poisoned animals have dull hair coat, decreased libido, infertility, abortion, cardiovascular disease and death. Many animals, especially horses, may be hyper excitable, frightened or violent when stimulated. These signs are contrasted by the seemingly resistant rodents and mule deer. Poisoned deer and rodents lose weight and become thin and emaciated. However, neurologic signs are subtle and difficult to detect.

Other than loss of condition and emaciation there are few macroscopic lesions of locoweed poisoning in all species. However, microscopic lesions are common with species specific differences in distribution and severity. Characteristic microscopic lesions have been described as neuro-visceral cellular vacuolation with axonal dystrophy and foamy vacuolation of monocytes and macrophages in many tissues. Lysosomal enlargement seen as vacuolation is also seen in various non-neuronal tissues including thyroid follicular epithelium, exocrine pancreas, renal tubular epithelium, testes, ovaries, and macrophages/monocytes in nearly all tissues. Horses are highly susceptible to poisoning as they develop clinical signs and neurologic lesions at relatively low doses of short duration. Rodents and mule deer are relatively resistant to poisoning. These species develop similar neurologic lesions as horses, but only at much higher doses and longer durations. Different organ systems are also affected. Rodents and mule deer develop extensive pancreatic and intestinal lesions with little change in other tissues. Recent isolation of mannosidases with different swainsonine binding affinities suggests that differences in severity, distribution and progression of locoweed-induced lesions are probably due to tissue and species specific mannosidase expression.

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