Chemistry of Acacia's from South Texas

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BOTTOM LINE

Acacia species in south Texas contain numerous chemical compounds, many of which have negative effects on animal performance.

Summary

- Acacias such as guajillo (*Acacia berlandieri)*, blackbrush (*A. rigidula*), huisache (*A. smallii*), and twisted acacia (*A. schaffneri*) are common in south Texas.

- These plants contain a variety of chemical compounds that help defend them from consumption by insects and other herbivores such as deer and domestic livestock.

- Alkaloids, phenolic amines, phytoestrogens, and tannis have been identified in south Texas acacias.

- Management should seek to maximise grass and forb production and minimize consumption of shrubs by domestic livestock.

Introduction

Many of the acacias of south Texas are considered to be valuable forage for deer and domestic livestock. It is known, however, that at least one species, guajillo (*Acacia berlandieri*) will produce a paralytic condition in sheep and goats called "guajillo wobbles." As part of a larger study investigating the chemistry of south Texas range plants, we determined the chemical composition of the leaves of several south Texas acacias.

Most woody plants contain a variety of chemical compounds a number of which have the advantage to the plant of being toxic to animals that consume them. Many of these defensive compounds are nitrogen-based, though there also are a significant number of non-nitrogenous toxic compounds. Additionally, plants produce compounds which may be repellent or, as in the case of tannins, lower the nutritional value of the plant. Early research, using paper and thin-layer chromatographic techniques, identified several phenolic amines in *A. berlandieri*, including n-methyl-β-phenethylamine (NMP), tyramine, n-methyltyramine and hordenine. Improved methods of analysis were used by us to determine the seasonal variation in concentrations of tyramine and NMP in *A. berlandieri*. The advent of modern gas chromatography-mass spectroscopy (GC/MS) techniques allows for much greater sensitivity of analysis of organic compounds in plant material.

One potential result from this work is the identification of compounds with potentially important medical properties.

Experimental Approach

Leaves from plants of *A. berlandieri*, *A. rigidula*, *A. greggii*, and *A. schaffneri* were hand-plucked from ten plants at each of two locations on the George Lyles ranch in Zavala Co. Texas, in the spring and fall. Material was collected into plastic bags and placed on ice prior to transportation to the laboratory where it was frozen prior to analysis. Approximately 10 g from each plant was placed in a cellulose thimble and subjected to continuous extraction with methanol for 12 hr followed by extraction with chloroform for an additional 12 hr. Each extract was reduced to near dryness using fractional distillation, and then separated into acidic, basic, and neutral fractions. These extracts were concentrated prior to GC/MS analysis.

Results

All leaf samples contained phenethylamine, N-methyl-β-phenethylamine, tyramine and hordenine. These compounds were found in concentrations ranging from <100 to > 5,000 ppm, depend-ing on plant species and season of collection. Concentrations were always higher in leaves collected in the fall. The alkaloid fractions (those extractable with 10% HCL) of *A. berlandieri* and *A. rigidula*

contained a complex mixture of alkaloids including nicotine, nornicotine, anhalamine, mescaline, and 3,4,5-trihydroxy-phenethylamine (demethylated mescaline). Mescaline and it's derivatives are rarely found outside the *Cactaceae*. The presence of this suite of alkaloids may explain the infrequent occurrence of insect predation on these plants. The phenolic amines, such as tyramine, hordenine and N-methyl-β-phenethylamine are powerful activators of the sympathetic nervous system causing the release of cortisol and adrenocorticotropic hormone. In addition to the alkaloids, the plants were also found to contain intricate mixtures of tannins and flavenoids including catechin, fisetin and quercetin.

Determining the concentrations of secondary compounds in browse is important for a number of reasons. Primarily, knowledge of the occurrence of secondary compounds is necessary to understand the extent of utilization that browse plants may experience. Habitat managers and nutritionists alike require this information for management of the resource. While tannins and their antinutritional effects have been the subject of much research in recent years, little attention has been paid to the negative effects of consumption of other secondary compounds that are not acutely toxic. However, recent research has shown the negative effects on fertility of consumption of amine-containing forage. Consumption of guajillo and blackbrush was shown to reduce fertility in male goats, and to reduce their ability to handle stressful situations such as transportation. Reduction in ability to handle stress is believed to be a major factor in the development of shipping fever.

Livestock managers should seek to avoid stocking rates that lead to excessive consumption of acacias, especially in the fall.

Table 1. Major Chemical Compounds in South Texas Acacias

Amines and Alkaloids:

phenethylamine	N-methylphenethylamine
N,N-dimethylphenethylamine	amphetamine
N,N-dimethyl-α-methylphenethylamine	methamphetamine
p-hydroxyamphetamine	p-methoxyamphetamine
tyramine	N-methyltyramine
3-5-dimethoxytyramine	candicine
3,4-dimethoxy-5-hydroxy-β-phenethylamine	dopamine
hordenine	N-methyldopamine
N,N-dimethyldopamine	3-methoxytyramine
tryptamine	N-methyltryptamine
N,N-dimethyltryptamine	mescaline
N-methylmescaline	trichocereine
nicotine	nornicotine
anhalamine	anahalidine
peyophorine	mimosine (methyl ester)
nortryptyline	musk ambrette
3-α-cumyl-1,3,4-oxadiazolidine-2,5-dione	pipecolamide
p-hydroxypipecolamide	1,4-benzezediamine
4-methyl-2-pyridinamine	

Phytoestrogens:

octylphenol	nonylphenol
aristolone	3b-cholest-5-en-3-ol
(Z)-9-octadecenoic acid	(Z,Z)-9,12,-octadecanoic acid
(Z,Z,Z)-9,12,15-octadecatrienoic acid	
3b-acetoxy-17-methyl-5a-18-abeoandrost-13-ene	