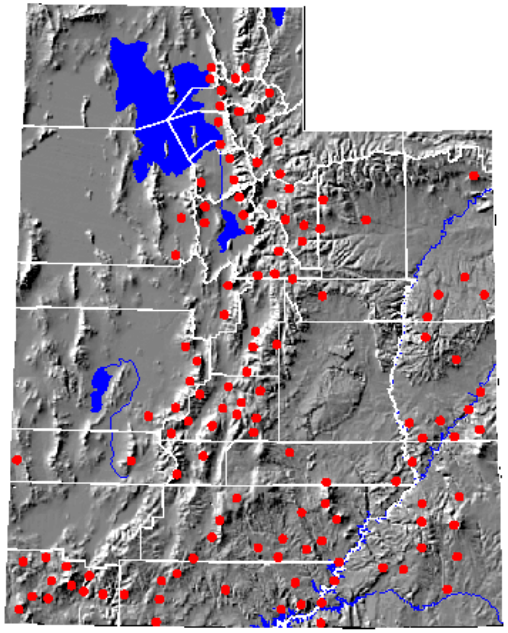
Oak Poisoning in Livestock

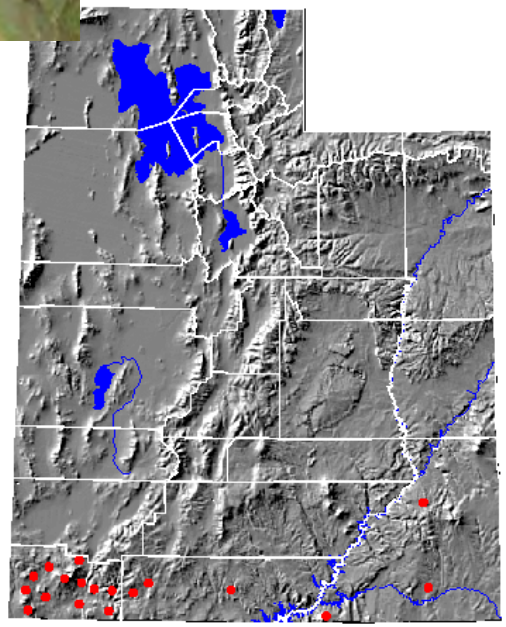
Oak Species

- > 75 Quercus species in U.S.
- Several account for most poisoning episodes
- Most reports of toxicity center in South western U.S.



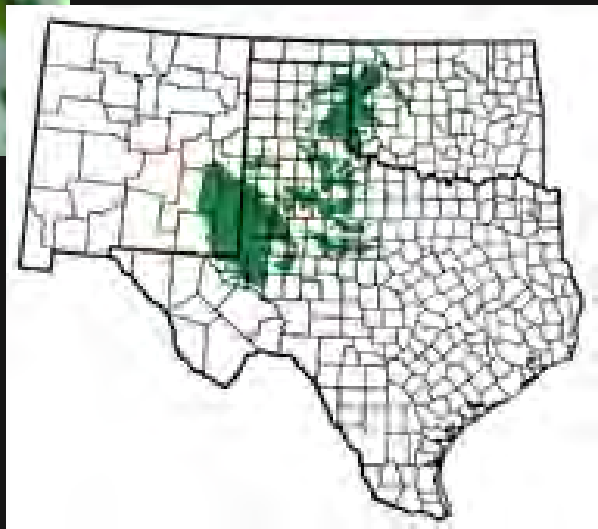
Quercus gambelii
Gambel's oak -
Utah woodlands at 5000
To 8000 ft elevation
Occur as Clones

Quercus turbinella
Shrub live oak -
Grows in semi-arid, lower elevation shrub woodlands or deserts from CA to TX.
Most common oak in AZ.



Quercus turbinella
Shrub live oak

Quercus havardii
Shinnery oak -
Grows in sandy soils in west TX
and eastern NM.



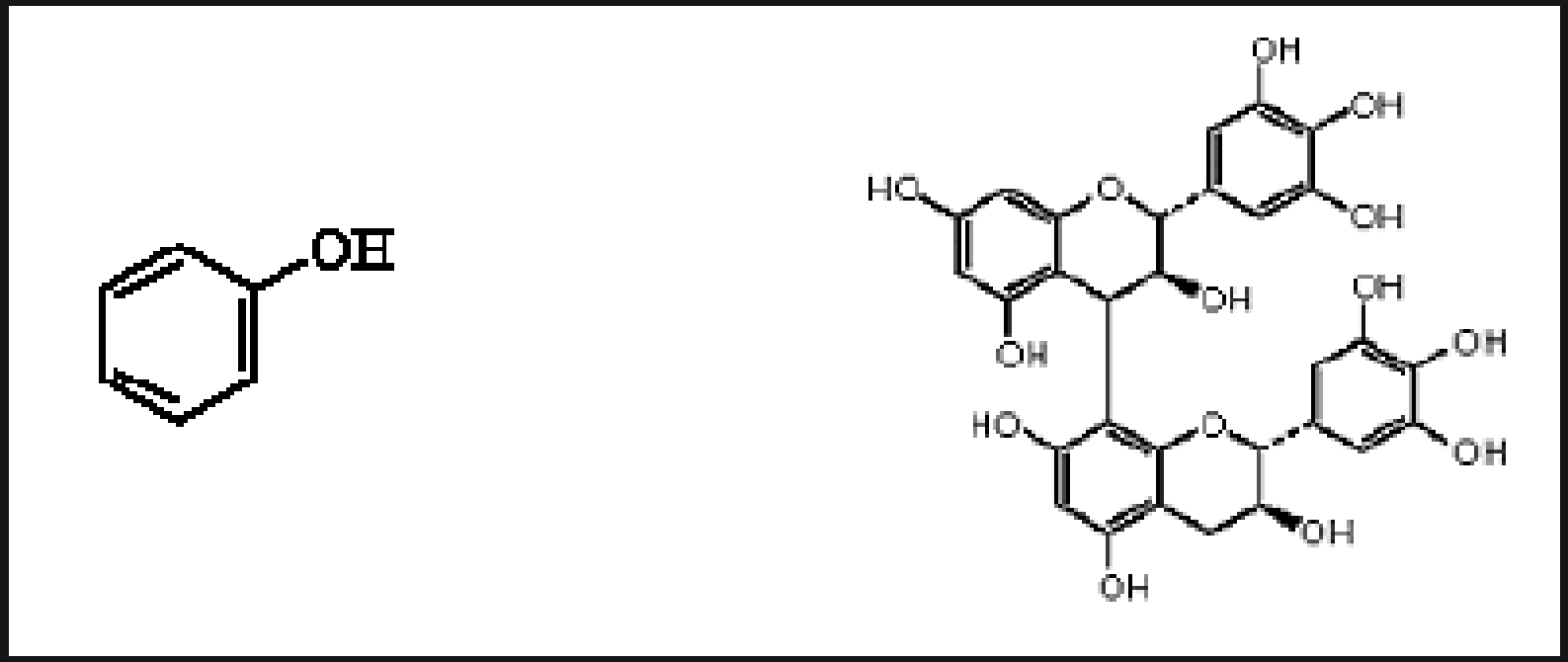
Quercus stellata
Post oak –
Small to medium (30-50 ft) trees
Slow growing; spreads in absence of fire

Toxins in Oakbrush are Tannins

Naturally occurring plant polyphenols which combine with protein and other polymers to form stable complexes.

- soluble in water, with exception of some high molecular weight structures,
- ability to bind proteins and form insoluble or soluble tannin-protein complexes.
- molecular weight ranging from 500 to >20,000,

Phenol **Poly phenol**



“Functional foods” make news every day, including polyphenols in wine and chocolate as antioxidants to scavenge free radicals

Definition of Tannins

- "Tanning" (waterproofing and preserving) was the word used to describe the process of transforming animal hides into leather by using plant extracts.
- Plant parts containing tannins include bark, wood, fruit, fruit pods, leaves, roots, and plant galls.
- Examples of plant species used to obtain tannins for tanning purposes are wattle (Acacia sp.), oak (Quercus sp.), eucalyptus (Eucalyptus sp.), birch (Betula sp.), willow (Salix caprea), pine (Pinus sp.), quebracho (Scinopsis balansae) .

Distribution of tannins

- Tannins are widely distributed in the plant kingdom. They are common both in Gymnosperms and Angiosperms. Within Angiosperms, tannins are more common in Dicotyledons than in Monocotyledons.

Distribution of tannins

- Leguminosae : *Acacia* sp. (wattle); *Sesbania* sp.; *Lotus* sp. (trefoil); *Onobrychis* sp. (sainfoin);
- *Anacardiaceae: Scinopsis balansae* (quebracho tannin)
- Others: Quercus (oak sp.); Sorghum sp.

Tannins

- Shikimic Acid Pathway Derivatives
  - 1. Phenolics & Quinones
  - 2. Tannins & Lignins
  - 3. Coumarins
  - 4. Flavonoids

Tannins

- Tannins can complex with:
  - Proteins
  - Starch
  - Cellulose
  - Minerals

Types of tannins

- The two main categories of tannins that impact animal nutrition are
  - hydrolyzable tannins (low occurrence in plants)
  - condensed tannins, identified more correctly as proanthocyanidins that are resistant to hydrolytic degradation (most common in plants).

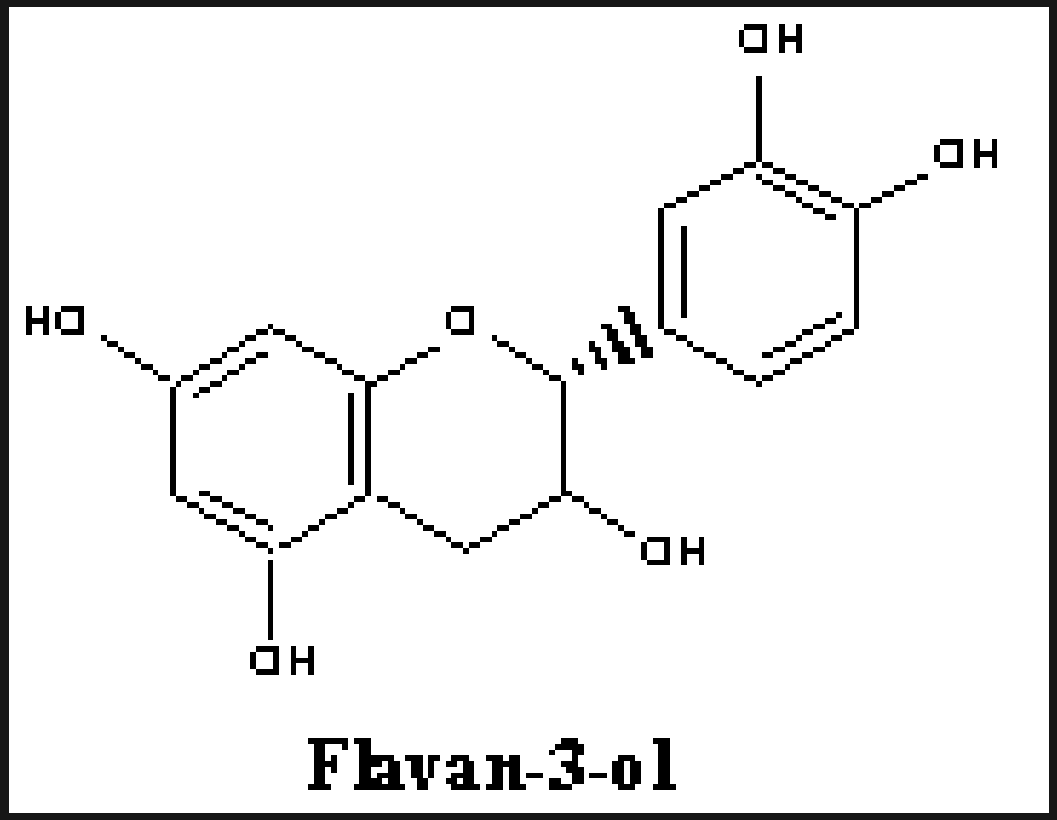
Hydrolyzable tannin properties:

- Hydrolyzed by mild acids or mild bases to yield carbohydrate and phenolic acids
- Proanthocyanidins (condensed tannins) do not hydrolyze under same conditions.
- HTs are also hydrolyzed by hot water or enzymes (i.e. tannase).
- Most common kinds: gallotannins and ellagitannins

Condensed Tannin properties

- Proanthocyanidins are more widely distributed than hydrolyzable tannins. They are oligomers or polymers of flavonoid units (i.e. flavan-3-ol) linked by carbon-carbon bonds not susceptible to cleavage by hydrolysis.
- Key property: astringency (e.g., unripe fruit and wine)

Most of the natural abundant proanthocyanidins are polymers of either catechin and epicatechin which both are flavan-3-ols



Flavan-3-ol

Oak poisoning

- Ingestion of buds, leaves, stems and acorns
- Spring: buds and current seasons growth, and immature leaves
- Fall: acorns
- E.g., N. California episode (1985) freezing rain/snow; 2700 cattle died from Quercus douglesii buds.
- Problems in Utah are relatively rare.

Acorns can be toxic

- Deer or livestock in locations w/ abundant oak species (e.g., Oklahoma) sometimes overeat acorns. Acorn crop tied to precipitation.

Tannins concentrations in oak

	Juvenile	Mature
Gambel oak	11.1%	8.7%
Shinnery oak	15.1%	4.2%

Toxicity to ruminants

- Clinical signs
  - Anorexia, depression, rumen atony, constipation changing to bloody diarrhea
  - Blood urea nitrogen (BUN) elevated from 10-20 mg/dl to > 150 mg/dl
  - Acute cases die in 1-3 days
  - Chronic cases linger weeks or months (e.g., 'shinneried' cows in NM)

Toxicity of HT

- Soluble and metabolized to low molecular weight compounds
- Smaller molecular wgt. compounds denature cell proteins resulting in cell death
- Lesions in GIT, liver, and kidneys

Toxicity of CT

- Difficult to separate from effects on protein or carbohydrate digestion
- Generally not absorbed from GIT
- May damage mucosal lining
- May disrupt absorption of some amino acids (methionine and lysine)

Toxicity to ruminants

- Animals that continue to eat other forage generally recover completely
- Most prominent finding is typically renal tubular necrosis. Renal lesions always present; may also have necrosis of GIT
- May have liver lesions and elevated liver enzymes

Impact on nutrition

- Tannins impact animal nutrition because they form complexes with numerous types of molecules:
  - Carbohydrates (Starch-tannin or cellulose-tannin)
  - Proteins (v. resistant to degradation)
  - Polysaccharides
  - Bacterial cell membranes
  - Enzymes involved in protein and carbohydrate digestion

Tannins effects on nutrition

- Palatability: astringent taste (immediate effect in oral cavity)
- Reduced digestibility-delayed effect (i.e., complexes with proteins and CHO)
- Toxic to some rumen microbes

Anti-nutritional aspects of tannins

- 1)depress food intake (astringency or post absorptive)
- 2) complex with dietary proteins or other dietary components
- 3) complex with digestive enzymes, thus interfering with normal digestion
- 4) complex with endogenous protein, resulting in a drain on the nitrogen supply, and on the amino acid supply
- 5) complex with or injure parts of the alimentary tract
- 6) tannins or their hydrolysis products are absorbed and have a toxic effect elsewhere in the body.

Adaptation by herbivores

- Some herbivores (e.g. deer) secrete proline-rich salivary proteins (PRPs).
- PRPs bind tannins in mouth and render them inactive. Rats and ruminants can have PRP secretion by parotid gland enhanced by feeding a tannin-rich diet.
- Sheep and cattle have < PRPs than goats

Consumption by livestock

- Data on Q. turbinella in AZ: 25-40% of diet in winter
- Shinnery oak in TX: spring and summer use by goats up to 60% of diet
- Generally animals must eat >75% of diet to be intoxicated.

Reducing losses to Oakbrush

- Good range management = diverse forage base
- Mechanical or fire treatment may reduce stands (risk of increasing problems in subsequent years)
- Keep livestock off oak stands until plants mature (i.e. > 30 days)
- Close observation of acorn consumption

Reducing losses to oakbrush

- Supplemental feeding may reduce oak consumption
- TX researchers recommended feeding calcium hydroxide (10-15%) as an antidote in feed. Counteracts metabolic acidosis from organic acids.
- 4 pounds per head per day containing
  - 10 percent hydrated lime (CaOH)
  - 6 percent fat
  - 30 percent alfalfa
  - 54 percent cottonseed meal starting before the buds are set in the spring

Supplements (B)

- Polyethylene glycol (PEG) also binds to tannins and reduces toxicity
- Dose: PEG at 50 g/animal/day (for small ruminants)
- Can be given in water or feed
- Greatly increases the amount of tannin-rich shrubs that animals can eat

Pistacia lentiscus – a common shrub in Mediterranean region
High in tannins

Effect of PEG on consumption of *Pistacia lentiscus* in Croatia

	Goats	Sheep
Controls	15.3 g/kg b.w.	12.1
PEG added	39.6	28.1

Collaborative research with Dr. Jozo Rogosic, University of Zadar, Croatia

Supplements (C)

- Activated charcoal mixed with grain also works
- 20 g/animal/day with 100 g grain supplement (small ruminants)

Coastal live oak tree in Texas, more than 1,000 yrs old.
One of the largest trees of its kind in the U.S.