



Saponins

Anuraga Jayanegara





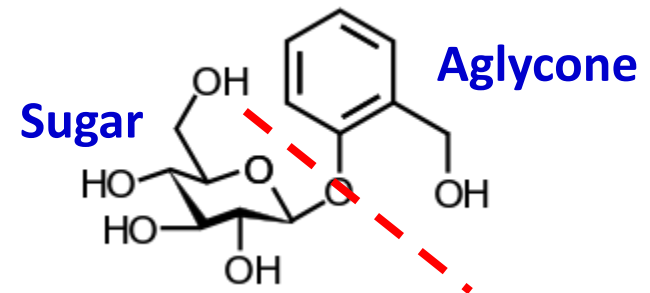
Outline

- A. Introduction
- B. Structure
- C. Interaction
- D. Analytical methods
- E. Biological effects

A. Introduction

Saponins

- Able to form stable, soap-like foams in aqueous solutions
- Naturally occurring surface-active glycosides (a molecule in which a sugar is bound to a non-carbohydrate moiety, usually a small organic molecule)
- Consist of a sugar moiety usually containing glucose, galactose, glucuronic acid, xylose, rhamnose or methylpentose, glycosidically linked to a hydrophobic aglycone (sapogenin) which may be triterpenoid or steroid
- Great complexity of the structure





Occurrence and role in plants

- Saponins are found in a large number of plants
- Occur in different parts of plants such as root, tuber, bark, leaves, seed, and fruit
- Generally saponins are found in tissues that are most vulnerable to fungal or bacterial attack or insect predation --> to act as a chemical barrier or shield in the plant defense system --> anti-microbial properties

Table 1. Saponin-Containing Forages Commonly Used as Livestock Feed

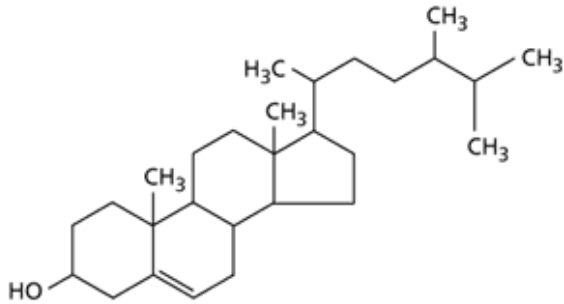
family and species	plant part	saponin or sapogenin name
Fabaceae		
<i>Acacia auriculoformis</i>	fruit	acaciaside
<i>Albizia lebbek</i>	Pods, bark	albiziasaponin
<i>E. cyclocarpum</i>	leaf, fruit	saponin content 3.9 mg/g
<i>Gliricidia sepium</i>	root, fruit	hederagenin
<i>Glycine maxima</i> (soybean)	seed	soyasapogenol
<i>Lupinus</i> spp. (lupin)	seed	soyasapogenol
<i>Medicago sativa</i> (alfalfa, lucerne)	leaf, root, seed	medicagenin (aglycone), soyasapogenol
<i>Melilotus alba</i> (white sweet clover)	leaf, flower, root	melitonin
<i>Medicago hispida</i> (burr clover)	leaf	hispidacin (soyasapogenol)
<i>P. saman</i>	fruit	saponin content 3.4 mg/g
<i>Pueraria montana</i> var. <i>lobata</i> (Kudzu)	root	kudzusaponins (soyasapogenol)
<i>S. sesban</i>	leaf, seed	glucuronide-oleanolic acid, stigmasta galactopyranoside
<i>S. pachycarpa</i>	leaf	saponin
<i>Trifolium repens</i> (ladino clover)	leaf	cloversaponins (soyasapogenol)
<i>Trifolium pratense</i> (red clover)	leaf	soyasapogenin
<i>T. foenum-graecum</i> (fenugreek)	leaf, seed	steroid saponin
Moringaceae		
<i>M. oleifera</i>	leaf	80 g/kg diosgenin equivalent
Poaceae		
<i>Avena sativa</i> (oat)	leaf, root, seed	avenacin
<i>B. decumbens</i> (signal grass)	leaf	dioscin, diosgenin, yamogenin



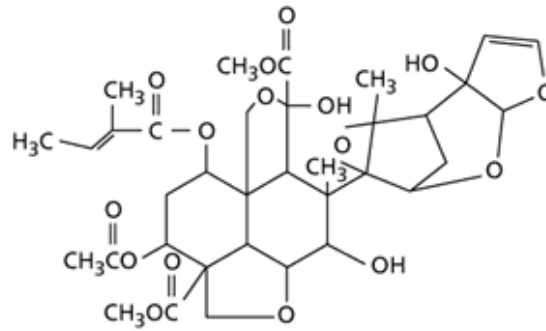
Table 2. Saponin-Containing Plants that Are Used as Feed Additives in Ruminant

family and species	plant part	saponin or sapogenin name	ref
<i>Q. saponaria</i>	bark	Rosaceae quillaic acid	30, 31
<i>Y. schidigera</i>	trunk, root	Agavaceae sarsapogenin, gloriogenin, markogenin	32
<i>S. saponaria</i>	fruit	Sapindaceae hederagenin (aglycone)	33, 34
<i>S. rarak</i>	fruit	hederagenin (aglycone), mukurozi-saponin	35
<i>C. sinensis</i>	seed, leaf	Theaceae theasaponin, camelliasaponins	40, 41

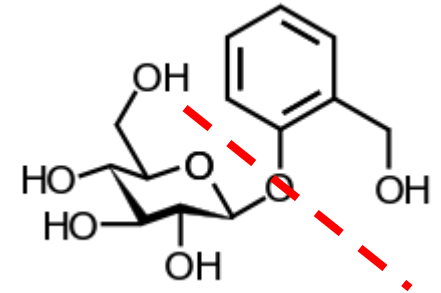
B. Structure



Sitosterol, a plant sterol



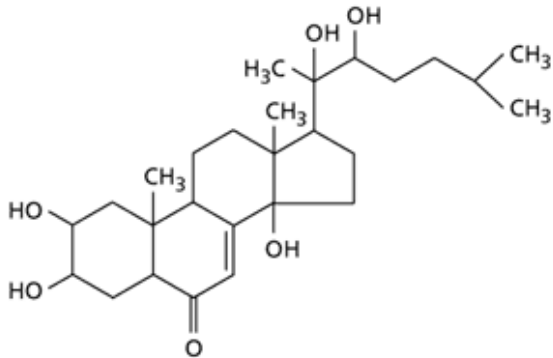
Azadirachtin, a limonoid



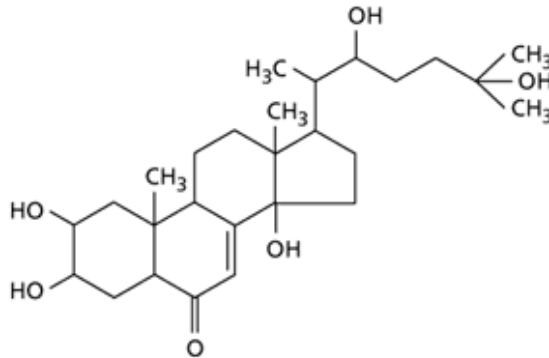
Triterpenes



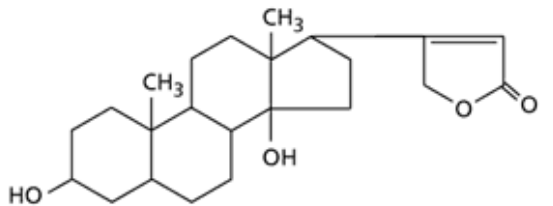
Triterpenoid saponins



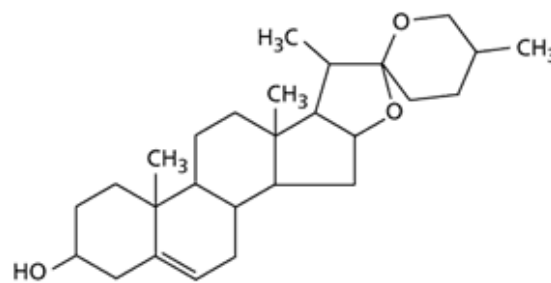
Ponasterone A, a phytoecdysone



α -Ecdysone, an insect molting hormone

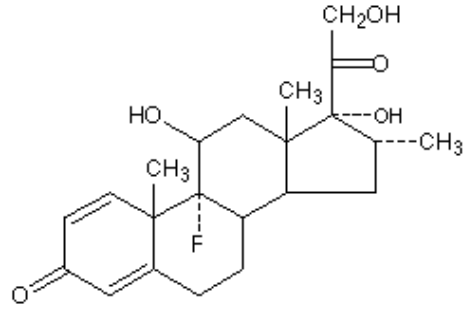


Digitoxigenin, the aglycone of digitoxin, a cardenolide

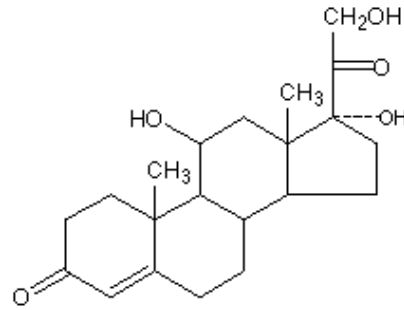


Yamogenin, a saponin

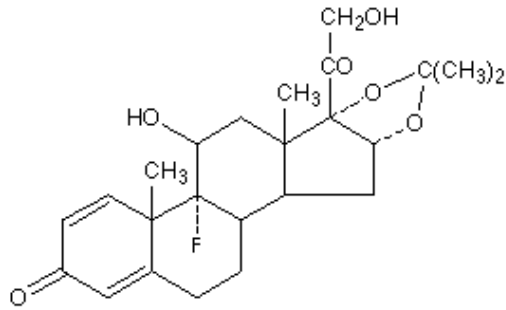
GLUCOCORTICOIDS



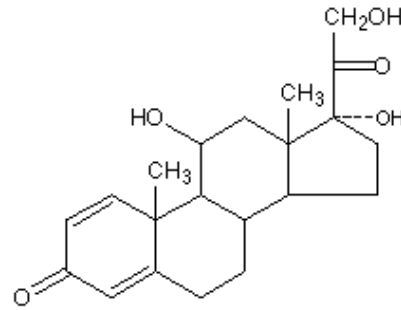
Dexamethasone
MW 392.5



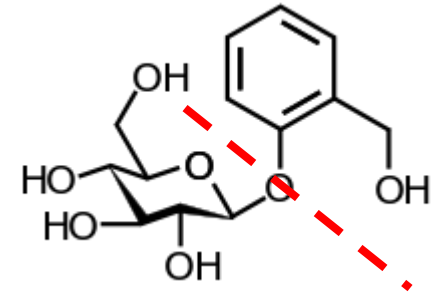
Cortisol
MW 362.5



Triamcinolone Acetonide
MW 434.5



Prednisolone
MW 360.5

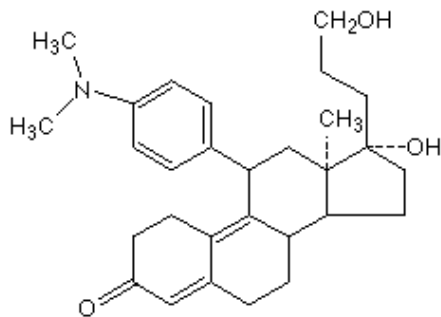


Steroids

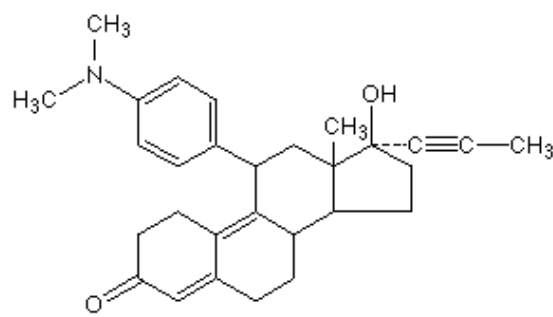


Steroidal saponins

GLUCOCORTICOID ANTAGONISTS



ZK 98.299
MW 449.6



RU486
MW 429.6

C. Interaction



Polar (sugar) and nonpolar (steroid or triterpene) groups -->
provides saponins with strong surface-active properties -->
interactions with cellular and membrane components -->
responsible for many biological effects, both adverse and
beneficial effects

D. Analytical methods



Methods

1. Determination of total steroidal saponins
2. Determination of total saponins
3. Determination of saponins based on hemolytic activity
4. Determination of saponin fractions by chromatography techniques
5. Qualitative evaluation of saponins

More detailed [Spectro based](#), [chromatography based](#)

E. Biological effects



Negative effects:

- Hemolysis of erythrocyte --> reaction of saponin with cholesterol in the erythrocyte wall --> permeability changes
- Effects on blood and tissue cholesterol levels --> form insoluble complexes with cholesterol --> reduce plasma (blood) and tissue (eggs, poultry and swine meat) cholesterol level in monogastrics, but little effects in ruminants --> cholesterol in the bile combines with saponin in the gut and prevents from being reabsorbed
- Growth depressing effects in monogastrics --> due to inhibition of cellular enzymes, digestive enzymes, and anorexic effects
- Bloat in ruminants --> saponin is among the foaming agents in the rumen, apart of pectins and certain proteins
- Inhibition of smooth muscle activity
- Inhibition of enzymes



Positive effects:

- Effect on methane emission and rumen fermentation --> [Hu et al. \(2005\)](#), [Holthausen et al. \(2009\)](#), [Zhou et al. \(2011\)](#)
- Effect on nitrogen utilization --> [Santoso et al. \(2007\)](#)
- Effect on milk production --> [Benchaar et al. \(2008\)](#)
- Effect on rumen and milk fatty acid profile --> [Lourenco et al. \(2008\)](#), [Khiaosa-ard et al. \(2009\)](#), [Benchaar et al. \(2009\)](#)



Thank you for your attention!