

Role of plant extracts in ruminant production

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Introduction

- Livestock production is consumer focused
- EU regulation 1831/2003
- Definition of feed additive
 - Substances, micro-organisms or preparations, other than feed material and premixes, which are intentionally added to feed or water in order to perform, in particular, one or more of the functions mentioned in Article 5(3) of 1831/2003
- Why plant extracts?

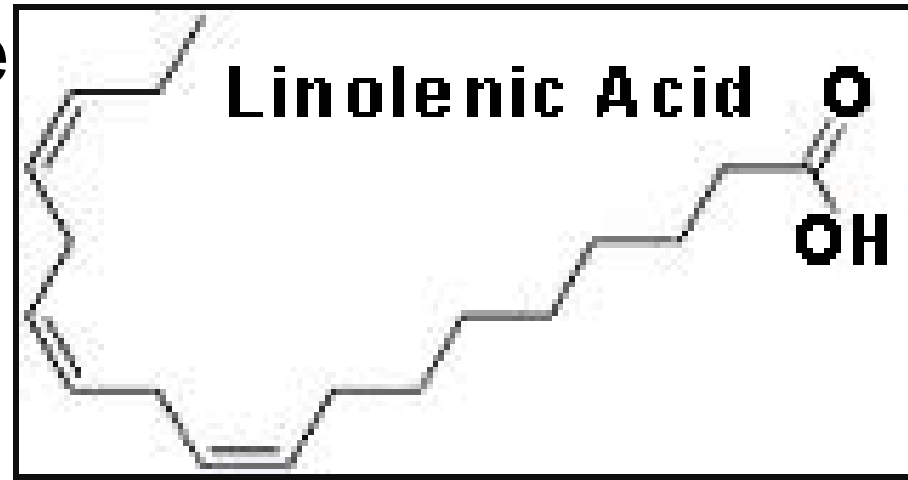
Plant extracts

- Plant oils
 - Contain unsaturated fatty acids
- Secondary plant metabolites
 - Polyphenols
 - Essential oils
 - Saponins
 - Organosulphurous compounds

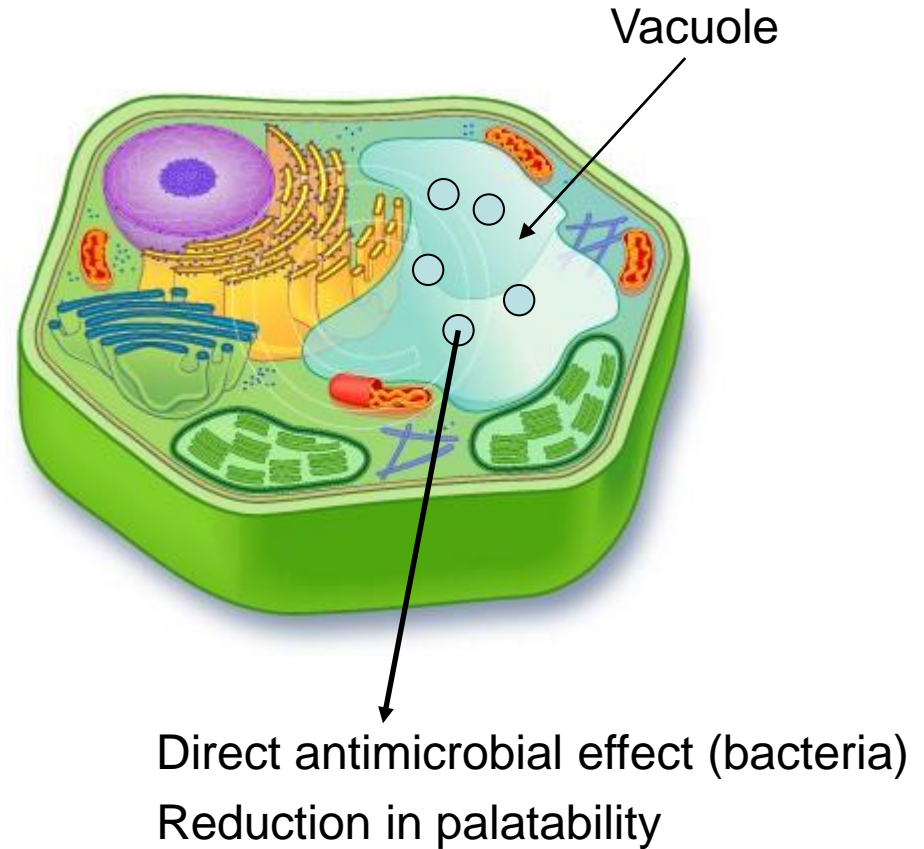
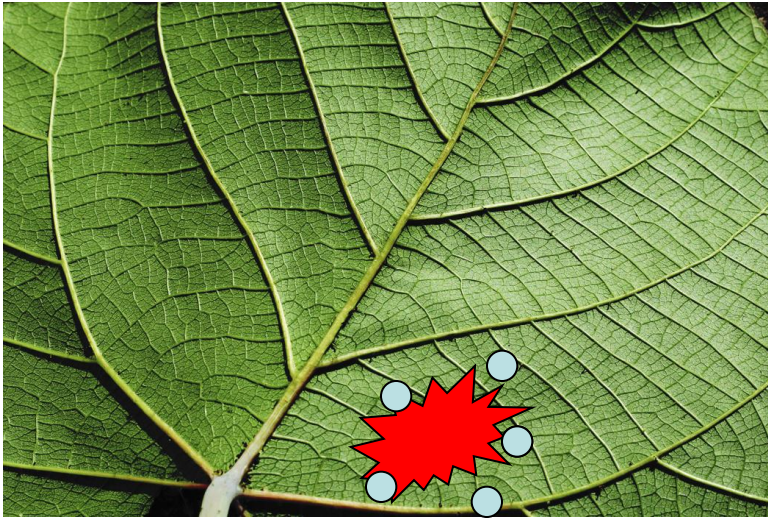
Role of plant extracts

Plant oils

- Have a high ME content
- Plant oils contain unsaturated bonds
- Acts as a hydrogen sink
- Reduce rumen protozoa
- Reduction in associated methanogens
- Reduction in methane
- Max safe inclusion
6% DMI



Secondary plant metabolites

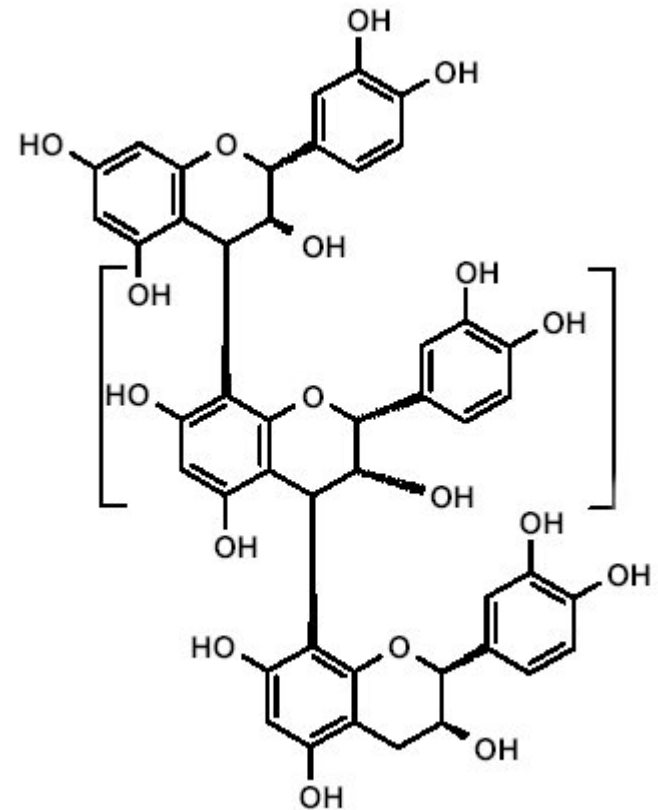


Not used for normal plant metabolism
Roles: attraction and defense

Role of plant extracts

Polyphenols

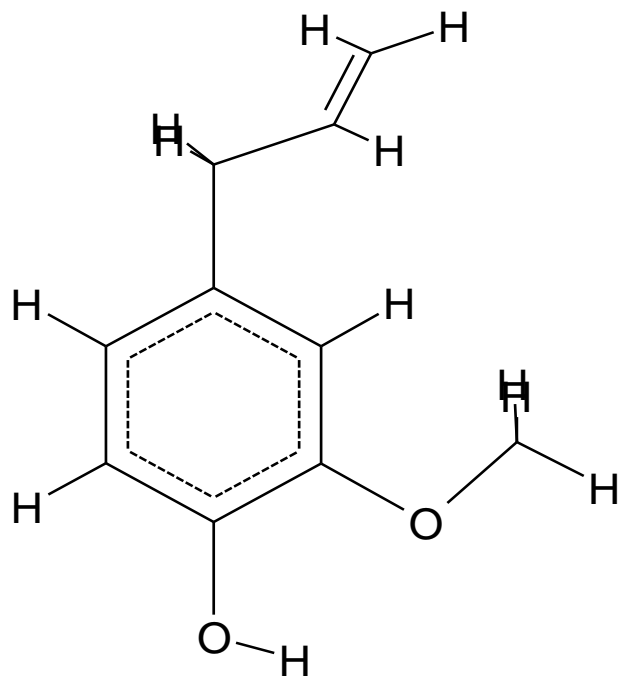
- 2 groups
 - Hydrolyzable
 - Condensed
- Macromolecules
- Reversibly binds proteins
- Reduces rumen ammonia
- Increase flow of protein to SI
- Can be toxic
- Linear response in methane reduction



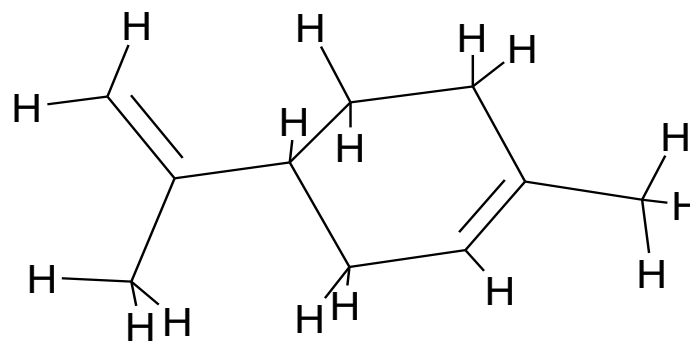
Essential oils

Essential oils are steam-volatile or organic-solvent extracts of plants, proven to have antimicrobial and insecticidal properties. They comprise mainly cyclic hydrocarbons and their alcohol, aldehyde or ester derivatives.

Structures of two typical essential oils



Eugenol

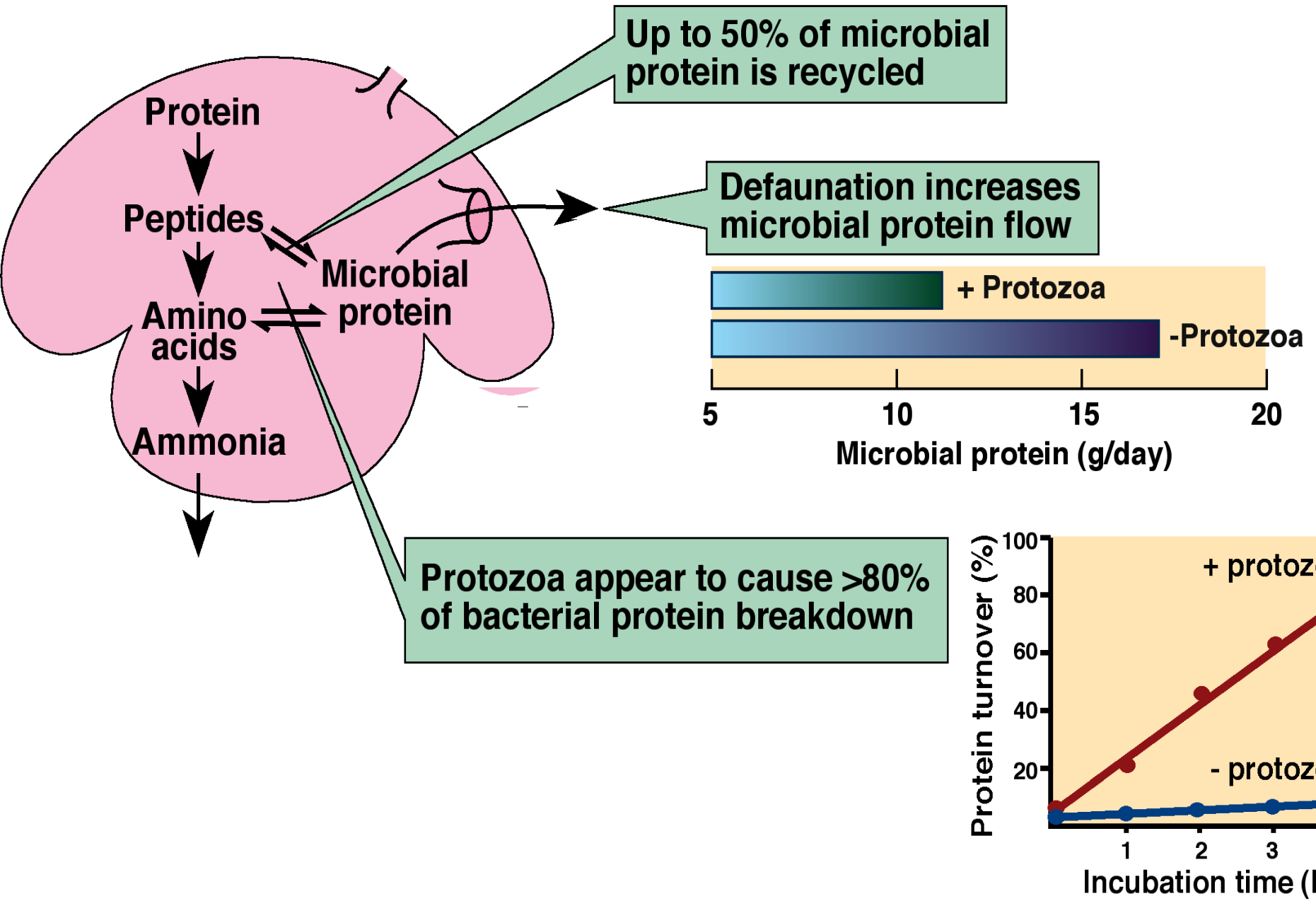


Limonene

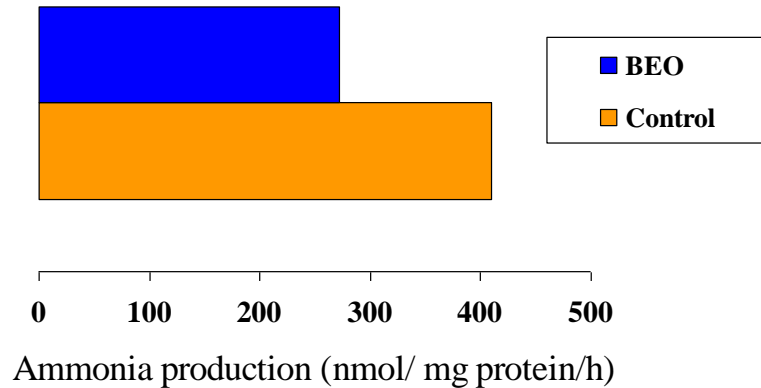
Claimed benefits from essential oils

- Lower rumen ammonia production
- Lower blood urea
- Reduced rate of protein degradation in the rumen
- Decreased rate of starch fermentation
- Modulation of rumen pH, reduced risk of acidosis

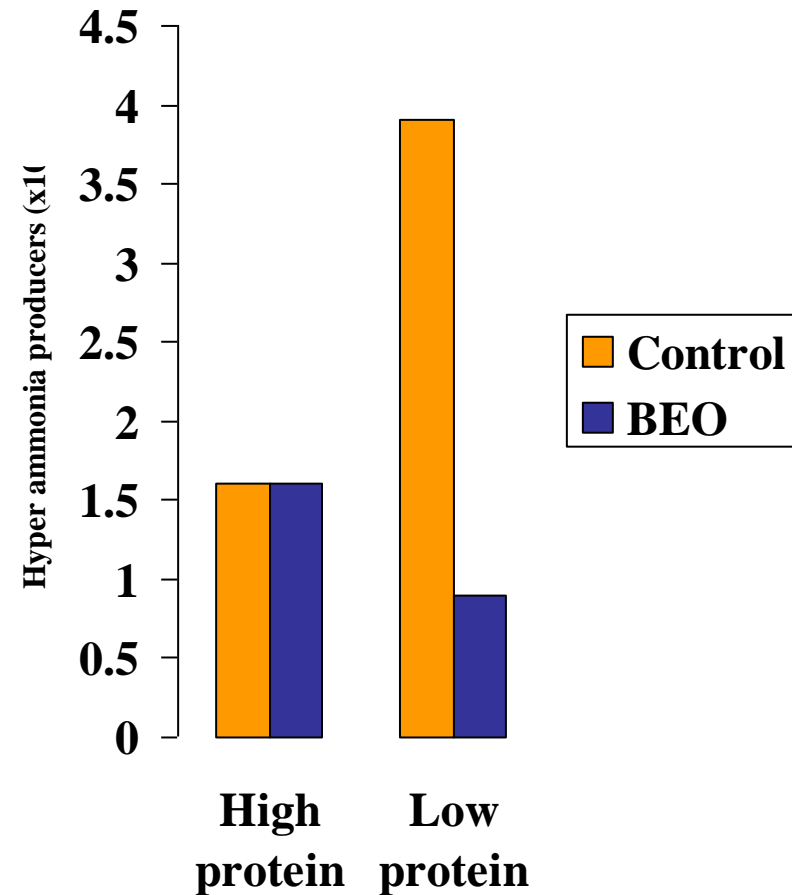
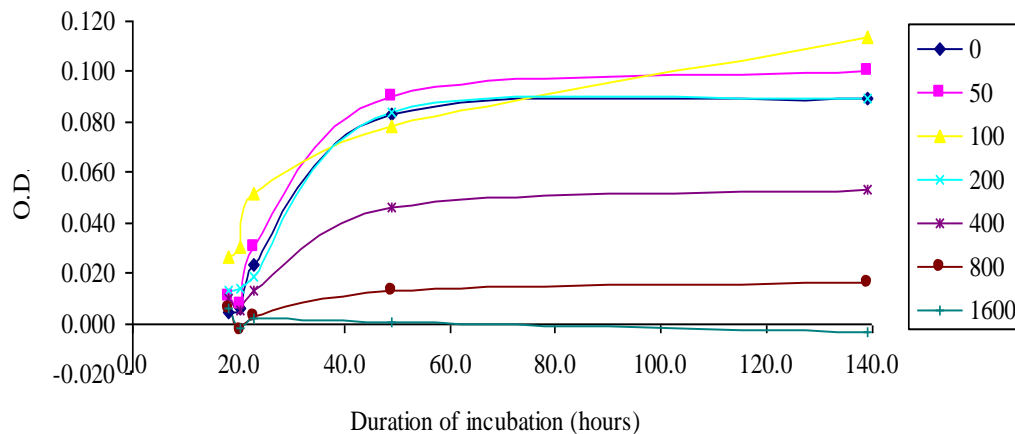
Breakdown of Microbial Protein



Amino-acids  Ammonia



Effect of different BEO concentrations (nl/ml) on the growth of *Clostridium sticklandii* 12662



BEO fed at 110 mg/hd/d

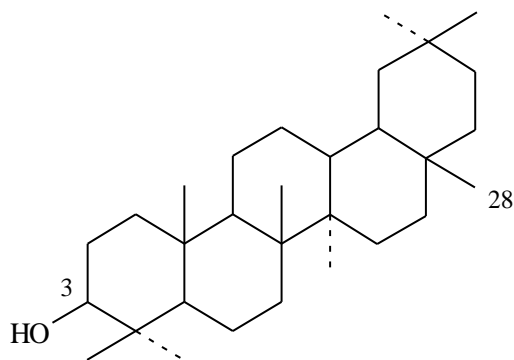
Essential oils

- Largely undefined composition
- Reduce rumen ammonia
- Reduction in numbers of hyper ammonia producing bacteria
- No consistent effect on methane
- No effect on VFA production

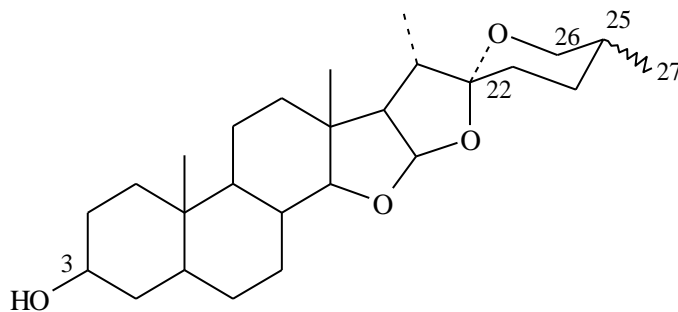
Saponins

- Form a stable foam in aqueous solutions similar to soaps, hence the name saponins
- Compose of a sugars attached to a sapogenin

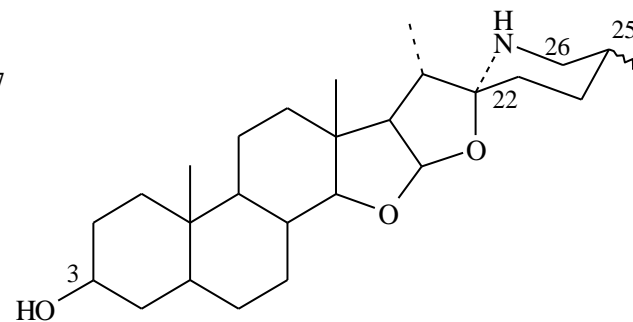
Chemical classes of saponins



Triterpene



Steroid

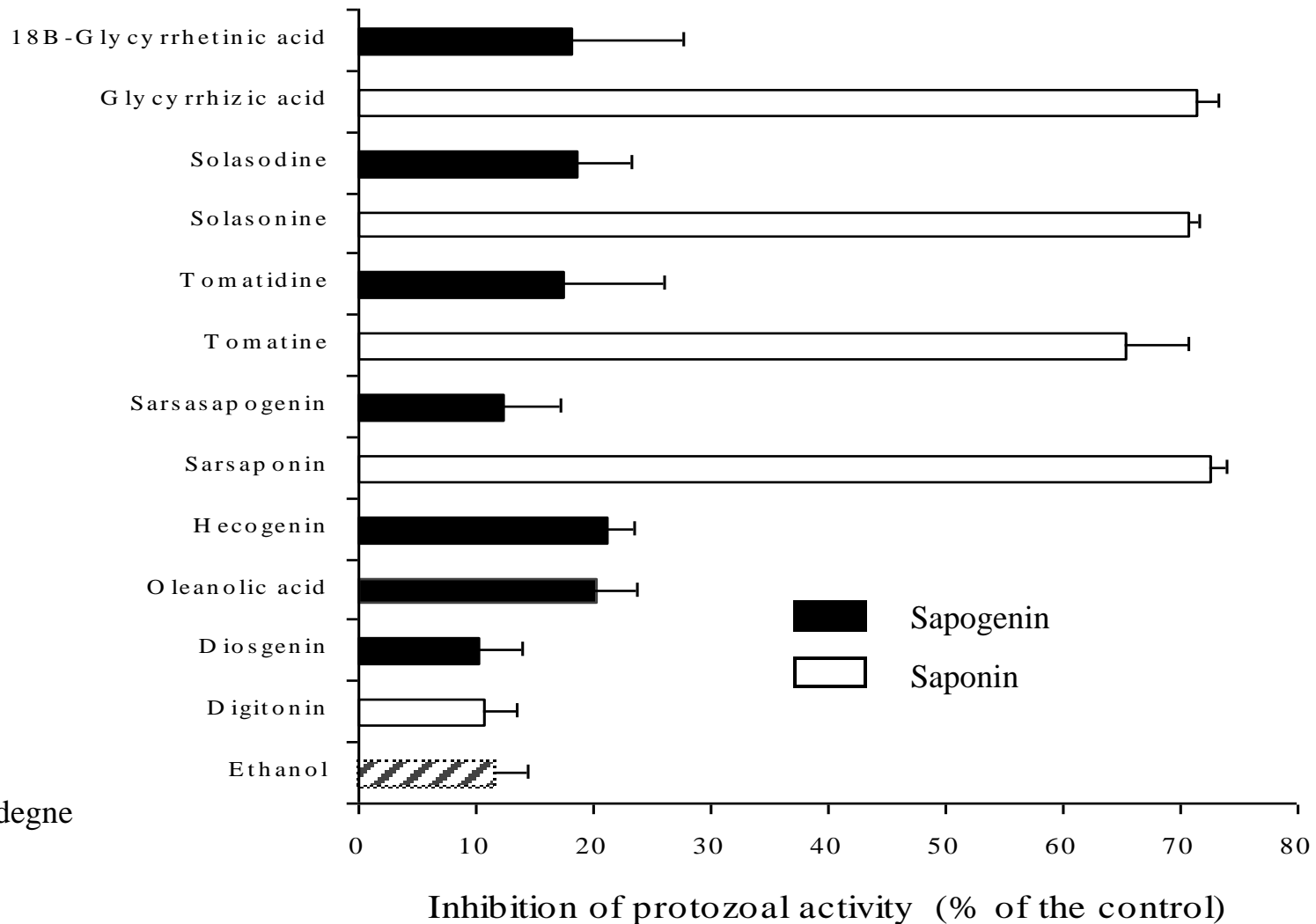


Steroid alkaloid

Saponins-containing plants as manipulators of rumen fermentation

- *Yucca schidigera*
- *Sesbania sesban*
- *Enterolobium cyclocarpum*

Effects of saponins and sapogenins (1 g/l) on bacteriolytic activity of rumen ciliate protozoa



From
Teferedegne
(1999)

Saponins

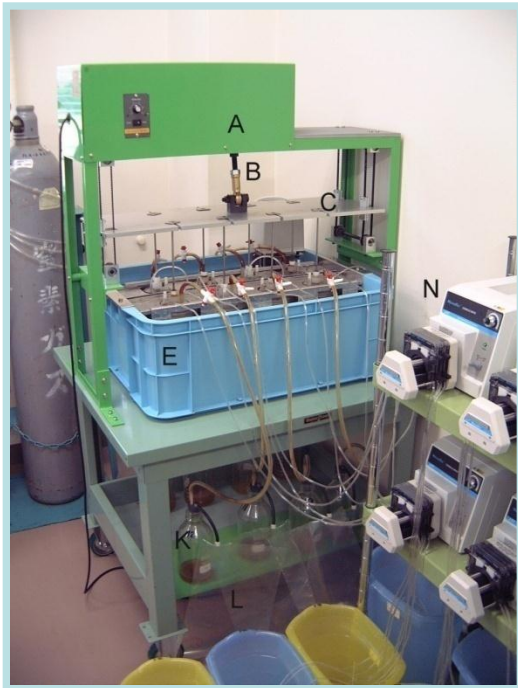
- Saponins, but not sapogenins, are anti-protozoal
- Bacteria hydrolyse saponins
- Saponins inhibit cellulolytic bacteria and fungi
- Some evidence for inhibition of methane

Organosulphurous compounds

- Derived from Garlic/Onions
- Garlic feed additives expressed as allicin content
- Allicin is extremely antimicrobial

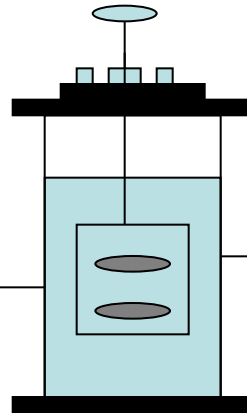
Rumen Simulation Technique (Rusitec)

Rusitec



Allicin

0, 2 or 20 $\mu\text{g/mL}$



- 250 mL ruminal fluid
- 250 mL artificial saliva
- 250 mL water

Dilution rate 26.5 mL/h

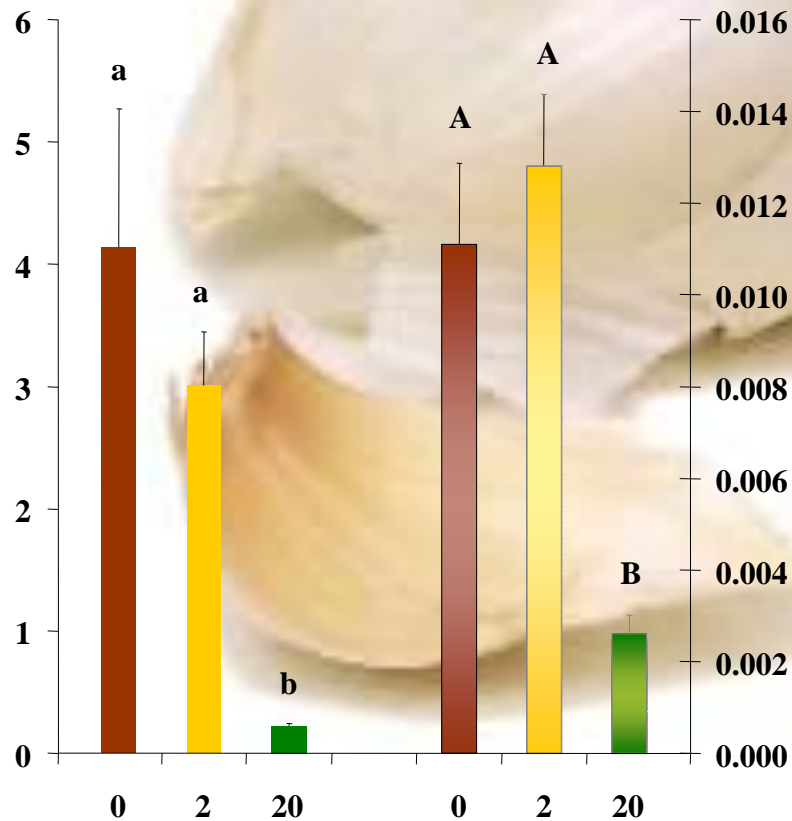
- Feed: 20 g/d
- 39°C for 17 d

Fermentation parameters

Item	Allicin concentration ($\mu\text{g/mL}$)			s.e.m.	<i>P</i>
	0	2	20		
Vessel pH	6.9	6.9	6.7	0.14	0.367
NH₃ (mmol/d)	43.9	42.0	46.5	3.20	0.412
CH₄ (mmol/d)	4.14	3.01	0.22	1.16	0.022
24-h DMD (%)	22.8	28.6	23.2	6.39	0.615
48-h DMD (%)	34.1	34.0	31.2	7.39	0.905
Bacterial counts					
Total (CFU/mL)	10×10^9	5×10^9	8×10^9	4.7×10^9	0.353
Cellulolytic*	8.16	8.22	7.89		0.845
	(14.5×10^7)	(16.6×10^7)	(7.8×10^7)		

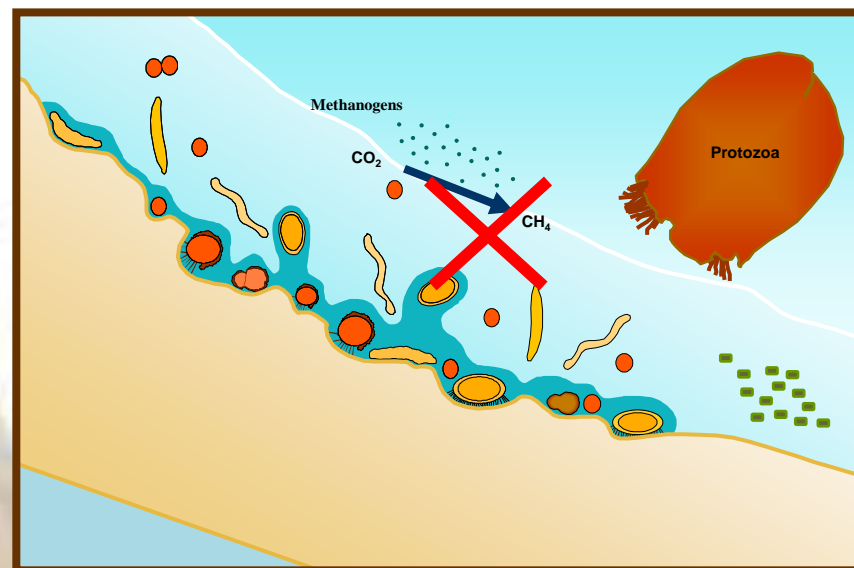
**log₁₀ CFU/mL. Values in parentheses are back-transformed means/mL.*

Methane production (mmol/d)



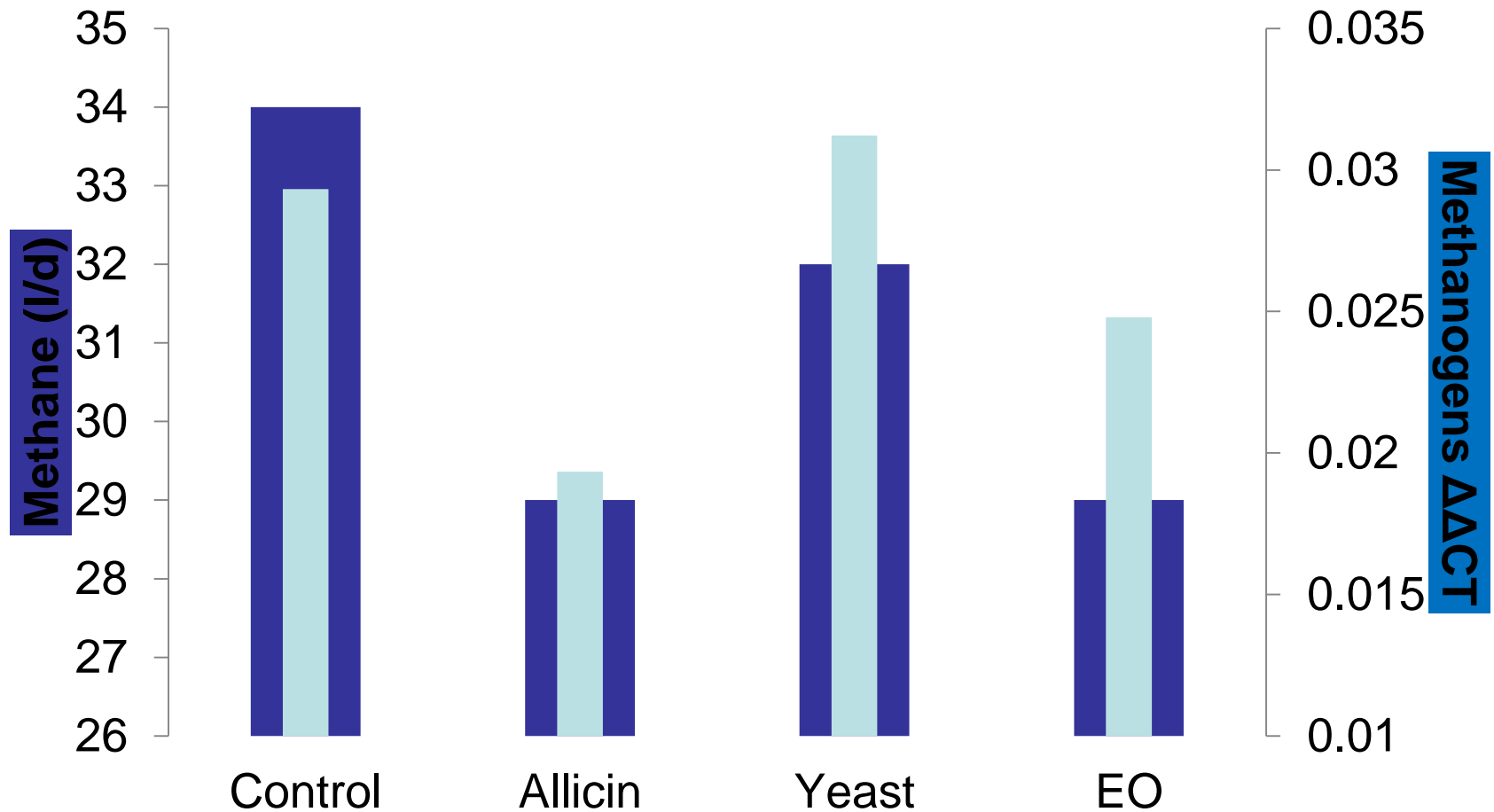
In vitro Allicin concentration (μg/mL)

Methanogens (ΔΔCt)



Inhibition of methanogens

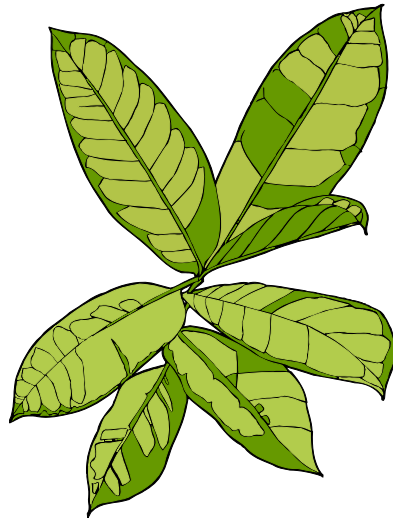
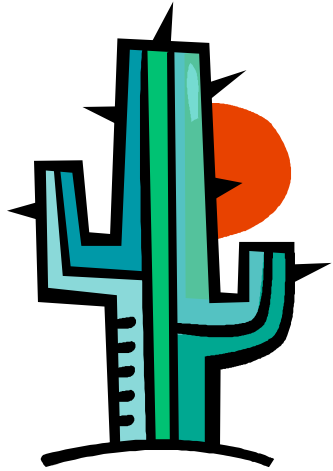
In vivo effect of allicin, yeast and essential oil in store lambs



Organosulphurous compounds

- Addition of allicin
 - Reduces methane by selectively targeting methanogens
 - Does not affect ammonia
- However, Allicin is extremely unstable
 - Is it allicin or the breakdown products that are having the effect?
- Unpractical 'as is' for farm use/storage

What is the ideal plant extract?



The 'IDEAL' plant extract

- Stable
- Definable
- Sustainable and economically viable
- Improved performance
 - Decreased ruminal ammonia and methane
 - Increased ruminal propionate
 - Increased milk/meat
- Persistent, quantifiable effects