The market for plant extract in ruminant livestock

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Types of Rumen Microorganisms

**BACTERIA**
- Ferment fiber, starches and sugars in feeds to VFA, H₂ and CO₂
- Produce most of microbial cell protein, but also ferment feed proteins to VFA + NH₃

**PROTISTS**
- Consume and ferment bacteria to VFA + NH₃
- Sequester and ferment starch
- Recycle N

**ARCHAEA**
- Convert H₂ and CO₂ to methane

**FUNGI**
- Assist in fiber digestion
The rumen

- Large and complex populations of microorganisms.
- Essential for energy/protein requirement.
- In balance in microbial community can lead to severe illness (acidosis, laminitis, liver abscesses, etc).
- Major contribution to GHG/pollutant emissions

**Bacteria**
- ~300 species
- $10^{10}$ to $10^{11}$ cells/ml

**Methanogenic Archaea**
- ~6 species
- $10^6$ to $10^8$ cells/ml

**Ciliate Protozoa**
- ~40 species
- $<10^5$ cells/ml

**Anaerobic Fungi**
- ~30 species
- $<10^5$ cells/ml
Rumen manipulation

- Diet manipulation
- Antibiotics
- Other chemicals
- Fats
- Buffers
- Immunological
- Probiotics
- Plant extracts
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
Fig. 1. Total EU market and forecasts for essential oils as feed additives: unit shipment (○—○) and revenue (■). (Adapted from Frost & Sullivan, 2000.)
livestock’s long shadow
environmental issues and options
United Nations

Approved Universal Standard in Measuring Greenhouse Gases and Carbon Credits

Cow Fart Unit (CFU)

1 CFU

0.8 CFU

0.02 CFU

1,000,000,000,000 CFU
(One million Gigafarts, or 1,000 Kyotos)

1,000 Cow Farts = 1 Megafart
1,000,000 Cow Farts = 1 Gigafart
1,000,000,000 Cow Farts = 1 Kyoto (1 billion farts)

Intergovernmental Panel on Cow Farts

ThePeoplesCube.com
Ruminants lose between 3 – 8% of GE as methane
Methane production: a microbially driven process to remove hydrogen

Feed

Methanogens

CO₂

H₂

CH₄

Protozoa
Mitigation database - global

- Global database search
- Wide scope of key words
- 1400+ potential references identified
- Limited by
  - Access
  - Selection criteria

Database so far...
- 232 references
- Ruminants only
- Global coverage
Major constraints limiting uptake of plant extracts

- the need to standardise and report the concentration of active component
- stability of the compounds in practical conditions
- persistence of the effects/adaptation of the rumen ecosystem
- lack of in vivo data over a range of livestock production systems
- effect of extract on the perceived quality of milk products
- a lack of production data on which to base calculations of market prices
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Genotypes

Variation commonly occur in plants containing volatile oils, e.g. Thyme (*Thymus vulgaris*) – has 7 different chemotypes, each with slightly different types & amounts of volatile oils.
Proportions of the different constituents of a volatile oil may vary greatly throughout its development. Wide ranges are commonly found in fennel, carrot and coriander (linalool is higher in ripe fruit than unripe fruit). *Mentha* (peppermint) is also greatly affected by the vegetative cycle.
Environmental factors

Temperature, humidity, duration of daylight (radiation), and wind patterns all have a direct influence on volatile oil content.

e.g. Peppermint: long days & temperate nights $\rightarrow$ higher yields of oil & menthofuran. Cold nights lead to an increase in menthol.
Environmental factors

Cultivation practices also play an important factor to the yield & quality of the final product.

Fertilization and the amounts of N, P and K have been studied for various species.

The watering regiment also plays an important role.
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CH_{4} production ( g per kg DMI )

Days

Chloroform added

Days
Influence of *Sesbania sesban* on protozoal numbers in the sheep rumen
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The effect of a yeast based probiotic, Allicin an extract from garlic and the essential oil analogue on methane production by and methanogen numbers in the rumen of store lambs.
Effect of Supplements on Methane Production by Lactating Dairy Cows

- Control: 30 L/kg DMI
- Glycerol: 25 L/kg DMI
- Allicin: 93% reduction, P < 0.25
- Naked oats: 89% reduction, P < 0.10

DEFRA Project AC0209
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Effect of Allicin and Spinning Cone Column Processing on Garlic Flavour Score

DEFRA Project AC0209
Removing Taint From Milk

DEFRA Project AC0209
Effect of Allicin and Spinning Cone Column Processing on Volatile Garlic Sulfides in Milk (ng/50 mg milk)

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