

ESSENTIAL OILS FOR RUMEN HEALTH
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INTRODUCTION

Many papers have been written on the activity of essential oils and their compounds - a good review has been presented by Calsamiglia et al, 2007. This paper will concentrate mainly on the rumen effects of essential oils as they relate to the manipulation of rumen fermentation to achieve improved health and production (milk and meat). Data is sourced from research and university trials, but also commercial experience. The intention is to give an overview of the current position with these products and their potential benefit for commercial dairies and beef enterprises.

PLANT EXTRACTS, ESSENTIAL OILS, ESSENTIAL OIL COMPOUNDS

Crushed plants and their extracts, especially herbs, have been used for centuries as homeopathic remedies for all manner of afflictions for man and animal. Essential oils are just one group of compounds that can be extracted from plants. They (together with tannins and saponins) are the plants mechanism to help defend against disease, fungus and insect attack and demonstrate a wide range of anti-microbial and other activities (fig.1)

Properties of Essential Oils	
Anti-inflammatory	Anti-microbial
Antiseptic	Antioxidant
Aphrodisiac	Antiviral
Decongestive	Diuretic
Expectorant	Flavoring
Fungicide	Immuno stimulant
Insect repellant	Stimulate Digestion
Sedative	

Figure 1. Some of the areas of activity of essential oils

In manipulating rumen fermentation the main interest lies in essential oils and essential oil compounds. Any individual essential oil, for example oregano oil, is made up of a number of compounds, in this case approximately 34. There are pros and cons of using individual compounds over the entire oil (fig.2), but the majority of interest in these products now focuses predominantly on blends of individual compounds.

Essential Oils	Essential Oil Compounds
Extracted by steam distillation or solvent	Typically solvent extraction or synthesized (nature identical)
Potential for organic use	
Variable composition (depends on species, weather, harvest conditions)	Stable and predictable with good QC
Some known synergy between components	Make use of known synergies in blends
Some unknown synergies	Can avoid unknown interactions

Figure 2. Essential oils compared to individual essential oil compounds

Commercial development of essential oil blends for the animal feed industry has been underway for over twenty years. In the past 12 years a growing number of companies are appreciating the potential for these compounds. In Europe they have been of particular interest as pressure has grown toward the banning of antibiotic growth promoters.

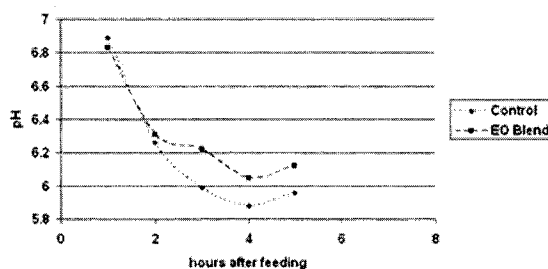
The main effect of essential oil compounds in manipulating rumen fermentation is their activity against groups of rumen microbes. Different compounds also exhibit synergistic activity, increasing the efficacy of a blend rather than an individual compound. (Ultee et al., 2002).

RUMEN Ph

High energy diets which are rapidly fermented in the rumen frequently lead to lower rumen pH as volatile fatty acids are quickly developed. Although buffers are frequently included in diets to counter this effect, manipulating the rumen fermentation can help reduce this pH fall. In order for rumen bacteria to break down carbohydrates in the rumen, they must first attach to the starch/sugar/fiber feed particles. They then release enzymes to promote the degradation process. One commercial blend of essential oil compounds (EOB) has been shown to reduce the rate of attachment and colonization of starch degrading bacteria on rapidly degraded starch particles in the rumen. There was no such inhibition to attachment on fiber particles. The result was that rapidly degraded starches were degraded less quickly, although no less completely, than other feed components (Wallace et al, 2002). This effect was confirmed in fistulated cow experiments with nylon bags. Starch substrates such as barley and maize were degraded less quickly in the rumen of animals with the EOB included in their diets. Animal trials with commercial EOB have shown consistent trends to reduced pH relative to control, although these rarely achieve statistical significance.

Effect of an Essential Oil Blend on Rumen pH

Number of animals: 4 mature double-fistulated (ruminal and duodenal) cows
 Dosage: 100 mg EOB / 100 kg BW / animal / day
 Measurement: 3 weeks adaptation followed by 1 week collection, 2 periods cross-over design
 Feed composition: (DM) 6 kg maize-silage, 0.6 kg rye-grass hay, 3.8 kg concentrate



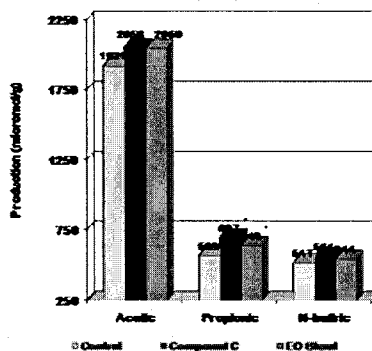
Source: Ecole Nationale Vétérinaire, Toulouse, France, 1999

PROPIONATE:ACETATE RATIO

Many studies have shown that shifting volatile fatty acid production toward a higher propionate:acetate ratio leads to improvements in milk yield (Seymour et al, 2005). Typically this shift is linked to lower rumenal pH, increased milk protein and reduction in milk fat. Some commercial EOBs' (and individual compounds) have demonstrated a shift

toward increased propionate:acetate ratio, but have been associated with an increase in total VFAs', maintaining acetate levels, and increasing butyrate and propionate. These changes may help account for improvements in yield with no reduction in milk fat, or protein, per cent.

Effects of an EO Blend and one of its compounds on rumen VFA production

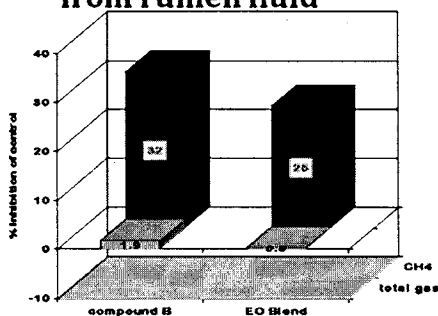


Source: Univ. of Aberystwyth, UK, 2007

METHANE

Frequently associated with EOBs' increasing propionate:acetate levels have been reductions in rumen methane emissions. This suggests inhibition of rumen methanogens. Methane belched from the rumen represents wasted energy - on average 2% to 10% of energy intake. As methane is a potent greenhouse gas (25 times more so than carbon dioxide) - there are financial and environmental benefits to reducing the eructation of methane.

Effects of an EO Blend and one of its components on methane production from rumen fluid



Source: Univ. of Aberystwyth, UK, 2007

AMMONIA

Protein is degraded in the rumen to peptides, amino acids and ammonia. Many trials have now confirmed that not only commercial blends of EOBs' but also a number of individual compounds can interfere with one or more of these phases, reducing the rate of release of ammonia into the rumen. While rumen microbial growth requires a regular supply of these amino acids and ammonia, too rapid release of ammonia into the rumen leads to diffusion through the rumen walls into the blood stream.

There it is toxic and must be transformed to urea in the liver (with an energy cost) - either for excretion in the urine or for recycling. By reducing the rate of degradation of rapidly fermented proteins in the rumen, EOBs' can help improve efficiency of use of proteins while reducing the toxic effects and energy costs of dealing with excess ammonia.

Effects of EO Blend on slowing rate of deamination and reducing ruminal ammonia in rumen fluid (12 hours)

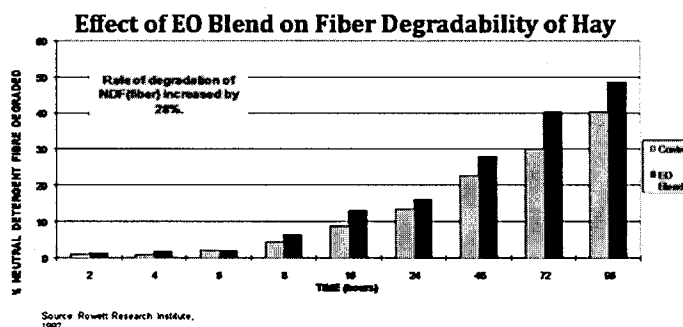
Parameter (mg/100 ml)	Negative Control	Negative Control + EO Blend
Small peptides and amino acids nitrogen	17.9a	21.0b
Ammonia nitrogen	16.5a	13.9b

a, b: p<0.05

Source: Autonomous University of Barcelona, Spain, 2004

FIBER DIGESTION

The key role of the rumen is the breakdown and utilization of fibrous materials. Below a pH of around 6.0 the fiber digesting microbes become less active. So there is a clear link between fiber digestion and pH. With EOB's reducing the rate of degradation of both proteins and starches - the microbial balance can shift toward fibrolytic bacteria. Thus the trend toward higher pH and this shift in bacterial balance would help explain the trend toward improved rates of fiber degradation which have been shown in a number of EOB trials.



FEED INTAKE

Improving the efficiency of rumen fermentation, particularly of fiber, would be expected to result in improved feed intakes and many EOB trials have demonstrated feed intake responses.

MILK YIELD/QUALITY

Trials with research institutes, universities and with commercial companies have demonstrated increased milk yield and milk component yield with a range of essential oil compounds. In most cases the financial payback has been shown to be greater than 5:1 (\$5 return for each \$1 spent). While more established companies have considerably more data, some more recent products have established EOBs' based on good research and have some promising production data.

EOB Trial, Penn State University

Number of animals
88 (control) & 82 (CRINA)
multiparous Holstein cows

TMR
Biological model balanced
for 95 lb milk / d with
3.1% protein & 3.55% fat

Feeding
TMR twice per day
(total DM 50.8 lb / head /
d)

Composition (as fed)
50% com. silage, 20%
haylage, 30% concentrate

Experimental group
EO Blend
(10 g / head / day)

Item	Control	EO Blend
Milk, lb d	88.2 ^a	91.8 ^b
Milk fat, %	3.59	3.55
Milk protein, %	2.81	2.86
Milk fat, lb d	3.17	3.26
Milk protein, lb d	2.48	2.63
DMI, lb d	50.8	50.8

a,b p<0.05

Source: Pennsylvania State University, 2003

SUMMARY

Essential oil blends show real potential in manipulating rumen fermentation toward more efficient production of milk and meat. Many hundreds of thousands of cattle now have these products included in their feeds. There is still much to learn and more trials to be undertaken. Responses to EOBs' vary with different dietary ingredients. Cattle with different rumen microbial profiles can be expected to respond differently to the same blend.

Additional research has looked at the effects of "essential oils" on fertility parameters, somatic cell counts, feet. More recently some of the other benefits of essential oil compounds mentioned above, such as their powerful antioxidant activity, have been included in animal research and are now being brought to market.

Not all essential oil blends are equal. "These compounds are powerful" – was the response to some independent early in vitro trials in the UK. If that power is properly harnessed these products will likely provide significant cost effective benefits for the future.

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