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Dairy Briefs

The Latest Information on Dairy Cattle Nutrition

Essential Oils in Dairy Cow Diets

By Pedro Nogueira

Let's see! What am I going to feed my cows today: some thymol (thyme and oregano) or maybe eugenol (clove), or perhaps limonene (dill) or better still some cinnamaldehyde (cinnamon)? This is starting to seem like a culinary bulletin, but all of these strange names are compounds of Essential Oils, and are the object of a growing interest by scientists due to the fact that essential oils can interact with microbial cell membranes and inhibit the growth of some gram-positive and gram-negative bacteria enabling some degree of control on rumen fermentations.

First it's important to define the term "essential" in the case of essential oils. When we talk about essential fatty acids or essential amino acids, the term "essential" is used because the body is unable to synthesize those substances and so they must be supplied by the diet. In the case of essential oils the term "essential" derives from "essence", which means smell or taste, and relates to the property of these substances of providing specific flavours and odours to many plants. They are defined as volatile aromatic compounds with an oily appearance extracted from plant materials typically by steam distillation.

The symbiotic relationship between ruminants and the rumen microorganisms is great: the rumen is a good growing environment for the rumen bugs and these degrade fibre to produce volatile fatty acids and synthesize microbial protein as an energy and protein supply for the ruminant, respectively. However, it is also known that this fermentation process has energy (losses

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of methane) and protein (losses of ammonia N) inefficiencies that may limit production performance and contribute to the release of pollutants to the environment. Scientists and ruminant nutritionists have always tried to manipulate the rumen population to a certain extent, hoping to improve the efficiency of energy and protein utilization in the rumen. Dr. Calsamiglia, from the University of Barcelona, explains that this has been achieved through the optimization of diet formulations and the utilization of feed additives that modify the environment and enhance or inhibit specific microbial populations. Antibiotics, like monensin for example, enter in this last category.

What properties make essential oils (EO) interesting for dairy production?

In a review about essential oils published in 2007 in the Journal of Dairy Science, the aforementioned Dr. Casalmiglia summarizes the properties and mechanisms of action of EO. Essential oils have a wide variety of effects; however, the most important activities of these compounds are as antiseptics and antimicrobials.

Research done in the 60's showed some promising results with these compounds. However, as referred in Dr. Calsamiglia's review, at the beginning of the 1970s, authorization on the use of ionophores antibiotics as growth promoters stopped research on the use of essential oils in animal feeding, and few studies were conducted in the following 30 years. Since the ban on antibiotics as feed additives in the European Union in 2006, there has been a renewed interest in studying the effects and mechanisms of action of EO on rumen microbial fermentation.

What this research shows so far, and is of interest for ruminant production, may be divided in the following categories:

- Stimulation of rumen fermentations;
- Inhibition of methanogenesis;
- Modification of the production of and profile of the ruminal volatile fatty acids (VFA), nitrogen metabolism, or both;

We can see that its effects are of great importance in ruminant nutrition: inhibition of methanogenesis not only provides more energy to the animal but also contributes to reduce the impact that methane has as a greenhouse gas. On the other hand, if we can modify the VFA profile in the rumen increasing the amount of propionate and reducing the amounts of lactate (main responsible for acidosis) and methane, without reducing total production of VFA, we'll be helping high producing animals, either dairy cows or finishing beef animals. The same is true for nitrogen metabolism: some EO inhibit the degradation of proteins in the rumen, potentially improving the amount and quality of amino acids available for milk production or muscle deposition.

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What about its use in Dairy Cows?

Jim Paulson, an Extension Educator from the University of Minnesota reported that researchers from the University of Wisconsin recently completed a trial with dairy cows pre-calving to 15 weeks into lactation. In this trial, 40 cows were used with 20 cows as control and 20 cows receiving 1.2 g of an essential oil product. The product is a blend of several oils. There was not an observed benefit to the cows receiving the product prepartum. However, there was a benefit of increased fat corrected milk and dry matter intake the longer cows received the oils. It is unfortunate that the trial was discontinued after 100 days. It has been speculated that there is an adaptation time required for the oils in the rumen.

Two previous trials with lactating cows were run with the same product. The first trial was completed in 1997 involving 33 cows with older cows in mid-lactation. The supplemented cows showed increased milk production, increased components and increased fat corrected milk yields. Cows were fed a common 50:50 forage to concentrate diet with corn silage and alfalfa as the forage.

Workers at Penn State did a production field trial involving 170 cows fed a 42:58 forage to concentrate diet where corn silage made up over 2/3 of the forage and the diet contained a fair amount of by-products. Similar results were seen in this trial with cows receiving the essential oil blend producing more milk and more fat corrected milk. Components in milk were similar but slightly higher in the treatment cows.

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Conclusions

There is still a limited amount of data with controlled studies with animals to recommend which oil or combination of oils will work with different diets. As Jim Paulson indicates, we do not fully understand their actions and mechanisms or if there are any affects on the milk that could result in wrong or inappropriate use of essential oils. Another aspect is that so far most of the research with essential oils has been done in-vitro in a controlled lab setting. The effects of oils seem to be diet and pH dependent with certain oils working better with a particular diet. Whether or not the effects observed in-vitro carry over to a much larger and diverse ecosystem as a rumen is under investigation. Research seems promising though, and we'll probably hear more about these compounds in the future.

Essential oils with antimicrobial activity, their main active components, and susceptible microorganisms

Essential oil of	Name	Active components	Susceptible microorganisms
Allium sativum	Garlic	Allicin, diallyl sulfite	Enteropathogenic bacteria
Anethum graveolens	Dill	Limonene, carvone	Gram-positive and gram-negative bacteria
Capsicum annum	Paprika	Capsaicin	Gram-positive and gram-negative bacteria
Cinnamomum cassia	Cassia	Cinnamaldehyde	Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Salmonella enteritidis
Juniperus oxycedrus	Juniper	Cadinene, pinene	Aeromonas sobria, Enterococcus fecalis, Staphylococcus aureus
Melaleuca alternifolia	Tea tree	Terpinen-4-ol	Staphylococcus aureus, Escherichia coli, gram-positive and gram-negative bacteria
Origanum vulgare	Oregano	Carvacrol, thymol	Gram-positive and gram-negative bacteria
Pimpinella anisum	Anise	Anethol	Aeromonas hydrophila, Brevibacterium linens, Brochothrics thermosphacta
Rosmarinus officinalis	Rosemary	1,8-Cineole	Staphylococcus aureus, Listeria monocytogenes, Campylobacter jejuni
Syzygium aromaticum	Clove	Eugenol	Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Salmonella enteritidis, Campylobacter jejuni
Thymus vulgaris	Thyme	Thymol, carvacrol	Salmonella typhimurium, Staphylococcus aureus, Aspergillus flavus
Zingiber officinale	Ginger	Zingiberene, zingerone	Gram-positive and gram-negative bacteria

Calsamiglia et al., 2007, JDS 90:2580-2595.

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