How to improve ruminant feed efficiency through phytoexpertise

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Unlike pigs and poultry, feed efficiency is rather poor for ruminants due to their specific digestive tract and the intense microbial fermentation processes occurring in the rumen.

Several studies have been undertaken to control these fermentations and increase the use of the nutrients in the diet.

Phytogenic additives seem to be a promising tool but this research area is still new and requires more proof from the field.

CCPA Group has worked on this subject since the early 1990s and has implemented a scientific program in close collaboration and partnership with INRA (the French agronomic research institute).

Feed efficiency for dairy cows consists of the kg of milk produced per kg of consumed dry matter. This is a useful indicator to evaluate the ability of cows to turn feed nutrients into milk.

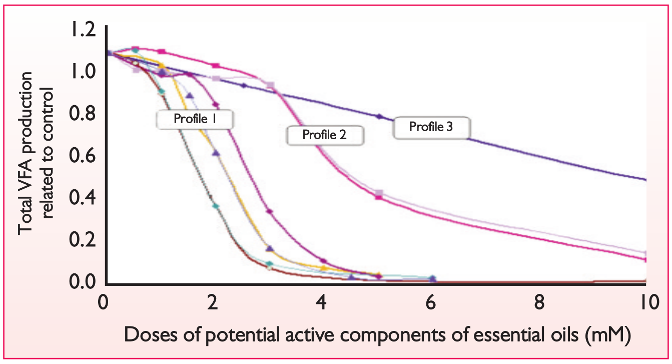

Fig. 1. Dose-response on volatile fatty acid (VFA) production, related to an additive free control batch (Macheboeuf D., 2006).

In vitro tests

Following a bibliographical research, the first step consists of characterising the different sources of essential oils or plant extracts which could be effective for ruminants.

Then, these active ingredients have to be tested alone or in combination, to find the best association and dosage. Due to the huge number of possible combinations, the best way to proceed is to set up 'in vitro' experimentations.

CCPA Group led these trials using the INRA testing facilities. Fig. 1 shows one of these experiments on the use of plant extracts (essential oils and polyphenol extract) to reduce the ruminal degradability of proteins.

We can easily see three groups of essential oils with different sensibility on gas production. The same work has been done for protein degradation through the measure of ammonia release, in the batch.

The different trials show that essential oils can cause various responses on ruminal fermentations, depending on the essential oil and the dose considered. Indeed, these tests reveal the importance of considering threshold dose, when dealing with essential oils.

The second part of the in vitro trials consists of testing different combinations of single molecules to identify the best blend.

A simplex centroid experimental design is used to take advantage of the different modes of action of the molecules and to identify possible interactions between them. Fig. 2 shows the effect of these blends on ammonia production.

According to this trial, the best blend to reduce ammonia release is the specific combination of substances C + A, identified in Fig. 2.

In vivo validation

After this selection through in vitro experimentations, the blend of ingredients chosen is tested in vivo, in an experimental farm.

For instance, a specific blend of plant extracts was tested in vivo to evaluate the effects on dairy production (Table 1). The control batch was given a diet comprised of 70% fodder (54% maize silage, 19% hay, 12% beet pulp silage and 14% grass silage) and 30% concentrates (40% rape oil cake, 35% nitrogen concentrate and 25% wet grain-maize).

The two test batches were given the same diet, supplemented with either blend 1 (batch E1), or blend 2 (batch E2), incorporated into the feed. The two blends consisted of a combination of plant extracts and essential oils. The blend E2 shows noticeable positive effects on milk yield and milk urea. Following these trials in experimental farms, tests are then undertaken on real farms to get a feedback on a large number of cows.

Quality control analyses

As essential oils and plant extracts are natural, they are highly variable. Therefore, it is necessary to control the concentration of the active principle, during the different steps of the manufacturing process, from the raw material to the final feed.

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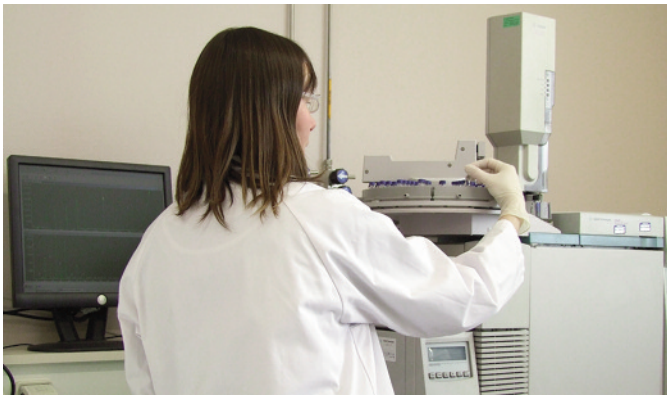
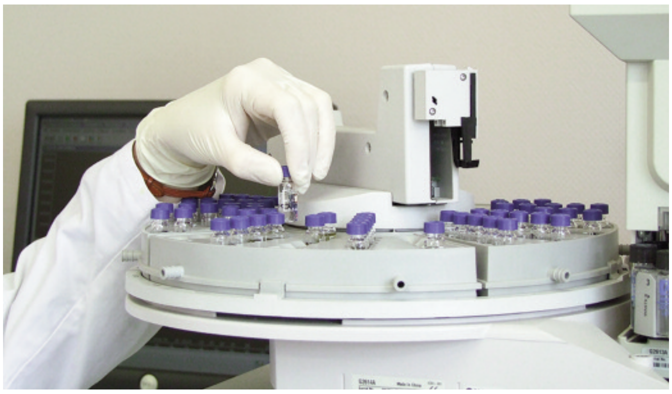
HPLC analyses are led in the laboratory to control the concentration of active principles in final feed.





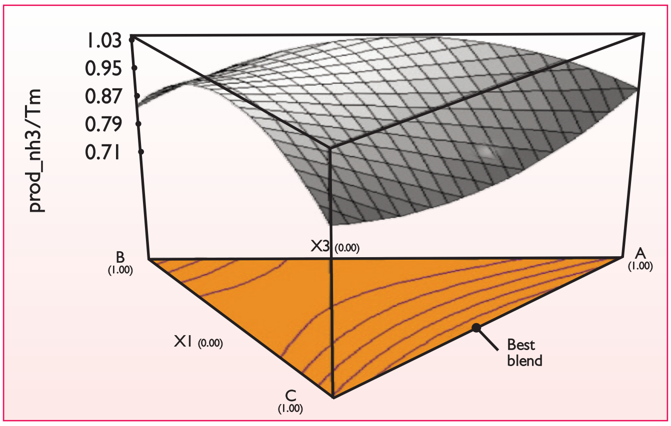


Fig. 2. Effect of a blend of three ingredients (vegetal extract A, essential oil B and essential oil C) on ammonia release, compared with an additive free control batch (D. Macheboeuf , 2006).

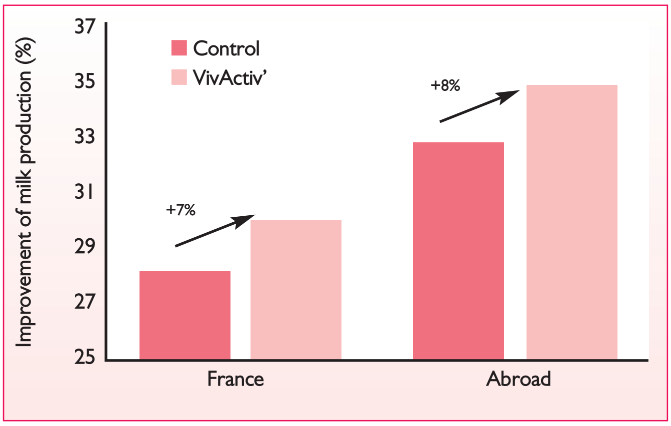


Fig. 3. Improvement of milk production with VivActiv' (l/day) (CCPA Group trials, 2014).

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The CCPA Group laboratory is able to precisely determine the concentration of the different active principles of an essential oil, in a raw material as well as in the final product, through HPLC analyses. This step guarantees the efficiency of the feed additive in the final product.

Nutritional feed additives

Over the last 15 years, based on the Group's phytoexpertise, several nutritional solutions have been developed. VivActiv' is one of them and improves protein and energy valorisation, in ruminant diets.

To develop VivActiv', over 400 single molecules and molecule combinations were tested. This in vitro test phase, partly led with INRA collaboration, was confirmed by more than 100 field trials worldwide: in France, Morocco, Turkey, Italy, Portugal, Czech Republic, Germany, Vietnam and Mexico.

In 2014, the product was incorporated in 1,200,000 tons of ruminant feed, all over the world. This range of products is adapted to different diets (rich in starch, in fibre, high in energy) and compatible with organic farming specifications.

Including plant extracts and essential oils, VivActiv' plays a major role in increasing protein and starch digestibility, combining several synergistic actions:

- Direct protein protection from degradation in the rumen with more by-pass proteins, to increase production performance.
- Control of the balance between amylolytic and cellulolytic flora, driving more energy.
- Maintain an ideal pH level for the rumen flora, to prevent sub-acute ruminal acidosis.
- Intestinal and pancreatic enzymes stimulation to enhance the intestinal digestion.
- Increase in microbial protein synthesis.
- Reduction of urea production, with a positive impact on reproduction performance.

More milk yield

Incorporated in ruminant rations, VivActiv' improves feed efficiency. As a result, it leads to more production performance. Thus, over 107 trials conducted between 2000 and 2014, milk production increased on average by 1.5 litres per cow per day (Fig. 3).

As the product significantly improves the protein yield of feed, dairy farmers can choose to reduce the supply of proteins (namely soya) in the ration, while maintaining the same level of milk production. This strategy is particularly profitable when soya market prices are high.

VivActiv' also reduces methane emissions, which is on the list of greenhouse gases. Indeed, it has a repressive effect on the protozoa producing methane. Thanks to a better yield of protein assimilation, the product also reduces nitrogen losses.

To sum up, the VivActiv' technique – via its selected plant extracts – operates on both rumen (microbial synthesis) and intestine (by-pass proteins) and enables maximum digestion of the whole ration, leading to better feed efficiency, as for protein and energy.

In a market that is more and more receptive to money savings, animal welfare and respect for the environment, CCPA Group's new approach is definitely an interesting way to improve breeding profitability. ■

Table 1. Results of tested blends on dairy performance. The values with different letters are significantly different (Student, P<0.05) (Ballard V., 2011).

Variables	Control	Blend		SD	Effect
		E1	E2		
Ingestion (kg dry matter)	22.3	22.4	22.4	1.34	
Milk yield (kg/day)	28.6^{a}	29^{ab}	29.8^{b}	1.02	P<0.01
Milk fat (g/l)	38.4	37.9	37.9	1.56	
Milk protein (g/l)	32.8^{b}	32.5^{a}	32.1^{a}	1.09	P<0.01
Energy corrected milk (kg/day)	27.8^{a}	28.9^{b}	28.8^{b}	1.28	P<0.001
Milk urea (ml/l)	226^{b}	225^{b}	217^{a}	7.5	P<0.01
Live weight variation (kg)	+17	+41	+38	9.77	

References are available from the author on request