Natural feed additive to improve feed efficiency and the rumen microbiota

Feed efficiency consists of evaluating the quantity of feed required to obtain a unit of animal product (meat, eggs or milk). The focus is more on optimising the use of resources than maximising production per animal. This is a key point for animal husbandry today, firstly for economic issues, feed representing more than 50% of production costs, but also for sustainability.

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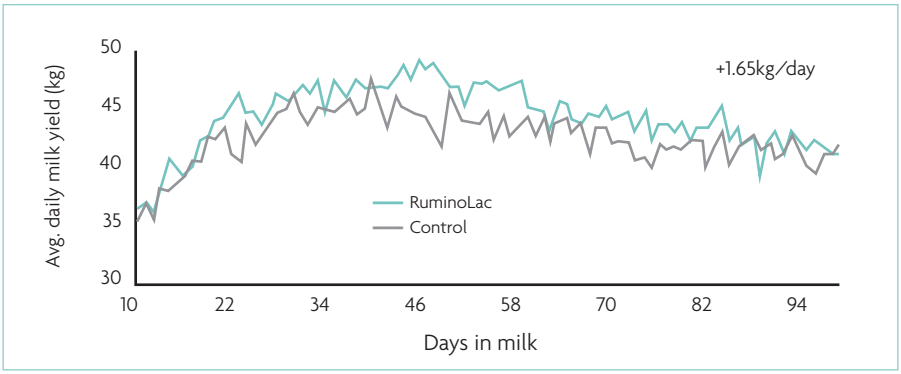

Fig. 1. The average daily milk yield in a controlled field trial for the first 100 days in milk (Kumprechtova et al, 2017. ADSA).

While it is important to remember that ruminants are able to convert human inedible plant resources into high quality human edible food, it is also important to consider that part of the nutrients are lost during the digestion process. The majority of losses occur during fermentation in the rumen where methane and ammonia are produced.

Roughage quality and digestive efficiency

On the scale of a dairy farm, the main factors identified to improve protein and energy efficiency are the improvement of roughage quality and digestive efficiency through rumen fermentation. Feed additives, including antibiotics (may be classified as non-ionophores and ionophore), have been used to manipulate rumen fermentation parameters since the 1950s. However, over the years, concern has grown over the use of antibiotics to improve animal growth and feed efficiency. The European Union applied a precautionary principle and prohibited their use as animal growth promoters. This regulation has created a strong demand for feed additives of natural origin that are effective in improving digestive processes, maintaining animal health and reducing their impact on the environment.

The integration of the animal production sector into the concept of 'One health/a single health' is more relevant than ever: the health of humans, animals and the environment are essential to consider in a systemic and unified approach. In this global context, the use of natural substances in animal nutrition is a promising strategy to promote environmentally friendly animal husbandry that takes into account feed efficiency and animal health, but also the safety and acceptance of consumers.

Plant extracts have incalculable secondary metabolites; many of them can have antimicrobial activities against an extensive variety of micro-organisms such as bacteria, fungi and viruses. Also, several bioactive phytochemicals, may be used as potential 'natural' alternatives to 'chemical' additives in the favourable modulation of rumen fermentation and animal performance.

For example saponins are known to have a specific activity on protozoa by forming complexes with cell membrane cholesterol. Antiprotozoal activity of saponins resulted in the modification of rumen fermentation, improving animal performance. Goel et al. (2008) demonstrated that fenugreek saponins could increase rumen efficiency when evaluated in vitro.

On the other hand, essential oils (EOs) have shown antimicrobial activities against Gram-negative and Gram-positive bacteria. It was reported by Calsamiglia et al. (2007) that EO can modify the ruminal fermentation parameters and decrease ammonia production in the rumen; thus, reducing nitrogen (N) excretion.

They also mentioned that cinnamaldehyde is an EO that appears to be a natural alternative source to antibiotics and has similar action modes to ionophores.

However, the promising benefits seen in vitro can sometimes disappoint when tested in vivo. Two hypotheses are often given to explain this: natural diversity and rumen complexity.

For the first point, it is important to understand that several parameters can influence the chemical properties of plants: geographic origin, extraction method, organ used, and climate. This diversity can be taken into consideration through several analyses to determine the content of active molecules in the ingredients and ensure repeated effectiveness of these additives.

Also, these analyses combined with plant expertise enable us to understand the importance of each factor impacting the molecule's active content and to manage variability. The use of powders and plant extracts standardised in active molecules define a phytogenic additive.

Considering rumen complexity, it is important to validate in vivo the tendency observed in vitro, as bioavailability of the active molecule can be affected by the rumen micro-organism. It has been proved that the digestive processes in ruminants can be beneficial to improve the biological effect of some bioactive molecules.

Effective natural solutions

The French company Phytosynthese has more than 25 years' experience using natural active substances to develop phytogenics and offers effective, natural solutions to all players in the animal feed sector.

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Item	CON	SAP	SAPEO	MON	EPM	P value
ECM (kg/day)	21.2	24.1	20.3	21.2	3.05	0.13
DMI (kg/day)	11.9[a]	11.6[ab]	11.2[ab]	9.99[b]	0.37	0.03
ECM/DMI	1.75[b]	1.63[b]	2.04[a]	2.11[a]	0.07	0.01

CON = Control, with no feed additive; SAP = saponins from whole-plant fenugreek powder, 16g/day/cow; SAPEO = a blend of natural essential oil, with carvacrol, cinnamaldehyde, and limonene as main components combined with SAP, 16g/day/cow; MON = Monensin, dietary inclusion of 24mg/kg DM of sodic monensin.

Table 1. The effects of supplementation with monensin and saponins alone or combined with essential oils on dairy cows.

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The company recently conducted a study to evaluate the effects of supplementation with monensin and saponins alone or combined with essential oils on dairy cows. The experiment consisted of a replicated 4 × 4 Latin square design with 21-day periods.

Saponin supplementation associated with essential oils (SAPEO) increases milk fat and protein contents in lactating Jersey cows compared to animals fed a monensin-supplemented diet. Also, both additives, decreased nutrient intake to a more energetically efficient pathway without altering digestibility or rumen fermentation (Table 1). Also observed was a significant reduction of blood urea and losses of nitrogen allowing better protein efficiency with natural additives compared to the control (Table 2).

These studies confirm an observation seen on a larger scale where cows receiving plant extracts (RuminoLac) showed an improvement of +1.65kg in milk production during the first 100 days of lactation without dilution of the milk components (fat and protein) and with a reduction of urea in the milk (Fig. 1). Moreover, the administration of RuminoLac allowed cows to limit body condition losses at the beginning of lactation. Supplementation with plant extracts has shown a numerical tendency towards reduction of ketone bodies in the blood suggesting a possible reduction in the risk of subclinical ketosis. Moreover, between the RuminoLac and control heifers there was a statistically significant ($P<0.05$) reduction in calving to-conception interval.

Conclusion

Residual feed intake (RFI), an inheritable character of feed conversion efficiency, can vary between 3-9% in dairy cattle. This therefore means that it is possible to improve feed efficiency and through several factors (genetic, nutritional).

Amongst them, plant extracts represent a real interest, to modulate rumen microbiota and increase diet digestibility. Analytical and scientific research allow us to standardise natural solutions and understand their mode of action for optimal and repeatable efficiency on the farm. ■

References are available from the authors on request

Table 2. Reduction of blood urea and nitrogen.

Item	CON	SAP	SAPEO	MON	EPM	P value
Total Loss N (g/100g)*	67.9[a]	64.1[b]	61.2[b]	65.9[ab]	1.90	0.08

*faeces N + urine N / N intake