There are other ways to improve ingredient digestibility in pig diets

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All over the world, farmers have a common goal, improve feed efficiency in order to optimise farm productivity (see Table 1). To achieve it, they try to provide the animals with the most appropriate feed in relation to their physiological needs.

But, feed efficiency depends primarily on ingredient digestibility on the one hand and the quality of the digestion process, itself dependent on several physiological parameters, on the other. In this, the efficiency of natural enzymatic digestion in the duodenum is key to an optimised digestion, and therefore of feed efficiency.

Feed cost decrease with FCR improvement	Low feed price	High feed price
Standard fattening pig feed price ($/T)	300	400
Standard feed cost with FCR = 2.9 ($/T of produced liveweight)	870	1160
Improvement of 2% in FCR		
Feed cost ($/T of produced liveweight)	852.60	1136.80
Net gain ($/T of produced liveweight)	17.40	23.20
Improvement of 4% in FCR		
Feed cost ($/T of produced liveweight)	843.90	1125.20
Net gain ($/T of produced liveweight)	26.10	34.80

Table 1. Illustration of the interest of investing in natural feed additives aiming at reducing the feed conversion rate (FCR): the higher the price of raw materials and feeds, the better the margin is improved by a reduction in FCR.

Geophagia

Complementing the pigs' diet with clays has existed for a long time, through an instinctive phenomenon known as geophagia. Geophagia comes from the Greek 'phagia', to eat and 'ge', the earth; and refers to the behaviour of eating clay. Several species of birds and mammals resort to geophagia in nature, most of the time in response to digestive troubles or intestinal pain. Some studies also report geophagia as a source of minerals. This natural phenomenon has been reproduced in animal nutrition, with the common supplementation of feeds with clays.

Over time, clays have been and are used in animals feed for two main purposes: technological and zootechnical. In the process of pelleting, some clays (mainly Sepiolite) are used to improve pellet durability.

On the other hand, other clays (like Montmorillonite) present a zootechnical interest, for providing intestinal protection to the animals. Indeed, clays are perceived as 'intestinal care' products thanks to their capacity of adsorbing some toxins and bacteria, their positive interaction with the mucus and their capacity to treat diarrhoea.

While there is scientific evidence showing the benefits of clays in the prevention or treatment of digestive troubles and in the protection of the gut mucosa, much less is known about their capacity to improve feed efficiency. Yet, the improvement of the digestibility of feed is an integral property of clays.

Digestibility crates during INRA trial of MFeed+ 2014-2015.

Multiple mechanisms

The mechanisms involved are thought to be multiple. The dominant hypothesis described in the literature is that clays slow down the transit of feed in the intestine, so the time for digestion is increased, hence a better digestibility of feeds and nutrient uptake.

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Such effect has been described for growing pigs, where supplementation with clay increased their speed of growth between 25 and 106kg and improved their carcase quality (higher lean meat). Weight gain and feed efficiency of broilers has also been improved when the feed was supplemented with Montmorillonite. In both studies, the stressed mode of action was a decrease in transit speed.

Nevertheless, it seems that the action of clays to enhance feed digestion in the intestine involves other mechanisms. Reichardt (2008) and Habold et al (2009) both report the ability of clays to favour the contact between enzymes and nutrients, and therefore to improve the rate of digestion of the feed. Indeed, digestive enzymes need to be in contact with their substrate in order for hydrolysis to occur.

The physico-chemical interactions of the enzymes with clay particles seem to enhance the contact between the digestive enzymes and the feed, making clays a good supporting matrix for enzymes and acting as a meeting point for them to be in contact with their substrate. Indeed, Cabezas et al (1991) demonstrated that clay-enzymes complexes are formed at enteric pH values.

Active stable complexes

These active stable complexes are resistant to proteolysis and increase the amount of active digestive enzymes in the intestine, thus improving nutrient digestibility.

In the same way, Habold et al (2009) observed higher pancreatic lipase activity in rats supplemented with Kaolinite; Xia et al (2004) showed an increase in small intestinal digestive enzymes activities on broilers supplemented with Montmorillonite; and Paolo et al (1999) observed an increase in protein and energy retention coefficients for growing pigs supplemented with clay.

Some studies also suggest that the increased activity of enzymes in contact with clay not only comes from their stabilisation, but also from the presence of cofactors in the clay.

Cofactors are defined as thermostable non-protein compounds that form the active portion of an enzyme system. In other words, cofactors are helper molecules required for enzymes to be active. They can be organic or inorganic, most commonly vitamins in the first case and metallic ions in the latter. Clays are layered mineral materials, composed of a succession of aluminium and silicium based sheets, which order varies according to the type of clay.

Substitution phenomenon

In Montmorillonite, several metallic ions replace some aluminium and silicium ions in the structure. Known as the substitution phenomenon, this event provides Montmorillonite part of its physico-chemical reactivity. Moreover, the presence of metallic ions may contribute to the activation of some enzymes, through their action of cofactors. Thereby, copper is known to activate lipase and phospholipase A and zinc is a required cofactor of carboxypeptidase, to mention only a few examples.

The combination of the matrix support provided by the clay and the cofactor effect coming from the metallic ions present in its structure can be referred to as biocatalysis: the improvement of performance of a biochemical reaction through the action of an external compound, a biocatalyst. Due to a large variety of clay minerals, one can imagine that all clays do not have the same potential for biocatalysis depending on their type, their purity, their source or their treatment. As such, clay structure can be modified and associated with other materials in order to potentiate its biocatalytic properties. Such technology has been developed by Olmix Group, France, in the frame of its research program conducted on seaweeds and clays.

The micronised form allows a fine dispersion of the product in the intestine, providing many sites of reaction of enzymatic digestion with more easily accessible metal ions. Moreover, it benefits from a synergy between clay and seaweeds in the process of biocatalysis, as seaweeds bring in many diverse metallic ions, sometimes absent in the feed, which are required cofactors for the activation of several enzymes. This unique combination of seaweeds and clay makes it a unique tool to boost enzyme activities through the action of biocatalysis.

Proven efficacy

MFeed+, the only product benefiting from this new technology, has proven its efficacy in several studies conducted in collaboration with different external scientific partners like INRA or ANSES and CTPA in France, and also internationally, with BARC in Thailand for example.

The diversity of partners allowed a variety of protocols to be set up, from very specific digestibility cages to experimental pens installed in conventional commercial farms.

Among these studies, investigators highlighted in their conclusion the interest of using MFeed+ in diets using by-products, as a way to decrease the feed cost, while maintaining a standard level of performance.

With by-products like DDGS being more and more present on the market, though not used widely because of their nutritional profile, such outlet is a great perspective to manage feed cost while ensuring optimum performance of the feed. ■

References are available from the author on request