Feeding to reduce antibiotics – anything new?

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In pig production in Western Europe during recent years the subject of reduction of antibiotics has been gaining attention.

Governments, research institutes and consumers have expressed a growing concern about antibiotic residues from livestock production being linked to a general increase of bacterial antibiotic resistance, and issue warnings about the consequences for human medicine. This concern is demonstrated by a series of publications regarding emerging multi-resistant bugs like MRSA and ESBL bacteria.

There is an increasing urge on the livestock sector to preventively tackle – for example – digestive disorders primarily via farm management, biosecurity and dietary measures. This pressure puts more and more limitations on the use of in-feed antibiotics. Farmers are being forced to rethink antibiotics as a secondary curative option, rather than as a primary prophylactic option. This governmental interference will not limit itself to Western Europe, but inevitably will also start to influence animal farming practices in other parts of the world.

So, what is new, when focusing on dietary measures to reduce antibiotic use in pig production? In fact, nothing is completely new.

Primarily feed intake is still regarded as the major factor in maintaining intestinal health around weaning, to prevent enteric disease, which is one of the main boosters of prophylactic use of antibiotics.

Feed concepts to reduce dependence on standard in-feed antibiotics will therefore be aimed at maximising intestinal integrity by maximising feed intake of piglets around weaning. In the meantime, however producers are constantly searching for additional tools to reduce the impact of intestinal pathogens without compromising feed intake.

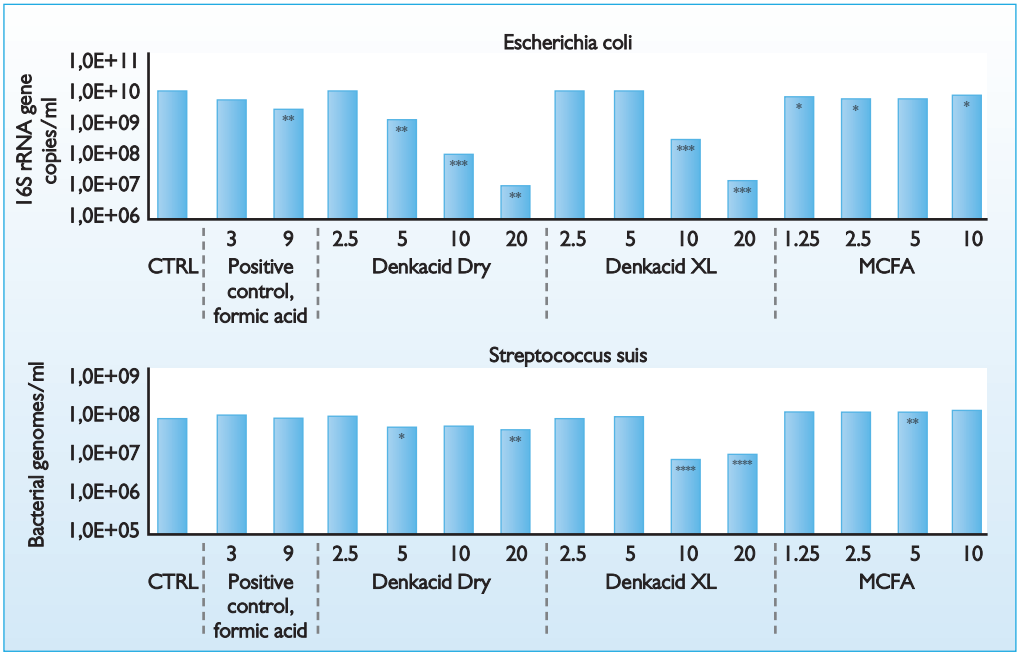
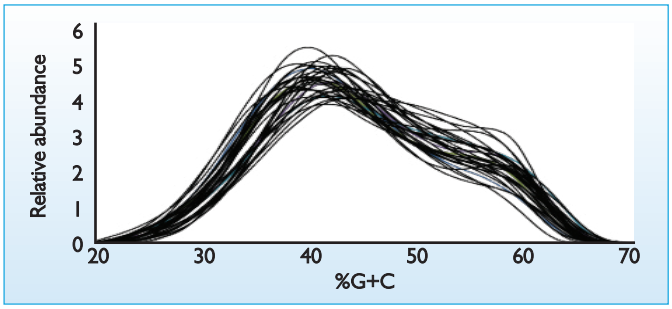


Fig. 2. In vitro effectiveness of Denkacid XL against E. coli and S. suis (Denkavit in vitro studies, 2011, piglet simulation model).

Fig. 1. Microbiota profiles in piglet manure (Denkavit in vitro studies, 2012-2013, piglet simulation model).



Related to diet-health interactions, fundamental research on a more exact identification of gut microbiota under specific circumstances, and on how to influence the balance of microbiota towards performance or health, is gaining interest.

As a spin-off, updated approaches at Denkavit are tuned towards improving existing acidification concepts and on ways of modifying intestinal motility.

Government interference

The extent to which governments are moving towards reducing the use of antibiotics varies considerably in different parts of the world. Some countries (Holland, Denmark, Korea) have developed specific restrictive legislation and surveillance systems, others have not yet moved at all in that direction (Brazil, China), or only partly (US, Australia).

In Holland, forced by legislation, sow farmers show a growing tendency to reinvest costs which previously were used for antibiotics in targeted preventive vaccination programs and in the application of special (safe) feed formulations.

Fundamental research

Both in human medicine and in animal science, fundamental research is targeted at identification and classification of gut microbiota.

Denkavit R&D, in a joint effort with an external laboratory is currently making profiles of faeces samples, analysing guanine and cytosine percentage as a marker to distinguish certain categories of gut bacteria.

In extended research the relative abundance of some of these categories may hopefully be correlated to the occurrence of either positive (weight gain) or negative (diarrhoea) performance characteristics.

Starting here, the aim would be to eventually develop feed formulation guidelines to promote gut colonisation of one category of bacteria above others (Fig.1).

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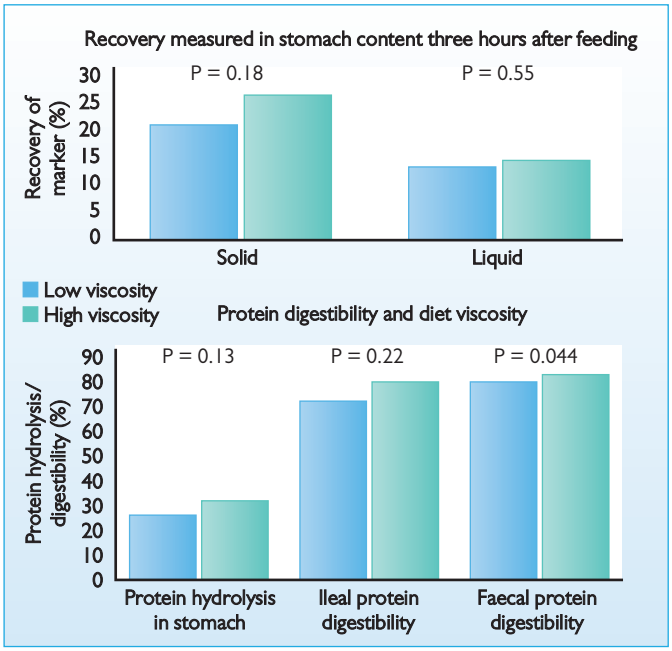

Fig. 3. Improving protein digestibility by increasing diet viscosity and slowing gastric emptying rate (Fledderus et al, 2006 – Effect of 1% CMC added to diet, measured at three weeks post weaning, weaning at 26 days).

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The constant search for effective additives which allow the formulation of performance diets without having to resort to the use of antibiotics will remain of the utmost importance.

This, however, does not exclude the need for general feed formulation practices to also be taken into consideration.

The formulation of low crude protein/high digestible protein diets has already for a longer period of time been a focal point in attempts to increase diet safety. Diet cost may increase when aiming at highest possible protein digestibility, but this is an inevitable choice for piglet diets, at least for the weaning phase.

Additives

With regard to additives, several non-antibiotic defence mechanisms exist in the gut, which can be enhanced or stimulated by using a wide variety of additives, with numerous different modes of action.

As such, organic acid mixes have proved their effectiveness in practice, but they often only provide a limited antibacterial spectrum.

A new approach to widen this spectrum is to combine short chain organic acids with a specific set of refined medium chain fatty acids (MCFA).

In a unique in vitro simulation model, Denkavit has shown the newly developed acid mixture Denkacid XL to be effective both against Gram negative and Gram positive bacteria. When tested against the conventional approach based on a product (Denkacid Dry) containing formic, citric, propionic and acetic acid, an inclusion of 1.0% of Denkacid XL, containing both these organic acids as well as added MCFA, shows a similar antibacterial effect on E. coli (Gram negative), however enhanced by an additional antibacterial effect on S. suis (Gram positive). This additional effect on S. suis could not be achieved by the mix of MCFA alone (Fig. 2).

When tested in the same simulation model against 0.5% inclusion of benzoic acid, 1.0% inclusion of Denkacid XL again shows a similar antibacterial effect on Gram negative bacteria, with an additional delaying effect on the multiplication of S. suis and Clostridium perfringens, which is not achieved with benzoic acid.

Table 1. Technical results of Denkavit Safe Concept under Dutch practical circumstances. Denkavit commercial trial. Farm size 350 sows – genetics Topigs 20 x Pietrain.

	Feeding schedule	
Mini start	Creep feed	0.7kg
Safe start 2	Weaner feed	3.8kg
Opfok S/P	Starter feed	28.5kg
Period	**01-01-2010 until 31-12-2010**	
No. piglets	9606	
Weaning age (days)	25	
Weaning weight (kg)	7.4kg	
Age end of rearing (days)	71	
Weight end of rearing (kg)	28	
Daily weight gain (weaning - end) (g/d)	448	
FCR	1.60	

Post weaning piglet feed (applied 0-14 days after weaning)	Safe start (15.7% CP)	Control (17.0% CP)
Feed intake (g/day)	325[b]	299[a]
Weight gain (g/day)	231	229
FCR	1.41	1.31
Mortality (% week 1-4)	0.63[a]	5.00[b]
Antibiotic treatments (days/piglet)	1.00[a]	3.25[b]

Table 2. Effect of Denkavit Safe Concept on mortality and frequency of antibiotic treatment under Dutch circumstances. Denkavit trial 2 x 160 piglets. Genetics Landrace (NL, Fi) x Large White.

Crude fibre sources

Crude fibre can be referred to as the forgotten nutrient. Often only the potentially negative aspects of crude fibre on diet efficiency, energy and ADG are considered. However, as in human nutrition, in the more recent approach to formulate non-antibiotic safe diets, selection of the appropriate fibre sources is increasingly reflected upon as an essential, gut health related, formulation tool.

Formulating with crude fibre thus can be tuned towards three main objectives; influencing diet viscosity, optimising diet fermentation and regulating gut peristalsis.

In the currently established Denkavit approach, inclusion of special heat-processed corn and barley based cereals, together with selecting specific crude fibre sources tested for optimum water binding capacity, already permitted diets to be formulated with a viscosity which delays gastric emptying rate without reducing feed intake.

Delaying gastric emptying rate will allow more effective protein hydrolysis in the stomach, and therefore improve ileal and faecal protein digestibility (Fig. 3).

The problem is that, in particular, the crude fibre sources which show the essential, desired characteristics (for example, unmolassed sugar beet pulp selected for its water binding characteristics) are not readily and globally available.

Recently, the use of crude fibre as a formulation tool can be even further optimised by utilising new high density fibre sources which influence intestinal peristalsis and limit or prevent remigration of pathogenic bacteria from the hind gut to the small intestine. Moreover, part of this crude fibre will attribute to the fermentation process in the hind gut.

The overall beneficial effects allow the microbiological status of the intestines to be indirectly shifted towards an increased production of potentially advantageous volatile fatty acids (especially butyrate) in the colon, thus improving water reabsorption and preventing diarrhoea. The combined conventional and updated approach will enable nutritionists to increase safety of low fibre (corn, rice based) diets towards higher intestinal safety, without necessarily having to resort to inclusion of zinc oxide and antibiotics.

Safe concept

Fusion of earlier mentioned raw material approaches with thoroughly researched newly introduced functional feed components has enabled Denkavit to develop a new generation of special safety diets for piglets as an answer to the restrictive Dutch legislation on the use of antibiotics.

As other markets are moving slowly but gradually in the same direction, these safe diets are now increasingly attracting attention as a tool to assist farms facing high infection pressure to solve digestive disorders with a minimum of antibiotics in a variety of circumstances.

Results in practice show that, by using the new generation of balanced low protein safe diets, technical farm performance can be equalled or even improved at a lower veterinary cost (Table 1 and Table 2), provided that farm managers are also prepared to review and improve their feed management, disease prevention (biosecurity) and general farm practices.

Conclusion

Feeding to reduce the use of antibiotics is a dynamic process which constantly adapts to new functional feed components and research data coming available.

The continuous efforts of Denkavit R&D to connect the scope of existing nutritional approaches with the integration of newly introduced nutrient solutions will hopefully continue to generate good news. ■