Healthy pigs with less use of antibiotics – a nutritional approach in three steps

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Raising healthy animals with less usage of antibiotics is the future challenge for animal husbandry in Europe. Consumers, retailers and authorities are clearly giving this message. In some countries measures are already implemented; in other countries the discussions are just starting up.

Overall the picture is clear that in Europe sustainable animal husbandry with controlled low usage of antibiotics will be the future demand.

What steps can be taken to reach this objective? It is clear that it will not be simply replacing antibiotics by one single alternative. To reach the goal farmers have to work on a multi-factorial approach, like farm management, climate and hygiene.

Nutrition can be an important part in this approach. Several steps can be taken from a nutritional point of view to increase the health of the animals. In order to reach this, three important steps are described.

1. Reduce undigested protein

Protein is normally digested in the small intestine and provides amino acids to the animal. Amino acids are the building blocks for protein deposition (growth) and are important for a great amount of functions in the body.

Unfortunately the protein that we supply via the diet is not 100% digestible. If protein is not digested in the small intestine, it will reach the large intestine and forms a substrate for pathogens (like E. coli) to develop.

Too much undigested protein can give an imbalance of the microflora and may lead to digestive disorders like diarrhoea.

On the one hand we want to provide high amounts of protein to the animal for optimal performance, on the other hand we want a low amount of protein to reduce the risk of digestive disorders.

This seems a paradox, but with the correct tools, nutritionists are able to manage this very well. To face this issue it is key to know the exact requirement of the animal for each essential amino acid, the so called ideal amino acid profile. This profile varies between species (pigs are different to poultry) and also varies per stage of life (piglets are different to fattening pigs). Over the last few years a lot of new research has become available that reveals this ideal amino acid profile.

Once we know the requirement of each amino acid we can supply a diet that meets this ideal amino acid profile as close as possible. The amino acids in the diet are supplied via protein feedstuffs and feed grade amino acids. Today we have the first five limiting amino acids (lysine, threonine, methionine, tryptophan and valine) available in free feed grade form. These feed grade amino acids are 100% digestible, so they do not contribute to undigested protein. The next limiting amino acids (isoleucine, leucine, histidine, etc) should be added via protein rich feedstuffs.

Most preferably the feedstuffs chosen have a high digestibility. It is important to formulate a diet which covers the requirement for each amino acid, but without oversupplying the animals' requirements, so no lack and no excess. With the current knowledge on the requirement of all these amino acids we can formulate a diet with a lower crude protein level (lower level of undigested protein), keeping the same or even better animal performance.

2. Optimise microbiota

The microbiota in the gut consists of billions of microbes that live in close relationship with the host animal. Three different types of host-microbiota relationship can be described, being symbiotic, commensal or pathogenic (see Table 1).

For an optimal microbiota we aim to lower the amount of pathogenic bacteria and to increase the amount of beneficial bacteria (symbionts). As described before, the first step for gut health is to lower the amount of undigested protein as much as possible. 100% digestibility will not be reached in diets, so we will always have a part of undigested protein that reaches the large intestine and be a substrate for the pathogenic bacteria.

Therefore in a next step we have to work on measurements to control the pathogenic bacteria. At this moment antibiotics still play an important role in this.

- **Symbiont**
  (Lactobacilli) At least one has an advantage, without harming the other.
- **Commensal**
  (Bacteroides, Enterococcus, etc) Coexist, not detrimental, but without obvious benefit.
- **Pathogenic**
  (E. coli, salmonella, C. perfringens, etc) Harmful for the host.

Table 1. The three different types of host microbiota relationship.

As an alternative different types of products could play a role. Organic acids or essential oils (plant extracts) could be used for their antimicrobial activity, so focusing again on lowering pathogens. This could be part of the strategy, but only focusing on lowering pathogens might not do the whole job. A more natural strategy would be to focus on promoting the beneficial bacteria (symbionts).

Lactobacilli produce lactic acid, which lowers the pH in the gut and acts against pathogens. So by stimulating the lactobacilli, the pathogens will consequently be reduced. This mechanism is also known as competitive exclusion. Stimulating beneficial bacteria can be done by probiotics, like Bacillus subtilis. These heat stable, spore forming living microbes produce certain enzymes and consume oxygen, both creating an optimal environment for lactobacilli.

By feeding B. subtilis, the lactobacilli are promoted and the pathogens are reduced. This mechanism has been shown in a trial where piglets were challenged with E. coli one week after weaning. The first group of piglets (control) received a basal diet, without antibiotics or additives.

The second group received a diet containing antibiotics. The third group received a diet containing the probiotic Calsporin (B. subtilis). The faeces of the piglets were analysed for E. coli and lactic acid bacterial counts. The results show that antibiotics lower numerically the amount of E. coli, but

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at the same time also lower the amount of lactic acid bacteria.

The Calsporin group also numerically lowered the amount of E. coli but kept the lactic acid bacteria on a high level (significantly higher compared to antibiotic). Both the antibiotic group and the Calsporin group showed an improved faeces score and lower mortality (Table 2). The end results in terms of health (diarrhoea, mortality) of antibiotic and probiotic treatment were the same, but the way this was reached differs significantly. Antibiotics clean the gut by reducing both negative and positive bacteria.

Probiotics stimulate the beneficial bacteria and help to suppress the negative ones.

The microbiota is established in the first stage of life. In the first period after birth, this microbiota has to develop and is rather unstable. In pigs, this period of unstable microbiota takes around 2-3 weeks after weaning.

Probiotics stimulate the development of beneficial lactobacilli and help to reach the stable microbiota more efficiently. Also after an (sometimes unavoidable) antibiotic treatment, probiotics assist in building up the microbiota again.

	Control	Antibiotics	Calsporin
E. coli			
Ileum (log cgu/g)	7.20	6.61	6.70
Colon (log cgu/g)	7.57	6.90	6.79
Lactic acid bacteria			
Ileum (log cgu/g)	7.88	6.63	8.79
Colon (log cgu/g)	9.67	7.87[a]	10.02[b]
Faecal score			
Six hours post-infection	1.55	1.33	0.89
24 hours post-infection	1.31[a]	0.47[b]	0.34[b]
72 hours post-infection	1.39	1.13	0.83
Mortality	6/18[a]	0/18[b]	2/18[b]

Table 2. Effect of antibiotic (100ppm ASP-250, chlortetracycline, penicillin, sulphamethazine) and probiotic (Calsporin) treatment on bacterial counts and faecal score of piglets (Bhandari, 2008).

3. Support immunity

As a third step the immunity of the animal itself could be supported. With an optimised immune response the animal is better protected from pathogenic pressure. Only fighting pathogens in the gut may not always be sufficient.

Some pathogens are mainly active in the gut (like E. coli), others also enter the body via another route. Streptococcus suis is a pathogen that enters the body of the piglet partly via the gut, but also partly via nose to nose contact and ear biting. By only working on gut health and fighting pathogens in the gut, the streptococcus suis is not always successfully eliminated.

β-1,3/1,6-glucans, found in the cell wall of yeast, are known for their ability to optimise immune response. In vitro work shows that it is very important to have the correct type and structure of β-1,3/1,6-glucan. Normal yeasts, yeast cultures or complete yeast cell wall products do not have the possibility to stimulate immune response. MacroGard, produced by Biorigin, Brazil, is the most researched β-1,3/1,6-glucan.

This product has been investigated intensively and has proven to be very efficient in in vitro trials as well as in animal trials in pigs.

In a recent trial it has been demonstrated that piglets can be protected from an E. coli challenge, by feeding them MacroGard. The piglets that received this product in their diets had a higher local immune response in the gut. This higher immune response protected the piglets.

The E. coli did not infect the piglets. No E. coli was found back in the faeces and the piglet showed no diarrhoea. In the control group the local immune response was very low and E. coli infected the piglets, which resulted in diarrhoea in the control group (Stuyven, 2009).

Total concept approach

In summary we can state that nutrition can be an important tool in the total approach to reduce antibiotics in animal production.

Only replacing antibiotics by just one single feed additive will probably not be successful. A total nutritional approach has a better success ratio. As a first step the amount of undigested protein can be reduced significantly by working on the ideal amino acid profile and formulate with feed grade amino acids and high digestible protein sources.

In a second step the microbiota can be optimised by stimulating the beneficial bacteria with the use of heat stable spore forming probiotics.

As a last step the immune response of the animal can be optimised with β-1,3/1,6-glucans. By working via a total concept approach, nutritionists have the tools to work on sustainable animal production. ■