Three nutritional steps for growing healthy animals

Raising healthy animals with fewer antibiotics – this is the main challenge for animal husbandry in Europe. Consumers, retailers and authorities are clearly expressing this message. In some countries controlling measures have already been implemented. In other countries the discussions are just starting up. Overall the picture is clear that in the whole of Europe sustainable animal husbandry with controlled low usage of antibiotics will be mandatory in the foreseeable future.

A three-way nutritional approach of optimising amino acid patterns, stimulating gut flora and enhancing the immune system will help to minimise antibiotic use in farm animals.

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What steps can be taken to reach the objective of minimal antibiotic use in farm animals? It is clear that it will not be simply replacing antibiotics by one single alternative. To reach the goal farmers will have to work on a multi factorial approach, like farm management, climate, hygiene, etc. Nutrition plays an important part in this approach. Several steps can be taken to increase the health of the animals through nutrition and here three important steps are described: reducing undigested protein, optimising gut health and improving the animal's immunity. In the northern part of Europe these items might sound like an open door; moving south, these subjects have just surfaced among nutritionists.

Step 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 number 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 may result in an imbalance of the microflora which leads to digestive disorders like diarrhoea. On the one hand we want to provide high amounts of protein to the animal for optimal performance, but on the other hand we need a low level 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 most relevant 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 vs. poultry) and per stage of life (piglets vs. growers/finishers). Recently 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. Amino acids in the diet are supplied via protein raw materials and feed grade

Table 1 – Ideal amino acid profile for piglet feeds.

Amino acid	Standardised ileal digestibility (as % of Lysine)	
Lysine	100	Feed grade amino acids
Methionine + Cystine	60	Feed grade amino acids
Threonine	65	Feed grade amino acids
Tryptophan	22	Feed grade amino acids
Valine	70	Feed grade amino acids
Isoleucine	53	From raw materials = crude protein
Leucine	100	From raw materials = crude protein
Histidine	32	From raw materials = crude protein
Phenylalanine + Tyrosine	95	From raw materials = crude protein
Arginine	42	From raw materials = crude protein

Source: Ajinomoto Eurolysine

Table 2 – Host - microbiota relationships.

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

Table 3 – Effect of antibiotic (100 ppm ASP-250, chlortetracycline, penicillin, sulfamethazine) and probiotic (Calsporin) treatment on bacterial counts and faecal score of piglets.

	Control	Antibiotics	Calsporin
E. coli			
Ileum	7,20	6,61	6,70
Colon	7,57	6,90	6,79
Lactic acid bacteria			
Ileum	7,88	6,63	8,79
Colon	9,67	7.87[a]	10.02[b]
	Control	**Antibiotics**	**Calsporin**
Faecal score			
6 hours postinfection	1,55	1,33	0,89
24 hours postinfection	1.31[a]	0.47[b]	0.34[b]
72 hous postinfection	1,39	1,13	0,83
Mortality	6/18[a]	0/18[b]	2/18[b]

amino acids. Currently the first five limiting amino acids (lysine, threonine, methionine, tryptophan and valine) are 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. *Table 1* shows an ideal amino acid profile in the feed for piglets following the latest results from amino acid dose-response trials.

It is important to formulate a diet which covers the requirement for each amino acid, but without oversupplying the animals' requirements, so no shortage and no surplus. With the current knowledge of requirements of all these amino acids we can formulate a diet with a lower crude protein level (lower level of undigested protein), while keeping the same or even better animal performance.

Step 2: Gut health, optimising 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 – symbiotic, commensal or pathogenic (see *Table 2*). For an optimal microbiota we aim to lower the number of pathogenic bacteria and to increase the number of beneficial bacteria (symbionts). As described before, the undigested protein that reaches the large intestine is a substrate for the pathogenic bacteria. Therefore in a next step we have to work on measurements to control these pathogenic bacteria. For now antibiotics still play an important role in this; preventative outside Europe, 'curative' within EU. Different types of products could play a role as an alternative to antibioitcs. 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).

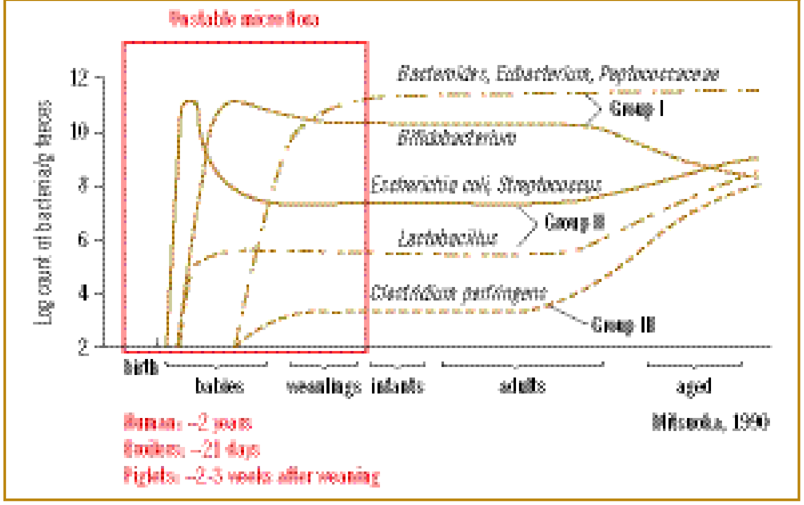
Take for example Lactobacilli that produce lactic acid, which lowers the pH in the gut and acts against pathogens. Thus, by stimulating the lactobacilli, the pathogenic ones will be reduced. This mechanism is also known as competitive exclusion. Stimulating beneficial bacteria can be done by probiotics, 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 tested 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 (*Table 3*, Bhandari, 2008) show that antibiotics lower numerically the amount of *E. coli*, but 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 improved faeces score and lower mortality. The final results in terms of health (diarrhoea, mortality) of antibiotic and probiotic treatment were the same, but the way how this was

Piglets need about three weeks after weaning to develop their intestinal microflora.

Figure 1 – Establishment of intestinal microflora in time.



achieved differed significantly. Antibiotics clean the gut by reducing both negative as well as positive bacteria. Probiotics stimulate the beneficial bacteria and help to suppress the negative ones.
The microbiota is established in the first stage of life (*Figure 1*). In the first period after birth, this microbiota has to develop and is rather unstable. In pigs, this period of unstable microbiota takes about two to three weeks after weaning and in broilers around three weeks. Probiotics stimulate the development of beneficial lactobacilli and help to reach a stable microbiota more efficiently. Also after an (sometimes unavoidable) antibiotic treatment, probiotics assist in building up the microbiota again.

Step 3: Immunity enhancement

As a third step, the immunity of the animal itself could be supported. With an optimised immune response the animal is better protected to 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* for example enters the piglet partly via the gut, but also partly via nose-nose contact and ear biting. By only working on gut health and fighting pathogens in the gut, the pathogen is not always successfully eliminated.
From a nutritional point of view the use of beta-glucans in the feed might support immunity building. Beta-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 beta-1,3/1,6-glucan. Normal yeasts, yeast cultures or complete yeast cell wall products do not have the capacity to stimulate immune response.
MacroGard is the most researched beta-1,3/1,6-glucan. This product has been investigated intensively and has proven to be very efficient in *in vitro* trials and in animal trials with pigs, poultry, pets and fish.
In a recent trial it was demonstrated that piglets can be protected against an *E. coli* challenge, by feeding them MacroGard (Stuyven, 2009). The piglets that received the beta-glucan in the diet had a higher local immune response in the gut, which protected the piglets. The bacteria did not infect the piglets. No *E. coli* was found back in the faeces and the piglets 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.
From analysing the above we can state that nutrition is an important tool in the total approach of reducing 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. AAF

Healthy animals, fewer antibiotics

By working via a total concept approach, nutritionists have the tools to work on sustainable animal production with less antibiotic use. The nutritional pathway consists of three steps:

1. Control crude protein level
   a. Minimise indigested protein
   b. Ideal amino acid profile
   c. Feed grade amino acids and high digestible raw materials
2. Optimise gut health
   a. Suppress pathogens
   b. Optimise microflora
3. Stimulate immunity
   a. Health status at animal level
   b. Immune modulation