**The use of antibiotics as growth promotants (AGP) was not only banned in the EU in 2006, but also the use of therapeutic antibiotics is more and more under pressure. An expansion of this policy can undoubtedly be expected in Asia sooner rather than later. With a continuous focus on improving sow fertility and better growth rate and feed conversion in piglets and fattening pigs, pressure on gut health becomes immense. Several non-antibiotic, plant-derived antimicrobial substances have been proposed as promising alternatives for AGP. WOUTER NAEYAERT* reviews the use of medium chain fatty acids (MCFA) as potential alternatives to AGP.**

# MCFA as an alternative to antibiotic growth promotants

The use of free (i.e. not coated, micro-encapsulated or esterified as mono-, di-, or triglycerides) MCFA as a pig functional feed ingredient (FFI) is an effective way to overcome the stressors faced by the current pig industry. MCFA are saturated fatty acids consisting of aliphatic tails of total chain length of either 6 (caproic acid), 8 (caprylic acid), 10 (capric acid) or 12 (lauric acid) carbon atoms and a polar head. They are known to exert lots of beneficial effects along the gastro-intestinal tract (GIT) of pigs, both on pathogen level, as well as on host level.

## MCFA - mode of action

Un-dissociated MCFA are capable of penetrating the phospholipid bilayer of bacterial cells, thereby destabilizing the cell membrane. This results in leaking of bacterial cell content on the one hand and entering of MCFA in the bacterial cells on the other hand. Once inside the cell the MCFA's dissociate, which results in the accumulation of protons and dissociated MCFA molecules. The protons cause intracellular acidification, and eventually killing of the bacteria. Dissociated MCFA's will intercalate with the bacterial DNA, thereby inhibiting DNA replication and thus bacterial growth. Free MCFA provide an early pathogen barrier in the stomach of the animal. This is an advantage over MCFA esterified mono, di- and triglycerides, which are only active in the intestinal tract after endogenous lipase releases the free MCFA molecules.

MCFA also inhibit the production of lipases by the bacterium. As lipases are needed to allow bacteria to attach to the intestinal wall, this process will be prevented and the bacteria will be washed out.

Next to a specific anti-bacterial action, MCFA will have a suppressing effect on the virulence of pathogens at small intestinal level. In this way, MCFA are able to decrease the risk for pathogenic virulence.

*Lactobacillus* is much more resistant to MCFA thanks to its very specific membrane. This makes that the beneficial microbial system of the gut will be largely unaffected. The addition of Aromabiotic to the diet

**Table 1: Effect of MCFA on intestinal villus morphology in the ileum of pigs.**

| | Control | MCFA |
|---|---|---|
| Villi (µm) | 529 | 582 |
| Villi/Crypts | 1.57 | 1.66 |

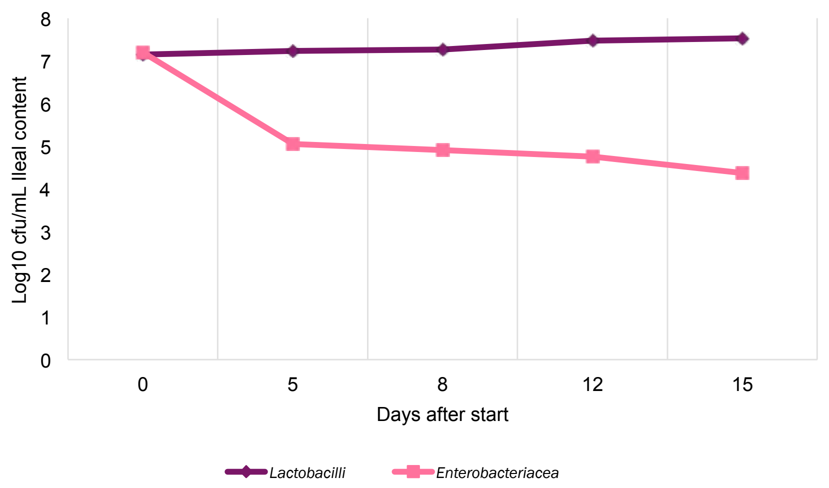
No proof of significance due to the small number of repetitions.

Table 2: Effect of MCFA (Aromabiotic MCFA) on veterinary treatments in piglets after weaning (8-20 kg).

| | Negative control | AMGP | Aromabiotic | Significance |
|---|---|---|---|---|
| Amount of pigs | 220 | 220 | 190 | |
| Number of animals treated with antibiotics | 26 | 23 | 13 | n.s. |
| Reason of treatment; | | | | |
| Streptococcus infections | 5 | 2 | 1 | a |
| Pulmonary disorders | 7 | 7 | 0 | * |
| Digestive disorders | 5 | 0 | 1 | a |
| Leg problems | 8 | 12 | 10 | n.s. |
| Others | 1 | 2 | 1 | a |

n.s. = not significant, * = significant, a = numbers too low to test significance

Figure 1: Microbiology in weaned piglets with Aromabiotic.




of weaned pigs reduced the number of *Enterobacteriaceae*, without affecting the population of beneficial *Lactobacilli* in the ileum of piglets (Figure 1). A healthy microbiota is important to maintain the pigs gut health, thereby improving the health, feed intake and digestion.

The combination of these antibacterial actions will eventually result in;

• growth inhibition and killing of bacterial pathogens in the stomach

• reduced virulence of surviving pathogens in the intestine

• a largely unaffected beneficial microbial ecosystem (e.g. acid-tolerant *Lactobacilli*)

## MCFA - increasing zootechnical performances

In comparison with Long Chain Fatty Acids (LCFA), MCFA provide the body cells with a quicker and more efficient source of energy. In the gut, this energy is used by the crypts to create new intestinal epithelial cells (IEC), which migrate towards the top of the villi resulting in an increased villus height. Next to directly increasing the number of live IEC, MCFA indirectly reduce pathogen-induced IEC cell death by lowering the infection pressure in the intestinal lumen (due to an antibacterial effect more upstream in the GIT, see above). Less renewal of epithelial villi cells is therefore necessary, meaning a sparing of energy for growth of the animal. An increased villus height is related to more fully mature enterocytes. Therefore, the increase in villus/crypt ratio that is accomplished by MCFA (Table 1) favours the digestive and absorptive capacities of the small intestine such as nutrient absorption and working of GIT enzymes, and thus ensures a better gut health.

Next to being absorbed by the intestinal epithelium, MCFA are accumulated in inflammation cells. This results in decreased inflammation, which is an energy-demanding process. MCFA's therefore lead to lower energy losses by improving immunity. The combination of these beneficial effects of MCFA on intestinal morphology and immunity of the host will eventually lead to an increased zootechnical performance - higher growth rate and better feed conversion ratio of pigs.

## MCFA as functional feed ingredient

Due to their unsaturated and antibacterial nature, MCFA are both chemically and microbiologically stable in feed. Next to being heat-stable compounds, this ensures a good shelf-life during storage of feed, which is of utmost importance in case of long transports and warm storage conditions. The use of carefully balanced mixtures of all four MCFA (Aromabiotic MCFA) will result in highly synergistic effects and a broad-range mode of action, ensuring an effective wide-spread use as FFI in sows, piglets and fattening pigs

## Piglets

MCFA reduce the numbers of opportunistic pathogens, hereby reducing the risk of dysbiosis in piglets. This results in an improved health status, a reduced incidence of diarrhea, less *Streptococcus* infections, a lower antibiotic use and less mortality (Table 2).

MCFA are also a very good energy source for epithelial cells, thereby preventing villus degeneration in piglets after weaning. This beneficial effect, together with the improved gut health eventually ensure an improved growth rate and feed conversion ratio (Figure 2). Aromabiotic can thus be considered as a valuable feed ingredient to replace in-feed antibiotics, resulting in an increased economic profit.

## Fattening pigs

MCFA are highly antimicrobial

Figure 2: Effect of Aromabiotic on growth performance of piglets after weaning in different trials.

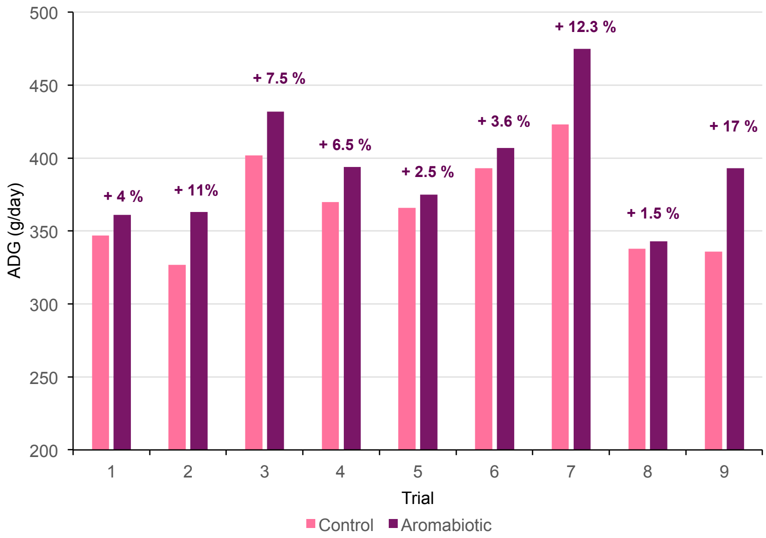



Table 3: Effect of MCFA (Aromabiotic MCFA) on the performances of growing and fattening pigs.

| | Control | MCFA |
|---|---|---|
| Amount of pigs | 373 | 375 |
| Weight at start (kg) | 26.9 | 26.9 |
| Weight at slaughter (kg) | 118.5 | 118.9 |
| ADG (g/day) | 815 | 820 |
| FCR | 2.61 | 2.57 |
| Mortality (%) | 2.4 | 1.6 |

No proof of significance due to the small number of repetitions.

against different pathogens like *Salmonella*, *Clostridium* and *Brachyspira*. Next to an antibacterial effect, MCFA supplementation results in an increased absorptive capacity of the intestines. Therefore, MCFA induce an increased availability of nutrients for growth. In conclusion the use of MCFA improves the health, growth and feed conversion of fattening pigs (Table 3).

## Sows

As in piglets and fattening pigs, MCFA improve the intestinal health of sows. A healthy intestinal tract is the most important factor to ensure a high feed intake and a good milk production, in this way improving fertility of the sow and piglet performances. Next to this the use of MCFA in the feed of the sow decreases the infection pressure of *Clostridium*, *E. coli* and *Streptococcus* suis. In this way the transfer of these pathogens from the sow to the piglets can be reduced, improving piglet health by sow nutrition.

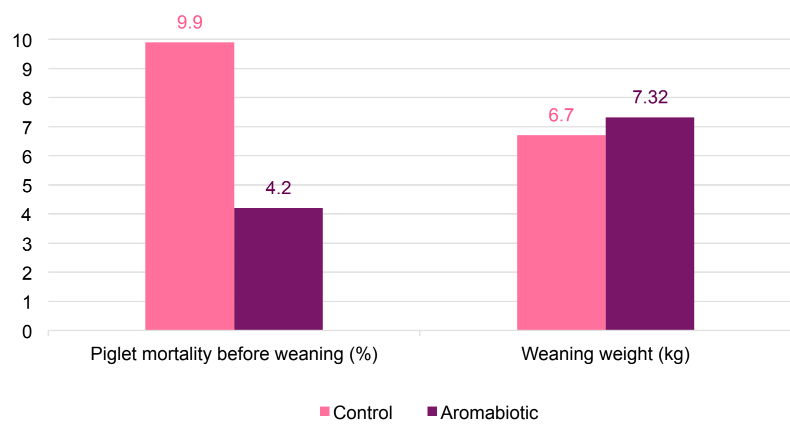
Furthermore, MCFA can increase the energy available for newborn piglets, by increasing the glycogen reserves in piglets. MCFA can also exert a bioactive effect on mammary glands and thus increase the colostrum production of sows. These properties reduce the pre-weaning mortality in piglets, while improving their performances (Figure 3).

## Conclusion

Modern pigs possess an enormous genetic potential which cannot be met by standard nutrition alone. Moreover, the reduced use of antibiotics, or increased societal demands to do so in the future, creates the need for reliable and scientifically proven alternatives. This makes the use of FFI indispensable to the pig industry. MCFA have been shown to exert a wide range of beneficial activities in pigs, both *in vitro* and *in-vivo* trials, at pathogen and on host levels, aiding in reaching the full genetic potential of these animals. The use of Aromabiotic MCFA can result in improved performances, combined with a lower mortality and antibiotic use. *AP*

**Wouter Naeyaert (Wouter.Naeyaert@nusciencegroup.com) is Product Manager - Pigs for Nuscience Group, Belgium.*

Figure 3: Mortality and weaning weight of piglets of sows fed with MCFA during lactation.




*No proof of significance because the number of sows and their piglets participating in the trial where low.*