Coconut oil: A new option for controlling pig pathogens

There is a wide range of bacteria that could affect a piglet's gut around weaning. Applying medium-chain fatty acids in piglet diets can help improve performance and health. And where to extract these from? From coconut oil…

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Weaning is the most critical phase for piglets, the stress due to the separation of piglets from their mother, the mix of different litters, new environment and the change in the diets, from a liquid milk to a solid feed, is usually associated with low and variable feed intake that results in a transient growth check. There are marked changes in small intestine histology and biochemistry, such as villous atrophy and crypt hyperplasia, which cause decreased digestive and absorptive capacity and contribute to post-weaning diarrhoea, impaired immune re-activity, altered composition of the intestinal microbiota and ultimately result in a reduced weight gain and animals are more vulnerable to infections.

Since the ban on the use of antibiotics as growth promoters in 2006, due to concern about the feed safety and the development of antibiotic-resistant pathogens, animal nutritionists are highly interested in active and non-medicated nutritional alternatives for optimising the weaning transition and minimising enteric diseases. Several alternatives have been proposed: enzymes, probiotics, prebiotics, phytogenic agents, and organic acids, some of which, alone or in combination, clearly contribute to animal health, mostly through acidification of the gastrointestinal tract (GIT) environment and/or control of potentially-pathogenic bacteria.

Concretely, the administration of medium-chain fatty acids (MCFAs) appears to provide a promising approach to reduce negative effects associated with the post-weaning phase in piglets. MCFAs may serve as an alternative, non-antibiotic approach to improve performance and health.

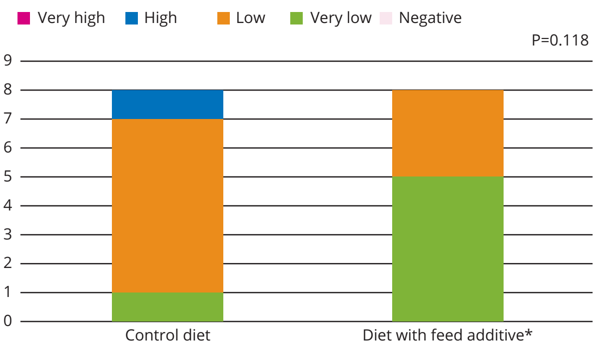
Medium-chain fatty acids (MCFAs)

MCFAs are a family of saturated fatty acids that includes caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0) and lauric acid (C12:0).

MCFAs are naturally present as parts of triglycerides in various vegetable fats/oils, particularly, coconut and palm. Typically, MCFA content in coconut oil is high; of the oil fraction 3.4-15% is composed of caprylic acid, 3.2-15% of capric acid and 41-56% of lauric acid. High contents of caprylic (2.4-6.2%), capric (2.6-7.0%) and lauric acid (41-55%) can also be found in palm kernel oil.

MCFAs are mainly considered as anionic surfactants, which, because of this property, have antibacterial effects. Membrane destabilisation by the incorporation of MCFAs into the bacterial cell wall and cytoplasmic membrane, as well as the inhibition of bacterial lipases, which are necessary for the colonisation of the skin and the intestinal mucosa, may be the cardinal mechanisms. Besides the direct lytic effects of MCFAs, the activation of bacterial autolytic enzymes might also play a role in the activity against pathogens. Alternatively, the uptake of undissociated fatty acids into the bacterial cell appears to have cytotoxic effects. The MCFAs are dissociated into protons and anions in the basic cytoplasm of the cell, decreasing the pH. Cytoplasmic enzymes are inactivated as a result, leading to the death of the bacterial cell. Antimicrobial properties of and MCFAs have

Figure 1 - Semi-quantitative caecal counts (CFU/g) of *Salmonella* Typhimurium on day 8 after the oral challenge. Group size: 8 animals per treatment.



** Dicosan, Norel.*

been described as well as protective effects on the intestinal microarchitecture, based on studies in pigs. MCFAs have also been suggested to have immune-modulating effects but evidence from the pig is lacking.

Lauric acid

Lauric acid is the primary fatty acid of coconut oil, which is present at approximately 45-53% of the overall fatty acid composition. The properties of coconut oil can indeed be attributable to the properties of lauric acid.
Lauric acid has the strongest antimicrobial activity among all saturated fatty acids against gram-positive bacteria and some viruses and fungi. The following gram-positive organisms were tested in an in vitro study where lauric acid showed the strongest inhibitory effect among the saturated fatty acids: *Staphylococcus aureus*, *S. epidermidis*, beta-hemolytic streptococci (group A and non-group A), group D *streptococcus*, *Bacillus subitilis*, *Sarcina lutea*, *Micrococcus sp*., *Nocardia asteroids*, *Corynebacterium sp*., *Pneumococcus* and also *Candida albicans*. With respect to *Clostridium perfringens*, lauric acid showed the highest antimicrobial activity, followed by myristic, capric, oleic and caprylic acid.

Effectiveness controlling pathogenic bacteria

One study was performed in order to evaluate the effect of sodium salts of distilled coconut fatty acids in case of an oral challenge with *Salmonella* Typhimurium in weaned piglets.
A total of 48 piglets of 28 days old were randomly divided into two experimental groups with eight replicates each (three animals per replica):

- **Diet 1**: Piglets were fed *ad libitum* with basal diet without ingredients; and
- **Diet 2**: Piglets were fed *ad libitum* with basal diet containing 3 kg of sodium salts of distilled coconut fatty acids/tonne of feed.

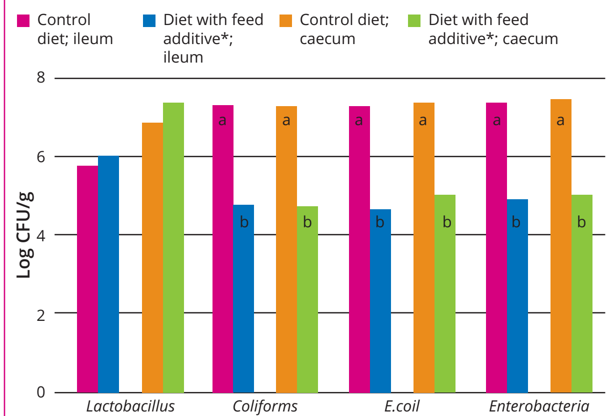
After one week of adaptation period, the animals were orally challenged with *Salmonella* Typhimurium (1.2×10^8 CFU/animal). After inoculation, feed intake and body weight were monitored along the experiment. Faecal consistency and rectal temperature (before and two days post inoculation) were evaluated. One piglet per pen was euthanised on days 4 and 8 post-inoculation, and caecal content was sampled to carry out *Salmonella* counts.
During the experimental period, no significant differences were observed in productive parameters, faecal consistency or rectal temperature. The number of negative animals to *Salmonella* in caecal content tended to be higher in the group of animals receiving Diet 2 on day 4 post-inoculation and that trend reached statistical significance at day 8 post-inoculation. The semi-quantitative analysis of *Salmonella* in positive samples revealed that the number of the bacteria also tended to decrease in the group receiving Diet 2 (*Figure 1*).

Table 1 – Effect of sodium salts of distilled coconut fatty acids* on performance in piglets.

	Initial body weight (kg)	Final body weight (kg)	ADG (g/d)	ADFI (g/d)	FCR (g/g)
Diet 1	7.07	8.96	134	237	2.32
Diet 2	7.07	9.95	197	261	1.35
SEM	0.159	0.823	65.8	40.0	0.820
P	0.9679	0.0777	0.1452	0.3562	0.0810

* Dicosan, Norel.

Figure 2 - Effect of diet 2 on ileum and caecum gut microbial population of piglets at 35 days.



* Dicosan, Norel.
a,b Different letter means statistical differences (p<0.05)

Improvement of performance and gut health

Another study was performed aiming to evaluate the effect of sodium salts of distilled coconut fatty acids on performance and gut microflora in piglets.
A total of 48 piglets weaned at 21 days old (7.1 ± 0.15 kg) were randomly divided into two groups with six replicates each (four animals per replica):

- **Diet 1**: Basal diet without ingredients; and
- **Diet 2**: Basal diet with 3 kg of sodium salts of distilled coconut fatty acids/tonne during two weeks (21-35 days).

Mash feed and water were offered *ad libitum*. At the end of the trial body weight (BW), average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) were recorded, and one piglet per replica was euthanised, and samples from ileum and caecum were taken to analyse gut microflora.
In comparison to Diet 1, piglets receiving Diet 2 tended to be 11% heavier and showed an improvement in FCR (1.35 vs 2.32). Moreover, the group receiving Diet 2 had numerically higher ADG (+63 g/d) and ADFI (+24 g/d) than Diet 1, also see *Table 1*. Delivering Diet 2 significantly reduced the count of coliforms, *E. coli* and *Enterobacteria* in ileum and caecum (*Figure 2*).

Conclusions

It can be concluded that the use of sodium salts of distilled coconut fatty acids at 3 kg/tonne of feed may be able to reduce the colon colonisation of *Salmonella* in piglets orally challenged with a pathogenic strain of the bacterium and may be able to improve productive parameters in piglets and induce a favourable effect on gut health, modulating intestinal bacteria.

References available on request.