Strengthening the piglet microbiome for gut health and performance

The animal production industry is under increasing pressure to develop ever more refined methods to produce animal protein, in more sustainable, and cost-effective ways. This is not only in order to provide food for today, but to set up sustainable and ethical systems for future generations. The use of feed additives to achieve these goals is becoming ever more important as both legislation, as well as consumer focus, requires our current precision nutrition, to be even more precise.

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A new strain of yeast was isolated from the exotic mangosteen fruit.

Whilst it is unlikely that additives such as enzymes will provide many further large steps as they initially did. As nutritionists we are now looking to support healthy animals' growth, rather than just blindly aim for bigger, faster and cheaper.

With 70% of an animal's immune response being within the gastrointestinal tract (GIT), and responsible for some of the largest production losses, gut health is a topic we are all focusing on. Within the GIT resides a diverse population of bacteria known as the microbiota or microbiome; this population is becoming better understood to have a key position in a healthy immune system.

One of the microbiome's functions is to assist in the resistance of pathogens, whilst, as reported below, also assisting in facilitating nutrient absorption by the production of short chain fatty acids, or providing a favourable environment by producing lactic acid.

With each year of research, the importance of maintaining a positive homeostatic balance within the host of this microbiome is becoming more and more apparent in high welfare production.

It is currently understood that piglets that go on to develop post-weaning diarrhoea, have very distinct and reduced microbiota profiles, which is somewhat to be expected when a cascade of E. coli takes hold.

Two strains of the genus Prevotella and Roseburia have in recent years been highlighted to be in higher prevalence in healthy animals. These strains have also been shown to be significant in the positive effect of increasing gut health and assisting in the reduction of post-weaning diarrhoea, alongside the well documented effects of Lactobacillus populations.

In a recently published study by Pathway Intermediates, in Animals 2021, Dietary Yeast Cell Wall Improves Growth Performance in Piglets, we can observe both the importance of a dynamic microbiome, and how supplementation of yeast cell walls can be beneficial in gut health and many of the modern metrics of success.

Further supporting research into both Prevotella and Roseburia populations, reinforce the findings such as, Microorganisms 2020, Prevotella in Pigs.

With their yeast cell wall product from Saccharomyces boulardii, Pathway Intermediates investigated piglet growth performance, nutrient digestibility, immune responses, intestinal health and the microbiome. 112 weaned piglets of 7.99kg (± 1.1kg) at 28 days were randomly allocated into two experimental groups. Each group was then split into eight pigs per pen.

A control diet containing corn and soybean meal with whey powder, providing 21.69% crude protein (CP) and 1.55% total lysine, was produced. The control diet (CON) and CON plus 0.05% yeast cell wall (YCW) was fed for a period of four weeks.

Benefits to growth performance and a reduction in diarrhoea

During the study, body weights and feed intake were individually recorded every seven days, and each piglet was observed for

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Fig. 1. Frequency of diarrhoea over the test period when fed CON or YCW (0.05% YU product) diets.

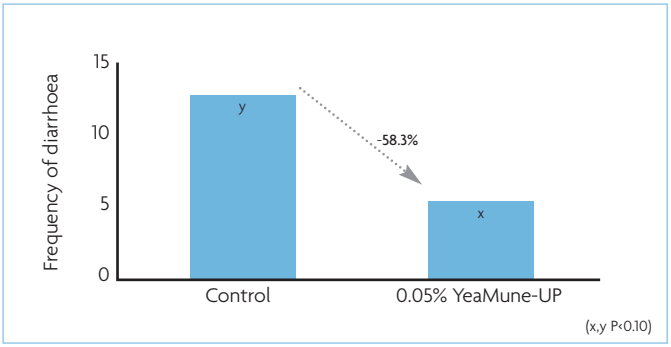
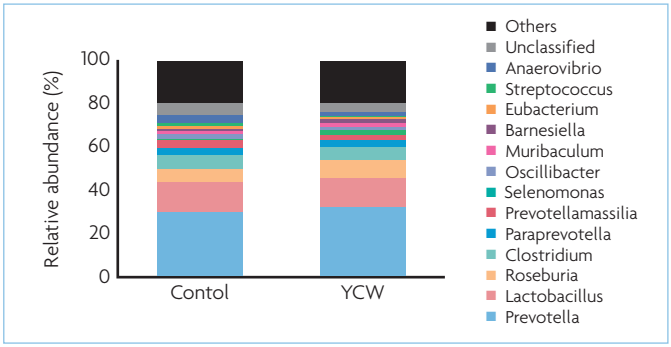


Fig. 2. Dietary supplementation of YCW indicates a positive response in Prevotella, Lactobacillus and Roseburia populations.



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diarrhoea and its score recorded. Whilst it was noted that there was no statistically significant effect on feed intake, YCW diets were observed to increase average daily gain (ADG) throughout. Over the 28 day period, an average of 27g/d increase was observed, from 421g/d to 448g/d. Perhaps more importantly in the focus of the study, YCW diets reduced the occurrence of diarrhoea from 12% down to 5% over the first 14 days, as can be observed in Fig. 1.

Investigations into nutrient digestibility

During the final week of the study a non-digestible indicator (0.2% Cr_2O_3) was added to all diets to assist in confirming nutrient uptake. Samples from dietary, ileal digesta, and excreta, were collected and analysed for dry matter (DM), CP, and energy. Utilising an absorption spectrophotometer to detect chromium concentrations, apparent total tract digestibility and apparent ileal digestibility were determined.

Pigs under the YCW diet indicated higher digestibility of DM and energy which was reflected in the higher ADG as reported earlier. The results of investigations into the genus Prevotella and Roseburia provide some explanation as to why this could be the case.

Microbiota analysis

Three pigs from each treatment group had faecal samples collected at day 35. Genomic sampling was conducted by Macrogen Inc and a table of taxonomic units was produced from an operational taxonomic unit cut-off at 97% (see Fig. 2). Most notably the abundance of Prevotella and Roseburia have been increased at the genus level.

Both these strains are linked to the production of intestinal short chain fatty acids, by the fermentation of indigestible polysaccharides. Their presence are strong indicators for both a positive environment for a healthy GIT, and allowing access to otherwise indigestible nutrients.

Effect on the small intestine

Intestinal morphology was reported on day 28 by fixing tissue samples, staining with haematoxylin and eosin, then observing under fluorescence microscopy. The metrics reported were villus height, crypt depth and their ratio, plus goblet cell counts.

Diets containing YCW showed the villus height to crypt depth ratio, and numbers of goblet cells increased indicating a healthier and more efficient small intestine. It is well documented that under a poor microbiome, villus stunting and burning are often observed.

Could an effect on the immune system be observed?

On days 0, 7 and 14 after weaning, blood samples of one pig per pen were collected and analysed for white blood cell counts (WBC).

At the same time, serum samples were also analysed for recognised cytokines such as cortisol, tumour necrosis factor-α (TNF-α), transforming growth factor-β1 (TGF-β1), interleukin-1β (IL-1β), and interleukin-6 (IL-6).

Expression of these typical pro-inflammatory cytokines, TNF-α, IFN-γ, IL-β1, IL-6, and TGF-β1, is a clear sign of an immune response.

It is worth noting that throughout the study the YCW diet showed a lower expression of all precursors, apart from TNF-α, indicating that a more positive environment was achieved.

Further reinforcing that a supportive effect was observed, was the lower WBC in the YCW group throughout.

For example, on day 14, piglets on the CON diets had 21.81 x $10^3/\mu L$ compared to 16.95 x $10^3/\mu L$ in the YCW.

In conclusion, supplementation with dietary YCW can result in some significant improvements in commercial performance metrics. This will not only show a boost to ADG and a reduction in diarrhoea, but can also help in the drive to support the healthy immune system. ■