Precise microbiome modulation: a new era in microbiome research

Imagine watching an orchestra: you are interested in the music produced by the musicians together, not what each individual is playing.

Recent research suggests that we should look at the microbiome like that orchestra, focusing on what all the microbes are producing together, as a symphony, and how it benefits its animal host.

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With this idea in mind, and with the development of more advanced technologies in microbiome research, it is time to change the paradigm: instead of focusing only on which bacteria are present in a microbial community, it is imperative that we also examine what they are doing as a group.

In doing this we consider one of the most important characteristics of the microbiome, cooperation, and how micro-organisms interact with each other.

In the Human Microbiome Project, it became clear that the functions performed by all the bacteria together are far less dependent on the presence or absence of single microbes than previously thought. This functional view of the microbiome provides opportunities to explore what the micro-organisms are doing and how the end products of their metabolism benefit the host.

Indeed, a large portion of substances in the bloodstream of animals originate from the intestinal microbes, and these are key when linking physiological processes (for example digestion and fermentation) with health and welfare.

Modulating the functions of the microbiome by adding nutrients or feed additives brings new opportunities to harness the full potential of the microbiome.

Modulating the microbiome with precision biotics

Precision biotics (PB), a new category of nutritional feed additives, are being developed to leverage the recent advances in microbiome sciences and to cope with challenges faced by the poultry industry. The mechanism of action employed by PBs is different from that of prebiotics or other conventional gut-health products.

Precision biotics are carbohydrates with glycosidic linkages and size distributions selected specifically for their ability to modulate intestinal microbiome pathways. In other words, it is a very precise conductor of the microbiome that brings overall harmony to the gut. For instance, our specifically selected PB (Symphiome, DSM Nutritional Products) increases the number of genes associated with protein and amino acid metabolism and short-chain fatty acid production, which reduces intestinal ammonia production.

In studies, the result was an improvement observed in litter quality and welfare indicators, such as foot pad dermatitis.

A publication from Walsh et al. (2021) reported that our PB modulated the functions of the caecal microbiome related to propionic acid production and nitrogen metabolism.

A publication by Jacquier et al. (2022), comprising two studies of broiler chicken studies raised in floor pens to evaluate the effect of our PB, showed that PB supplementation improved litter score, ammonia output and gait score.

As a consequence of improved welfare and gas emission indicators, the PB improved body weight gain (BWG) by 44g on day 35 and feed conversion ratio (FCR) by 11.4 points. In the second study, BWG was improved by 112g, and FCR by 4.7 points.

Mechanism of action of precision biotics

Precision biotics are microbiome metabolic modulators that conduct bacterial functions, encouraging the production of substances that promote beneficial outcomes to the animal. The high quality research conducted to understand the exact mechanism of action of PBs has demonstrated that it increases metabolic functions intrinsic to the microbiome that are able to detoxify unabsorbed amino acids and leaked host protein, independent of the microbiota composition.

This leads to higher resilience to enteric stress, better nutrient utilisation, improved welfare and reduced emissions.

Similar to its host, the microbiome possesses a metabolism that can be modulated in specific ways. For example, being able to positively alter the protein metabolism of microbes would lead to an enhanced production of beneficial substances, such as branched and short-chain fatty acids, and polyamines.

On the other hand, suppressing undesirable functions of the bacteria can reduce ammonia/ammonium production and emission, and reduce the generation of skatole and other indoles that increase luminal pH, cause epithelial damage and negatively impact litter quality and welfare, among other negative effects.

We have demonstrated that our PB consistently shifts overall microbial metabolism (Fig. 1A), by increasing the abundance of beneficial pathways and

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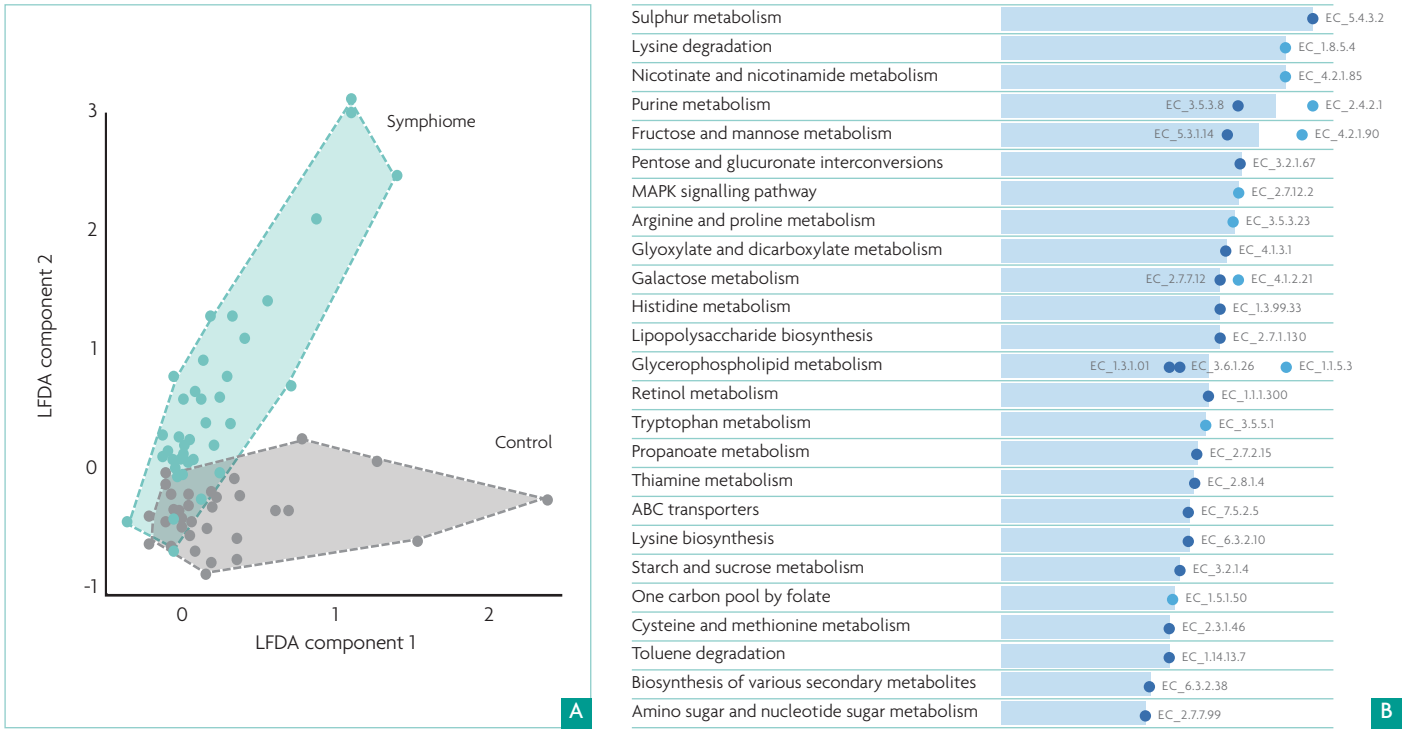

Fig. 1. Overall microbiome metabolism shift promoted by Symphiome (A), and abundance of pathways changed with Symphiome relative to control (B).

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decreasing the abundance of putrefactive pathways (Fig. 1B).

It is essential to understand that it is not protein fermentation in general that is a concern, but specific functions of bacterial protein fermentation. Being able to specifically reduce these undesirable functions is important in poultry production.

Increasing nitrogen metabolism and the conversion of ammonia into amino acids can influence the total amount of nitrogen and ammonia excreted, with the amino acids potentially used to build microbial protein. Decreasing nitrogen and ammonia secretions can help lower producers' environmental impact.

Final considerations

Enteric bacterial infections are one consequence of modern intensive animal production, and can lead to major financial losses and increase the risk of foodborne illness from bacterial contamination of meat and meat products.

However, influencing the functions of the microbiome that can lead to higher utilisation of nitrogen, and lower production of undesirable products may be a viable approach to mitigate intestinal issues. The increased production of propionic and butyric acids by the bacteria may be another mechanism by which precision biotics act on the host and support nutrient use. By modulating what bacteria produce in the intestines of chickens, we can support performance and welfare and deliver more consistent results for producers. ■