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Focus on gut health growing

Research findings present many potential opportunities for the discovery and development of novel management strategies for improving the efficiency of food production worldwide.

By **EMMA WALL***

THE optimization of animal health and nutrient utilization is a key component of improving the production efficiency of agricultural animals, and with the recent and projected increases in demand for animal products, large efforts have been made to identify novel ways to increase the efficiency of food production.

Scientists are focusing on new potential targets of feed additives to improve animal health and nutrient absorption. For example, a new emphasis has been placed on the gut of the animal and, in particular, gastrointestinal health, which can influence animal development, health and susceptibility to disease and nutrient metabolism.

The second annual Pancosma Worldwide Scientific Exchange (PWSE2), held in December in Paris, France, covered the topic of gut health in great detail, especially as it relates to overall animal health, nutrient utilization and consequent production efficiency.

The two-day program discussed: the major roles of the gut and how it interacts with other organ systems to influence health and metabolism; feed additives and how they influence gut health and nutrient absorption, and current and future challenges for producers and scientists in agriculture.

More than digestion

One of the main PWSE2 themes was the emphasis on the gut as more than simply a digestive organ system. Research continues to reveal the importance of this organ system in regulating many processes, including those related to animal health and production efficiency.

The first session opened with a presentation by Marta Wlodarska, a doctoral student in Brett Finaly's laboratory at the University of British Columbia. They studied an animal model of colitis and found that the presence and distribution of bacteria in the gut have a major effect on susceptibility to disease. The bacterial population can be altered by the administration of antibiotics and also by feeding certain plant extracts.

Although this research is not directly relevant to production animals, it has clear implications for the prevention and possible treatment of diseases of the digestive tract.

Dr. Philippe Sansonetti from Paris, France, discussed interactions between the host and the bacterial population living in the gut — or so-called microbiota — that influence development, metabolism, disease susceptibility and more. He described a group of receptors called the Nod-like receptors, which are involved in the recognition of pathogens and act as "watchdogs" to detect danger signals that come from the pathogenic bacteria in the gut. These pathogenic bacteria can be distinguished by symbiotic bacteria because they disrupt homeostasis.

The microbiota is markedly influenced by changes in the diet. Research from Dr. Liping Zhao's laboratory in China has shown that the microbiota plays a symbiotic and protective role in people, but it can also produce toxins that may be linked to aging, diabetes and obesity.

Zhao introduced the concept of the gut microbiome representing the second genome, which plays a huge role in animal health and disease.

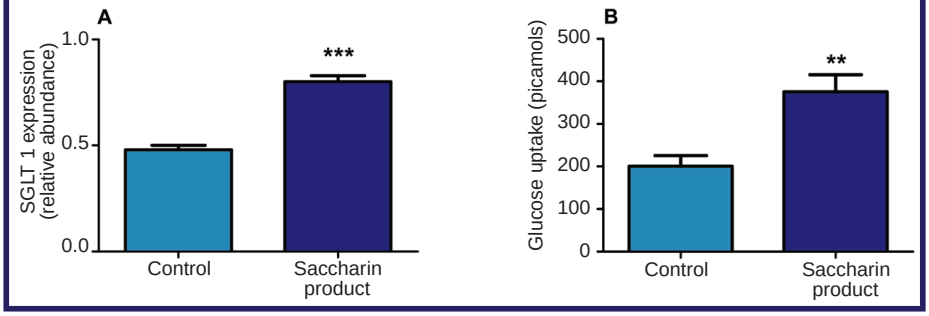
Animals are considered a walking bioreactor, and what they eat determines what types of microbes will survive in the gut. If survival of the wrong species is promoted — for example, during ingestion of high-fat diets or *ad libitum* feeding — lifespan is shortened, and health is compromised. These effects are reversible, however: Switching to a low-fat or restricted diet restores the original bacterial population.

Zhao emphasized the need to use strategies to keep the microbiota balanced to ensure a healthy and long life, and he also suggested that the microbiota might be used as a health diagnostic tool in both animals and humans since there are specific bacterial species associated with disease.

How does the gut know what types of food are being consumed? Recently, it was discovered that the gut has the ability to detect nutrients and even flavors on its own.

Dr. John Furness from the University of Melbourne explained that the gut is indeed a sensory organ and that nutrients and nutrient byproducts are detected by specific receptors in the intestines. These receptors have the ability to sense flavors

Expression of glucose transporter SGLT1 in the small intestine of piglets (A) and uptake of glucose by the gut (B)



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and nutrients, independent of taste in the mouth, and then send hormonal signals to other cells in the gut that will then elicit local and/or systemic responses. FURNESS described a fascinating example of nutrient-initiated modification of nutrient handling in which the presence of fat in the duodenum stimulates activity in the distal ileum, presumably to prepare it for the fat that will soon be coming its way.

His laboratory has also used an intragastric gavage with bitter mix, which stimulates an increase in feed intake, and the response is all mediated locally within the gut since the mouth is never exposed to the flavor.

There is clear potential to exploit these findings to improve animal production not only by increasing feed intake but also by improving the efficiency of nutrient digestion and utilization.

More than intake enhancers

Pancosma is a company that manufactures various feed additives, but it is mainly known for flavors and feed palatants. Pancosma's top product has been a sweetener called Sucram, which contains saccharin and has been shown to increase feed intake and weight gain, especially in weanling piglets and calves. It has largely been unknown how exactly the product works.

About five years ago, Pancosma teamed up with gut microbiologist Soraya Shirazi-Beechey from the University of Liverpool. Their collaborative research efforts have revealed that the saccharin product is far more than just a sweetener and enhancer of feed intake; it appears to actually increase the absorption of glucose in the gut.

At PWSE2, Shirazi-Beechey explained that there are receptors in the small intestine called taste receptor type-2 and type-3 that, when combined, have the ability to "taste" sweet flavors. Upon tasting sweet, these receptors induced the expression of the glucose transporter SGLT1 in the small intestine of piglets (Figure 1A), and this resulted in an increase in the uptake of glucose by the gut (Figure 1B).

This was observed when the saccharin product was added to either the feed or the drinking water, and the supplemented piglets also weighed more at weaning than their control littermates.

The expression of SGLT1 was also increased in the small intestine of calves fed milk replacer supplemented with the saccharin product, and this is now a new area of research.

Dr. Sergio Calsamiglia, a nutritionist from Spain, discussed the potential to increase the absorption of glucose in the small intestine of dairy cows. Although dairy cows are extremely efficient at absorbing glucose, most dietary glucose is fermented in the rumen, so there is very little available for the small intestine to absorb.

Research in Calsamiglia's laboratory is exploring the possibility that an increase in glucose absorption by the small intestine might decrease the incidence of ketosis in dairy cows and might also increase the protein content of milk. According to Calsamiglia, a product like the saccharin product — if protected from digestion in the rumen — has the potential to alleviate glucose deficiency in high-producing dairy cows.

More than food production

With the population steadily increasing and consequently increasing the demand for food and food security, it not surprising that challenges and potential strategies for increasing production efficiency were discussed at PWSE2.

Dr. Ercole Zerbini from Cargill talked about the importance of understanding the needs of various producers in different areas of the world with different management styles and challenges.

According to Zerbini, one of the biggest future challenges for agriculturalists will be to discover ways to produce food more efficiently and to create a balance so that intensive farming and optimal animal welfare can coexist. To accomplish this, it will be critical for agricultural scientists to appreciate the application of research findings.

Because the efficacy of most feed additives is influenced by the conditions in which they are used, it is also important to understand how they work and in which types of management systems they work best. It will be critical to continue to educate consumers as strategies are identified to increase production efficiency.

Novel strategies for improving the health and productivity of poultry animals were presented by Dr. Hyun Lillehoj, an immunologist from the U.S. Department of Agriculture who pointed out that many producers and consumers are pushing agriculturalists to get "back to basics," with a resulting increase in demand for all-natural or organically produced food products.

Many U.S. poultry producers use antibiotic growth promoters (AGPs), which Lillehoj predicts will be banned in the future (they have been banned in Europe since 2006). Therefore, there is currently great interest in identifying all-natural alternatives that promote animal health and growth.

One of the major diseases that devastates poultry farms is necrotic enteritis, but the use of AGPs has decreased the incidence considerably. As an immunologist, Lillehoj is focused on understanding how some essential oils might influence the immune system of poultry and elicit effects similar to those seen with AGPs.

Lillehoj's research laboratory has shown that cinnamaldehyde, the essential oil from cinnamon, has the ability to decrease the incidence and severity of necrotic enteritis in several poultry species. Birds supplemented with cinnamaldehyde in their diet lost less weight, had fewer lesions in the intestines and had a dampened inflammatory response compared to controls.

The mechanism is not totally clear, but it appears that cinnamaldehyde influences the species of bacteria in the gut, which alters the immune response of the animal when exposed to the disease.

Lillehoj continues to work on understanding how essential oils influence animal health, and she suggested that once the mechanisms are understood, essential oils can be used more effectively, and troubleshooting can be more efficient when no effects are observed.

Essential oils have also shown promise in promoting piglet health. Dr. James Pettigrew from the University of Illinois presented data showing that some plant extracts, including garlic, turmeric and capsicum, have the ability to decrease the inflammatory response to a challenge with *Escherichia coli* and also decrease the frequency and severity of diarrhea associated with infection. Furthermore, treatment with these plant extracts reduced the white blood cell count in the gut during infection and preserved the integrity of gut villi.

Feeding essential oils during a challenge with respiratory syncytial virus delayed the onset of the disease and also increased feed efficiency during infection. Importantly, Pettigrew's work has shown that some plant extracts can influence the susceptibility to/severity of both bacterial and viral infections, even when fed at very low doses.

Research by Dr. Alexander Hristov from The Pennsylvania State University explored the effect of essential oils on immunity in dairy cows. Results look promising, although more trials need to be done to confirm the effects.

Conclusion

In summary, research presented at PWSE2 consisted of a balanced mix of basic and applied science all aimed at understanding the roles the gut and gut health play in immunity, consequent animal health and production efficiency.

Research findings present many potential opportunities for the discovery and development of novel management strategies for improving the efficiency of food production worldwide. ■