Exploring the Farm Animal Gut Microbiome with Next-Generation Sequencing (NGS)

Porcinotec is the first private NGS service provider for researchers and companies focusing on Thailand's livestock market.

DR. LAMPET SANINJUK

CHIEF SCIENTIST
PORCINOTEC CO., LTD.

From swine to cattle, livestock are central to the global food system. These animals make up 40 percent[1] of the world's agricultural production and ~1.3 billion people around the planet depend on them for their livelihoods and food security. Because of this, livestock health is profoundly important to both individual farmers and everyone else who depends on it for food. The question, then, is how to keep these animals healthy and productive. Porcinotec, thinks that sequencing the gut microbiome can help.

The company, founded in Thailand in 2019, uses NGS to investigate animal gut microbiomes, with a special emphasis on livestock. It is the first NGS private service provider in Thailand's livestock market. Researchers and companies send Porcinotec samples, and the company uses 16S or whole genome sequencing (WGS) to analyze microbial genetic material in the samples. Porcinotec also provides technical help to interpret the genetic data for clients.

The company's chief scientist, Dr. Lampet Saninjuk, is a researcher who has years of experience in the characterization of microbial communities using NGS technology. The inspiration for Porcinotec came from seeing other researchers' need for NGS services particularly for the study of the gut microbiome. The company aims to expand its genomic services to support both research and applied work in the livestock market both domestically and internationally.

iCommunity spoke with Dr. Lampet about the NGS services that Porcinotec currently provides researchers and companies, her own research on the swine gut microbiome, how NGS can help combat antimicrobial resistance (AMR) in livestock, and how she and her team are trying to advance the field of livestock genomics by using NGS approaches.

"In the field of livestock management, Porcinotec may be the pioneer. The company mainly focuses on livestock, such as swine, cattle, chicken and aquaculture such as shrimp and fish. With Illumina's NGS technology, these services can be expanded to any animal where we would like to know more about the gut microbiome"

Q: What exactly does Porcinotec do?

Lampet Saninjuk (LS): Porcintotec was set up with the aim to provide advanced molecular techniques for sequencing animal gut microbiomes, and to use NGS for technical services. Many people want to investigate the animal's gut microbiome, but the problem is that not many companies provide NGS services to assist with it. In the field of livestock management, Porcinotec may be the pioneer. The company mainly focuses on livestock, such as swine, cattle, chicken and aquaculture such as shrimp and fish. With Illumina's NGS technology, these services can be expanded to any animal where we would like to know more about the gut microbiome.

So far, Porcinotec's focus is on researchers because they have specific questions they want answers for—for example, if they give an animal a product to eat, they might want to understand how that influences the gut microbiome dynamics in that animal. We have many researchers studying this area.

Q: What are Porcinotec's goals?

LS: The goal is to provide services that researchers and companies can use to enhance their gut microbiome research. We also give them the technical help to interpret and analyze the genetic data. Our company is a one-stop service. We also provide consulting solutions from the start to the end of the NGS workflow to help livestock producers prevent outbreaks of serious livestock infectious diseases.

Q: To what extent is the genomics approach being adopted in Thailand's agricultural space? Do you see a special need for it in the agricultural market?

LS: Yes, definitely. Many farmers are focusing on using fewer antimicrobial agents on their animals. Once they reduce or stop antimicrobial use in their animals, an alternative product for it will come to the market, such as probiotics, symbiotics, or postbiotics. So, researchers would like to know what will happen to the animal's gut microbiome after farmers use this kind of product or how the gut microbiome recovers after antimicrobial treatments with beneficial microbes. Because gut microbiota is a powerful tool to improve gut health. Without good gut health, the growth of healthy animals would be challenging.

Q: What genomic services does Porcinotec provide?

LS: So far, we provide 16S amplicon sequencing for samples. We can analyze feces, blood, and more. We've had customers send samples from swine, chickens, shrimp, fish, and cattle, and with the 16S service, we can identify the strain and the amount of bacteria in the sample. We also provide WGS[Δ] for pure culture bacteria because many researchers would like to know what is inside a bacteria's genome and the AMR[†] in that specific strain of bacteria. We are also planning to use the NGS platform to analyze AMR[†]; Illumina has a platform that can easily perform the metagenomics for AMR[†] for a whole population of bacteria. That is our next step.

Q: Who are the potential customers for Porcinotec's services?

LS: It's open to all. Right now, most of them are researchers from universities. They're the main priority. The second priority are companies with an R&D department. Animal feed companies are also our potential customers—there may be interest in the connection between what an animal consumes and what is inside an animal's gut that makes it grow faster. Other potential customers are companies that manufacture animal probiotics because when you give animals a probiotic, it's definitely going to change their gut microbiota.

Q: NGS is Porcinotec's method of choice, from 16S to WGS[Δ]. Why does NGS provide an advantage over traditional genomic methods?

LS: With NGS we can get several different answers in short period of time, and the price is permissible and comparable. For example, there are many strains of bacteria in the intestine and if you wanted to culture every strain of the bacteria, it might be not feasible because more than 90% of bacteria cannot be cultured. But with NGS, it's like a cross-section of what exists inside the gut. What species of bacteria are there? How do bacteria affect the host? And how much bacteria? The big data generated from NGS can also identify genomic variation and functional genes. This is the advantage of NGS.

"For example, there are many strains of bacteria in the intestine and if you wanted to culture every strain of the bacteria, it might be not feasible because more than 90% of bacteria cannot be cultured. But with NGS, it's like a cross-section of what exists inside the gut."

† AMR, antimicrobial resistance
Δ WGS, whole genome sequencing

"The big data generated from NGS can also identify genomic variation and functional genes. This is the advantage of NGS."

Q: AMR† is a pressing public health issue. Why is it so important to prevent in livestock?

LS: The main problem is that AMR† can develop in animals and then transfer to humans. If you want to prevent AMR† in humans, you must first prevent it in animals. This includes chicken, fish, shrimp, and cattle. If you address AMR† in animals, humans will be safer. That's why many researchers want to control AMR† in animals.

AMR† testing is currently not required for farms in Thailand, but several livestock companies are concerned about AMR† because they would like to provide safe meat products to their customers. Therefore, they are closely monitoring the problem on their farms. Moreover, the Thailand government is also trying to push producers to use fewer antimicrobial agents in order to reduce or slow the chance of it developing into an AMR† problem.

Q: Why is WGSΔ a better approach for detecting AMR†?

LS: With WGSΔ, you can detect the whole bacterial genome in a short period of time. This allows you to determine if the bacterium carries a resistant gene or not. With WGSΔ, we are able to submit a sample and process it so that within two weeks, everything in the bacterial genome can be identified—their genetics, their AMR†, and their functional genes. Therefore, if we can identify this population of bacteria before it is released into the environment, or before it spreads to humans, it can significantly reduce the chance of it developing into a superbug. That's why WGSΔ is so powerful. You can identify everything in the bacterial genome.

Q: What about the 16S approach? When do you get requests to perform 16S and why is this approach better than traditional methods?

LS: With 16S, you can identify the genus of bacteria and some species of bacteria in a short period of time. For example, one gram of feces can contain approximately 500 species of bacteria, or 500 genus of bacteria. With NGS you can identify the population of bacteria and estimate the proportion or relative abundance of bacteria in this one gram of sample without a bacterial culture. If you wanted to perform a culture to characterize the species of bacteria, you would have to do it one by one—which means you'd need to do it 500 times to classify the entire population. It would take months or a year to complete using this traditional method.

---

† AMR, antimicrobial resistance
Δ WGS, whole genome sequencing

An even bigger issue is that most bacteria cannot be cultured in a laboratory anyway. But with NGS you can sequence a sample once and it only takes a couple weeks.

Q: What are the challenges that Porcinotec has faced so far, when trying to promote NGS services to potential agriculture customers?

LS: The main challenge is interpreting the genetic data to answer our customers' questions. We need a good bioinformatician to analyze the data. When you have the sequencing data, you need to put everything together and analyze the full picture. This is quite complicated.

The second challenge is the cost for the customer. Even though our company tries to make it less expensive, it's still a high price for the customer. If we can make everything cheaper, we might have more customers and more information.

Q: What's your opinion on the trend of using NGS, like 16S and WGS[Δ], in livestock research? Where do you see this area going in the future?

LS: Many researchers want to connect everything with the gut microbiome—immune response, growth rate of animals, animal health, and more. That's why I believe in the future, WGS[Δ] and 16S will be increasingly used for research on the gut microbiome. Moreover, many researchers also want to know about drug resistance. With WGS[Δ], you can easily answer questions about drug resistance—how, when, and why it occurs in livestock animals.

Q: What are Porcinotec's plans for the future? Are there any new applications or services you're planning to offer?

LS: The company is planning to do shotgun metagenomics in the future. With this metagenomics service, you don't need to have a pure culture bacteria. You can just put the mixture of bacterial genetic materials in one environment and sequence to see the bacterial community for species profiling. We are also developing the data analysis pipeline for shotgun analysis and RNA sequencing. The ultimate goal for company is to be the best private service provider in agriculture for NGS services.

"It would take months or a year to complete using a traditional method. An even bigger issue is that most bacteria cannot be cultured in a laboratory anyway. But with NGS you can sequence a sample once and it only takes a couple weeks."

† AMR, antimicrobial resistance
Δ WGS, whole genome sequencing

Reference

[1.] Moving Towards Sustainability: The Livestock Sector and the World Bank www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank Last Updated October 18, 2021. Accessed November 28, 2021.

Learn more

Illumina MiSeq™ System www.illumina.com/MiSeq
16S Metagenomics www.illumina.com/systems/sequencing-platforms/miseq/applications.html
Porcinotec Co., Ltd. www.porcinotec.com/en/

illumina®

1.800.809.4566 toll-free (US) | +1.858.202.4566 tel | techsupport@illumina.com | www.illumina.com

APJ-5012-211220-01-EN