



A NETWORK APPROACH TO PIG HEALTH

COST ACTION FA1401



Impact Objectives

- Establish the first interdisciplinary European network focused on discussing the factors affecting the gastro-intestinal microbial balance in pigs topic
- Define both environmental and host genetic factors affecting the gastrointestinal microbiota and the complex interactions between microbiota and gut maturation, to maintain a healthy gut throughout life
- Coordinate databases and unravel innovative tools to study the status of intestinal eubiosis in pigs

A network approach to pig health

Professor Paolo Trevisi and Professor Jürgen Zentek talk about their efforts developing a European network called PiGutNet and the importance of engagement between academia and the general public



Professor Paolo Trevisi



Professor Jürgen Zentek

Can you share a little about how your research careers have developed?

PT: Since 2014 I have been an associate professor in animal breeding. Almost my entire career has been developed working in EU projects. This has provided me with the European dimension of the research, as well as understanding the key role networking plays to make sure science progresses. The last EU project in which I participated was 'Interplay of microbiota and gut function in the developing pig – Innovative avenues towards sustainable animal production' and this intriguing topic is still of high importance, driving my research activity until today, and this has led me to my latest work on the COST Action PiGutNet.

JZ: I received my degree as veterinarian in 1985 from the Veterinary School of Hannover. I had an extraordinary professorship at the Hannover vet school from 1999. After one year as research scientist at the School of Veterinary Science, Bristol, I was appointed on the Chair of Clinical Nutrition at the Veterinary University of Vienna where I

became the head of the Institute of Nutrition. In 2005, I was appointed as professor at the Institute of Animal Nutrition, Free University of Berlin. My main research interests cover the role of nutrition for the intestinal microbiota and immunity of the gastrointestinal tract and nutritional disorders.

Why is it scientifically important to investigate the gastrointestinal tract (GIT) microbiota in pigs?

PT: There is not a consensus on the definition of 'balanced or favorable microbiota', even though, in the last few years, the knowledge on the host-microbiota-environment interplay revealed a very complex picture. The available information points to a modern vision based on the development of a continuity concept in which sow, piglet and growing pig are connected. This highlights the need to move the focus onto the farrowing/lactation period when the early settlement/modification of a non-pathogenic microbiota can affect the health of the animals along all their life. Moreover, the advancements in genomic and phenotypic fields provide an enormous amount of information that is a milestone to defragmenting this complex picture. The work to define all the factors affecting the GIT microbiota and its metabolism, clarifying their relevance in the practice, is still in progress and is the first step to hypothesising effective strategies to manage/

restore the intestinal microbiota after an external perturbation, such as the early administration of antibiotic or a bacterial infection disease.

What problems and obstacles have researchers thus far faced in terms of learning more about the pig GIT microbiota?

JZ: The technological gap is one of the most important obstacles to strong progress in the study of the pig microbiota. The absence of reference methods, database, bioinformatics and biostatistics pipelines, pose serious threats to compare data from different groups. As already done for the study of the human microbiome, a collaborative approach on this topic is required.

In what ways do you think scientists can better engage with the public to demonstrate the socio-economic impact of their work?

PT: The need to improve the communication between the scientific community and the society is evident. Use of an adequate language widely understandable from the general public, joined with the ability to provide key messages, is essential. PiGutNet is widely accessible to the scientific community thanks to the COST Action website and the scientific and technical paper already published. The PiGutNet network needs to have a most effective approach in sharing its message with the general public. ●

Understanding pig gut health

Researchers across Europe are benefitting from the PiGutNet project, an EU COST Action designed to unite scientists working on antibiotic resistance in livestock and pig microbiomes

As the antibiotics revolution of the 20th century led to massive success in the treatment of many common infectious diseases, the increasing concern of the 21st century has been antibiotic resistance. Antibiotics place an enormous selective pressure on the organisms they kill. This means, that for them to remain effective, they have to kill 100 per cent of the population being targeted. Survivors are resistant and will therefore proliferate despite the presence of the bacteria.

This is a problem that has derived from human medicine, but has also been exacerbated by the widespread use of antibiotics in livestock populations. This is a particular issue amongst pig populations. Pork is a staple food for many countries and such needs to be disease-free both for safe human consumption and reliable rearing. At the same time, recent research has highlighted the importance of maintaining a healthy microbiome in mammals. The microbiome is the large and diverse population of bacteria that colonise the gastrointestinal tract (GIT). It plays an essential role in digestion and the maintenance of a healthy GIT, but is massively disrupted during a course of antibiotics. A healthy livestock population requires a healthy microbiome.

A COLLABORATIVE EFFORT

Tackling the issue of extensive and excessive use of antibiotics in pig farming in a particular country is a start, bacteria do not respect borders. Successful research in this field requires collaboration across the EU.

Pooling of resources – manual, cerebral, financial and results – is essential to achieving the ambitious scientific targets of the future. At a European level, international collaboration is necessary to solve problems in an increasingly interconnected continent.

Similar issues are important across the continent, but regional differences need to be appreciated in order to efficiently tackle them. Uniting researchers across the continent is the aim of the European Cooperation in Science and Technology (COST) scheme run by the European Union. The scheme provides resources aimed at encouraging meetings, conferences, researcher exchanges and dissemination. PiGutNet is an EU COST Action established by Professor Paolo Trevisi of the University of Bologna and Professor Jürgen Zentek of the Free University of Berlin with scientists and researchers coming from 22 COST Member Countries and the Cooperating States in order to better combat the issue of antibiotic use in pig farming and investigate the importance of the microbiome to pig health.

UNITING DISPARATE FIELDS

In order to adequately combat the effect of antibiotics on swine, PiGutNet is uniting four main areas of research, split into four working groups. Trevisi explains that these encompass areas that only together are capable of providing a complete understanding of the problem: 'PiGutNet has established the first network aimed at increasing knowledge about the effect and interaction of environmental and genetic factors on the composition of the microbiota

in the GIT of pigs and to improve the risk management associated with antibiotic resistance in pig production. The network involves a wide range of stakeholders including, for the first time on this topic, geneticists together with the other specialists in animal science, confirming the importance on holistic approach.'

Molecular microbiology is one cornerstone of the project. The skills of the microbiologists are necessary to investigate and understand the microbiome. They must be able to identify the bacterial composition in both healthy and antibiotic treated pigs. 'This metagenomics work is important to then be able to investigate the dominant bacteria in more detail and uncover how they may contribute to the current state of the microbiome,' observes Trevisi. Equally, the researchers will be looking to understand when, during the life of the pig, are the key points for GIT bacterial colonisation.

Research on the microbiome in recent years has shown that the presence of particular bacterial species is merely half the tale. It has become increasingly clear that the host's genomics plays an essential role in that interaction. Therefore, it was important for the PiGutNet project team to create a working group dedicated to looking at the host genetic factors at play. Additionally, the group is also investigating the impact of environmental factors on the microbiome. This includes the types of food, how the pigs were reared, the local environment and a multitude of other factors. In this regard, the genetic and environmental working group

overlaps with the feeding strategies working group. This third working group is looking at the optimal feed required for pigs to have a healthy gut microbiota whilst also taking into account the cost and accessibility of that feed.

The fourth working group is studying the effects of antibiotics on the microbiome and especially the dysbiosis extensive treatment with antibiotics can cause. Trevisi explains the joint aims of all the working groups: 'We look to encourage the maintenance of animal health and wellbeing and prevent the use of antibiotic. This is of utmost importance to enhance social (consumer acceptance and human health), environmental (reduce pollution, spread of antibiotics and Anti-Microbial Resistance) and economic (reducing production losses due to animal health problems) sustainability of livestock system'.

NEW DATABASES

PiGutNet is fundamentally about connecting researchers and working groups. One resource severely lacking in this field has been the sharing of results and data. To that end, PiGutNet has set up two databases designed to collate data and make it easily accessible to participating researchers. The first of these collects all the information on biological samples generated by the networks scientists into a single virtual sample repository. The second database is dedicated specifically to storing all the data on the bacterial composition of the microbiome of all the pigs investigated across the network. This data is acquired utilising 16s ribosomal DNA that can give a picture of the bacterial present in a given sample. These databases are a significant step towards streamlining activities within the scope of PiGutNet and towards creating a bioinformatics pipeline capable of analysing the collective data. However, Trevisi points out these are just the first steps in the plans for PiGutNet. 'Samples and data exchanges are only an

intermediary step in the achievement of the Action objectives. The analyses of literature are central to progress in the discussion, for this reason, several collaborative scientific articles are already published.'

As more data is gathered and researchers from the disparate fields become more familiar with one another's work, PiGutNet will help to mould the future direction of the research. Closer coordination means that the important questions that arise will be tackled by the right groups working in tandem. This means that key questions raised by one group won't go unexplored due to a lack of expertise in the field, ensuring that all groups are pulling in the same direction which should lead to increased efficiency within the research effort and thereby, better results. Equally, PiGutNet is building a store of experimental techniques used by the various groups, knowledge of which will be invaluable across the network.

LOOKING AHEAD

With the highlighted improvements that PiGutNet has made to the coordination, the impact is already being felt. However, this is not the end point for the network. Trevisi is still working on attracting more researchers into the network which will further expand the possibilities for breadth and quality of work. At the same time, the size of the network will allow it to have a greater impact on those who will ultimately benefit. PiGutNet should help in disseminating their research to pig farmers and consumers and thereby have a direct impact. Trevisi outlines his vision for the promising future of the network: 'I expect the network to generate the opportunity to create consortia to answer funding calls connected with the PiGutNet topic. Moreover, because PiGutNet has provided several networking tools dedicated to young researchers, I hope it will be a starting point for their future careers, as way to perpetuate the collaborative approach of the network'.

Project Insights

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PROJECT COORDINATOR BIOS

Professor Paolo Trevisi has been an Associate Professor in Animal husbandry at the University of Bologna since 2014. He is studying feeding and management strategies to increase the natural resistance of pigs to the infections, with attention on the gastrointestinal disorders in piglets around weaning, with special emphasis on the interplay host-microbiota on growth and health of the piglet.

Professor Jürgen Zentek is professor of animal nutrition at the Freie Universität Berlin. His main research interests cover the role of nutrition for the intestinal microbiota and immunity of the gastrointestinal tract. He also has an interest in the prevention of health disorders in domestic animals with a specific focus on gastrointestinal diseases. Zentek has been involved in many European and national research projects on feed and food safety.



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