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PRESSEMITTEILUNG

Showcase Bioeconomy: How laying hens can make optimum use of phosphorus

Researchers at the University of Hohenheim are investigating how laying hens can optimally process phosphorus from plants. This will conserve scarce resources and promote animal health.

Phosphorus is an indispensable mineral for all living organisms, but it is also a very limited resource. With the aim of conserving phosphorus from mineral sources, scientists from six departments at the University of Hohenheim in Stuttgart have joined forces to set up the DFG research group "P-FOWL" (FOR 2601). They have also brought in two other working groups from the Leibniz Research Institute for Farm Animal Biology (FBN) in Dummerstorf. They want to clarify the question of how laying hens can optimally process phosphorus from plant sources. Initial results show that this ability is, among other things, genetically determined – a starting point for breeding animals with better phosphorus processing in the future. In addition, when phosphorus is released from plant ingredients in the digestive tract, substances are formed that may have additional and as yet poorly understood animal health benefits. The first phase of the project has now been completed and was funded by the German Research Foundation (DFG) to the tune of EUR 2 million. This makes FOR 2601 a heavily funded research area at the University of Hohenheim.

Phosphorus is involved in many metabolic processes in the body. Among other things, the mineral plays a role in hormonal activity and energy metabolism. Along with calcium, phosphorus is one of the most important nutrients for bone growth. Laying hens therefore need to have enough of both. Phosphorus deficiency can lead to serious health problems.

Since animals cannot meet their needs from plant-based grain fodder alone, farmers usually add phosphorus or phosphate from mineral sources to the feed – resources that could be depleted in just over 100 years. In addition, if more phosphate than necessary is added to the feed, it is excreted unused by the animals. The result is a higher environmental impact.

Interdisciplinary research group creates synergies

In a project spanning several years, the P-FOWL research group is therefore taking a close look at how phosphorus is processed in the digestive systems of hens and quail. "Our research aims to help animals process the phosphorus contained in plant-based feed as efficiently as possible so that less phosphorus needs to be used from mineral deposits," explained Prof. Dr. Markus

Rodehutscord, spokesman for the P-FOWL project.

But first the research team has to gain insight into how exactly phosphorus is released in the animals' digestive tract. To this end, researchers at the University of Hohenheim are investigating all aspects of phosphorus processing in the digestive tract and metabolism of fowl, specifically laying hens and quails, in six sub-projects. They are supported by the Leibniz Research Institute for Farm Animal Biology (FBN) in Dummerstorf, which is involved in the research group with two sub-projects.

"The interdisciplinary composition of the research group constitutes a unique opportunity to combine different studies and obtain as much information as possible from the same animals, to accurately record their genetic background, and to incorporate all the data into an overall evaluation. This makes the results much more meaningful and comparable," stated Professor Dr. Rodehutscord with conviction.

Complex structure of the plant-based phosphorus reserve has to be cracked

It is true that many plant seeds such as legumes, cereals and oilseeds, contain larger amounts of phosphorus. However, this phosphorus cannot be readily processed by many animals. One reason for this is the complicated structure of the plant-based phosphorus reserve.

"In plants, phosphorus building blocks are tightly bound to a ring-like structure – phytin. These compounds must be broken down in the digestive tract with the help of enzymes. Many farm animals such as fowl can only do this very poorly, just like us humans," explained Prof. Dr. Rodehutscord. "They are not able to produce sufficient amounts of these enzymes."

Health-promoting side effect?

The Hohenheim research groups is also looking into the effect that the degradation of the plant-based phosphorus reserve in the digestive tract of the animals may also have on their metabolism. This is because when phosphorus is broken down from the plant-based substances, new compounds are formed whose impact on intestinal bacteria and animal health have hardly been studied so far.

One of them, known as myo-inositol, appears to influence energy metabolism in cells via a previously unknown mechanism. In the nervous system, myo-inositol influences the growth of brain and nerve cells and is also involved in the transmission of nerve impulses. In addition, it is still involved in a variety of metabolic processes and can thus positively influence animal health.

Optimize the processing of plant-based phosphorus by hens

"In the digestive tract, a complicated interaction of the animal with various microorganisms, the microbiome, regulates the processing of nutrients in feed," explained Prof. Dr. Rodehutscord. "It is accepted that the composition of this microbiome in the gut of mammals and birds is shaped and influenced by both diet and genetic makeup."

Consequently, calcium and phosphorus supplementation can significantly reduce the ability of animals to process plant-based sources of phosphorus. Conversely, this finding also backs earlier

research indicating that the phosphate concentrations used in laying hen feed are too high.

In addition, the research group also wants to use high-tech methods to find out which bacteria in the digestive tract of laying hens are involved in breaking up the phosphorus reserve and exactly what task they perform in the process. The expert hoped: "Once we have clarified the role of the microorganisms involved, then in the long term we could influence their composition to make it easier for the animals to process the organically bound phosphorus."

Efficient phosphorus processing – also a question of genes

To investigate in more detail the role genetics plays in efficient phosphorus processing in fowl, the researchers first drew on samples from experiments with quail obtained in a previous project. "Phosphorus processing varies greatly from animal to animal and this is also due to the genetics of the animals," the expert said, summarizing the results.

The researchers, therefore, selected two lineages in laying hens in which the lines were genetically very different from each other, but the animals were as similar as possible within the lineage. Here, too, they found evidence that the ability to process phosphorus is genetically predetermined. The differences between the lineages and also between individual animals within the same lineage can be clearly seen.

"This is a first step in identifying individual animals that can process plant-based phosphorus more effectively than others. Sooner or later, it would probably be possible to enhance this ability through breeding," said Prof. Dr. Rodehutscord, to emphasize the importance of this finding. "However, there is still a lot of research to be done. In the long term, our results could certainly help to further reduce mineral content in the feed of laying hens."

BACKGROUND: DFG Research Group "Inositol phosphates and myo-inositol in domestic fowl: Exploring the interfaces of genetics, physiology, microbiome, and nutrition" (FOR 2601)

Since 2018, the DFG research group "P-FOWL" (FOR 2601) has been investigating the effects of phosphorus from plant-based reserves on animals, using fowl as an example, and how exactly farm animals process the valuable nutrient in their digestive tracts, and how these processes can be made even more efficient.

Six departments at the University of Hohenheim are involved. The external partner is the Leibniz Research Institute for Farm Animal Biology (FBN) in Dummerstorf.

The German Research Foundation (DFG) is funding the project to the tune of around EUR 2 million. This makes it one of the heavily funded research areas in Hohenheim.

Further details:

Homepage of the project: p-fowl.uni-hohenheim.de/en

BACKGROUND: Use of animals in the project

For the project, the research group conducted two experiments with hens of brown and white

Leghorn hybrids. Frozen samples from a previous project were used for studies on the situation with quails.

In the first experiment, 80 hens in the highest laying performance range aged around 30 weeks were given feed mixtures with different levels of calcium and phosphorus. Excreta were collected from all animals and analyzed. To this end, the animals were kept in solitary confinement, but with visual contact to each other. Then, samples were taken from the animals' digestive tracts to analyze the degradation products and intestinal functions present there.

In the second experiment, in addition to the provenance of the hens, the age of the animals was also included as a factor. For this, samples were taken from ten animals in each lineage, and then analyzed at 10, 16, 24, 30, and 60 weeks of age as in the previous experiment.

Hens (3,365 animals) were the most common experimental animals at the University of Hohenheim followed by house mice (782 animals) and pigs (548 animals), according to the 2019 experimental animal report.

BACKGROUND: Heavily funded research areas

In 2019, scientists at the University of Hohenheim secured EUR 33.9 in third-party funding for research and teaching. In no set order, the series "Heavily funded research areas" presents outstanding research projects with a financial volume of at least EUR 350,000 for technical research or EUR 150,000 for non-technical research.

BACKGROUND: Science Year 2020|21 - Bioeconomy

In 2020 and 2021, the Science Year will focus on the bioeconomy – and, by extension, on a sustainable, biobased economic approach. The aim is to produce and use natural materials and resources in a sustainable and innovative way, to replace fossil and mineral raw materials, manufacture products in a more environmentally friendly way, and conserve biological resources. This is more necessary than ever in times of climate change, a growing world population, and a drastic decline in species. The Bioeconomy Science Year, organized by the Federal Ministry of Education and Research (BMBF), shines a spotlight on this topic.

Bioeconomy is the leading topic in research and teaching at the University of Hohenheim. It links the Faculty of Agricultural Sciences, the Faculty of Natural Sciences, and the Faculty of Business, Economics and Social Sciences. During the Bioeconomy Science Year, the University of Hohenheim is hosting numerous events to inform the public at large and experts about this topic.

Additional information

Science Year 2020|21 BMBF

#wissenschaftsjahr #DasistBioökonomie

Science Year 2020|21 Hohenheim

Bioeconomy at the University of Hohenheim

Text: Stuhlemmer

Prof. Dr. Markus Rodehutscord, University of Hohenheim, Department of Animal Nutrition,
T +49 711 459-22420, E markus.rodehutscord@uni-hohenheim.de