MEDIA INFORMATION

Leibniz Institute for Farm Animal Biology

Dummerstorf, May 8, 2019

LEIBNIZ INSTITUTE FOR FARM ANIMAL BIOLOGY

Heat stress impairs intestinal barrier in dairy cows

Previously uncharacterized immune cells infiltrate the intestinal wall.

For the first time, scientists from the Leibniz Institute for Farm Animal Biology Dummerstorf (FBN) were able to prove that high ambient temperatures in dairy cows can directly influence the natural intestinal barrier. A damaged protective barrier of the intestine provides access for bacteria and other pathogens, which are able to penetrate the intestinal layers in greater numbers and possibly even deeper, triggering an immune response by immigrating immune cells. The latest research results were published yesterday afternoon (May 7) in the renowned journal "Proceedings of the National Academy of Sciences of the United States of America "*.

"The findings are also of importance for human medicine. Analogous processes of a disturbed intestinal barrier ("leaky gut" - perforated intestine) occur in humans, for example, in the clinical pictures of celiac disease or Crohn's disease," said Professor Dr. Christa Kühn from FBN's Institute of Genome Biology.

Immigrated immune cells could be identified

In an experiment, Holstein cows were exposed to high ambient temperatures (28°C and THI 76) and a heat period of several days in hot summer months was simulated under standardized conditions in order to gain a better understanding of the physiological processes in dairy cows in response to heat stress. The Dummerstorf Leibniz Institute has a climate and four respiration chambers at its disposal in which research can be carried out using state-of-the-art methods under controlled temperature and humidity conditions.

What is special about this case is that it was not clear up to now whether many of the changes observed in animals (including milk yield, for instance) were merely the result of reduced feed intake during heat stress. For this reason, cows without heat stress that received just the amount of feed they had received from the most heat-stressed animals were also examined in parallel. By comparing the animal groups, the scientists were able to find out what were the direct effects of heat and what were the indirect effects of reduced feed intake.

"In the histological investigations of the small intestine (jejunum) of heat-stressed animals, we observed the immigration of cells and cell clusters in the connective tissue layer (submucosa) of the small intestine that had not been determined in any detail before," explained the agricultural scientist Dr. Elke Albrecht from the Institute of Muscle Biology and Growth at the FBN. "This in turn can be the result of a disturbed intestinal barrier."

"As a result of intensive cooperation between the FBN Institutes of Nutritional Physiology, Muscle Biology and Growth and Genome Biology, we were able to identify and characterise these cells jointly using a novel methodological approach. For this purpose, these cell populations were first cut out of the tissue with the aid of a so-called laser microdissection. We then analysed the information on all genes active in the cells obtained using RNA sequencing," said Albrecht.

The evaluation of the RNA data showed that the immigrant cells are immune cells, i.e. a subtype of macrophages that have not yet been described in this form and in this tissue layer of the intestine," emphasised Prof. Christa Kühn. Macrophages are immune cells that recognise proteins or glycoproteins that are foreign to the body, for example viruses and bacteria that have penetrated the tissue, and eliminate them by phagocytosis (dissolving and rendering harmless foreign substances in the organism). Furthermore, changes in the expression of intestinal wall sealing proteins indicate a disturbed intestinal barrier due to heat stress. "It is therefore clear that the increasing heat stress leads directly to health consequences in the intestines of dairy cows which have nothing to do with reduced feed intake at high temperatures," Kühn pointed out.

The challenge of climate change for livestock farming

Global warming leads to prolonged periods of heat in the summer months worldwide. In 2018 Mecklenburg-Vorpommernhad the hottest summer since the weather recording. The weather forecasts for 2019 also predict hot temperatures and droughts. Heat stress is a major problem for farm animals, especially for the approximately 4.1 million dairy cows in Germany, since they can hardly adapt to high ambient temperatures.

Scientists have already proven, among other things in the long-term climate research at the FBN, that high ambient temperatures and humidity in dairy cows lead to a reduction in feed intake and an increase in body temperature as well as respiratory and heart rate and consequently to heat stress and a significant decrease in milk yield.

"With regard to forecasts of global climate change, it is necessary to elucidate basic physiological mechanisms of heat stress. Therefore, further studies are planned at the FBN to investigate the impairment of intestinal permeability and immune defence in the course of heat stress", said Dr. Björn Kuhla from the Institute of Nutritional Physiology "Oskar Kellner". In addition, the focus is on targeted intervention measures to alleviate heat stress through the use of special feeding and husbandry strategies and the breeding of animals with better heat tolerance.

***Original Article PNAS (www.pnas.org)**

„Heat stress directly impairs gut integrity and recruits distinct immune cell populations into the bovine intestine“, PNAS first published May 7, 2019, www.pnas.org/content/early/recent
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For the first time, scientists from the Leibniz Institute for Farm Animal Biology Dummerstorf were able to prove that high ambient temperatures directly influence the intestinal barrier in dairy cows. The results have been published in pnas.org (6 May).

The Leibniz Association

The Leibniz Association connects 93 independent research institutions that range in focus from the natural, engineering and environmental sciences via economics, spatial and social sciences to the humanities. Leibniz Institutes address issues of social, economic and ecological relevance. They conduct knowledge-driven and applied basic research, maintain scientific infrastructure and provide research-based services.
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They are subject to an independent evaluation procedure that is unparalleled in its transparency. Due to the importance of the institutions for the country as a whole, they are funded jointly by the Federation and the Länder, employing some 19,100 individuals, including 9,900 researchers. The entire budget of all the institutes is approximately 1.9 billion Euros.
www.leibniz-association.eu

***Photo FBN/Ronald Brunner**: Several institutes have bundled their know-how and were thus able to prove for the first time that heat affects the intestinal health of dairy cows: from left Wietje Nolte, Ulrike Thom, PD Dr. Björn Kuhla, Dr. Elke Albrecht, Dr. Franziska Koch, Dr. Rosemarie Weikard and Prof. Dr. Christa Kühn in front of a LaserCapture-Microscope.*
***Photo FBN/Häntzschel**: Temperature and humidity conditions can be optimally simulated in a climate chamber and four respiration chambers at FBN.*

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