Heat stress in poultry and pigs - is there a link to gut health?

High temperatures are a long-observed stressor in poultry and pigs. It affects livestock production worldwide and has a significant impact on animal welfare and performance. It is the cause of high economic losses resulting from reduced feed intake, poorer growth performance, higher feed conversion rates, lower laying rates and poorer meat and egg quality.

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The aim of this article is to describe the link between heat stress and gut health and to propose strategies to mitigate the effects of heat stress with special emphasis on natural gut health and adaptogenic substances.

Heat stress

Stress is a biological adaptive response designed to restore homeostasis. Heat stress occurs when the amount of heat produced by an animal exceeds the animal's capacity to release heat to the environment. Animals in heat stress limit heat production by reducing feed intake, resulting in impaired performance. In addition to reduced feed intake, physiological alterations caused by heat stress include increased core body temperature, reduced immune function, altered electrolyte balance and blood pH, impaired endocrine, and reproductive functions, reduced energy available to cells, disrupted structure and function of the intestinal epithelium, intestinal dysbiosis and increased blood concentrations of stress hormones.

Is there a link between heat stress and gut health?

The gastrointestinal tract of poultry and pigs is particularly sensitive to any stress, including heat stress. In fattening pigs, the gastrointestinal tract is one of the organs most affected by heat stress. At the same time, a functional gastrointestinal tract is essential for the overall health and performance of the animals.

In addition, the gastrointestinal tract interacts bidirectionally with the neuroendocrine and immune systems, further emphasising the importance of its integrity. The functional integrity of the gut is dependent on the intact intestinal mucus layer, functional tight junctions between the epithelial cells of the intestinal wall (enterocytes), intact enterocytes and the functional immune system of the gut.

When an animal is exposed to heat stress, the availability of oxygen and nutrients to the intestinal mucosa is reduced due to lower blood flow to the intestine. The terminal part of the small intestine - the ileum - is most severely affected. Oxidative stress and inflammation occur, resulting in morphological changes and mucosal damage. Increased mucin production has been described in heat-stressed pigs. Mucin is the first line of defence of the intestine. Increased mucin production translates into increased requirements for amino acids, especially serine, threonine, and cysteine, which are then unavailable for growth (anabolic) processes. The increased concentration of stress hormones in the blood directly affects the tight junctions between the cells of the intestinal mucosa and adversely affects the immune function of the gut. Disruption of tight junctions between enterocytes results in increased intestinal permeability - the so-called leaky gut syndrome. This condition facilitates the penetration of bacterial pathogens through the intestinal mucosa and increases the concentration of endotoxin in the blood among other things. The increased load of bacteria and their toxins on the internal organs limits anabolic processes and, if severe, can lead to multi-organ failure. Heat stress significantly impairs the function of digestive enzymes of the brush border of the gut (e.g. sucrase, maltase and aminopeptidases), which further exacerbates nutrient deficiencies. A dysfunctional gut immune system reduces resistance to pathogens, and its inadequate activation exacerbates the animal's energy deficit. These changes occur after only two hours of heat stress.

Reduced nutrient availability negatively affects not only the intestinal mucosa but also the gut microbiota. The gut microbiota is further affected by changes in secretory functions and motility of the gastrointestinal tract and changes in the viscosity of the digestive tract caused by heat stress. The numbers of lactobacilli and bifidobacteria decrease and the numbers of pathogenic clostridia and coliforms increase. Moreover, due to the increased intestinal permeability described above, these pathogenic bacteria may more easily enter the whole body system.

From the commonly available tests, these changes can be demonstrated by histopathological and morphometric examinations, where, in broilers and pigs exposed to heat stress, we observe in particular shortened intestinal villi and deepened intestinal crypts. Changes in the gut microbiota can be detected by sequencing the intestinal contents, most commonly the cecal contents in poultry.

What are the management options using natural substances?

Nutritional strategies used in heat stress are many and include, for example, feed restriction, feed texture modification, supplementation with vitamins, minerals, betaine, probiotics, prebiotics and botanicals, reduction of crude protein, increase in fat and increase in digestible amino acids. In our article we would like to focus on the use of medium and short chain fatty acid monoglycerides and plant adaptogens.

The monoglycerides of medium and short chain fatty acids contained in Fortibac® have multiple beneficial effects on poultry and pigs. The focus of their action lies in their beneficial effect on the intestine, where they have a preventive and therapeutic effect on all the above-mentioned alterations. They optimize the mucin layer, serve as a source of energy for enterocytes, optimize the production and function of tight junctions between enterocytes, favourably influence the secretion of digestive enzymes by enterocytes, modulate the immune system of the intestine, exhibit anti-inflammatory effects, inhibit

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bacterial pathogens, and have a beneficial effect on the intestinal microbiota. **Experience with the use of Fortibac® in animals exposed to heat stress will be presented later in this article.**

Plant adaptogens are defined as substances that reduce the reactivity of host defence systems and tissue damage caused by stressors. Adaptogens facilitate adaptation to a wide range of physical, chemical, and biological stressors by enhancing homeostatic mechanisms and increasing non-specific resistance to stress. By acting on the hypothalamic-pituitary-adrenal axis, they influence the nervous, endocrine, and immune systems. Their action is mild, without significant side effects, and they can be administered on a long-term basis. The use of adaptogens is broad and includes in particular periods of increased stress, for example during transport of animals, housing of chickens, weaning of piglets, in dairy cows during the pre- and post-calving period, during the farrowing period, during periods of increased infectious pressure and during time of heat stress. Adaptogens increase performance. **ADDICOO s.r.o. is currently the principal investigator of a five-year grant on the use of plant adaptogens in different categories of animals. The aim of this grant is to develop an innovative combination of gut health improving substances and plant adaptogens with wide application in heat stress in poultry and pigs among other applications.**

Use of Fortibac® in heat stress in poultry

Long-term monitoring of the effect of Fortibac® in individual poultry categories included an evaluation of the effect of the product during periods of heat stress risk. A number of tests were carried out on laying hens. One of the trials involved 34,600 Lohman brown layers, where the experimental group of hens received Fortibac® Liquid in addition to the existing commercial feed at a dose of 700 ml/1000 l water (5 days per week). The evaluated parameters were egg production and hen mortality. Egg production in hens with Fortibac® was on average 1.8% higher than the laying rate in the control group. During the heat stress period, there was no significant decrease in laying compared to the control group, where significant variations in laying were observed (Figure 1). The mortality of layers in the Fortibac® house was slightly higher at the beginning of the application, but after two weeks the mortality in the experimental house stabilised and was then significantly lower, especially during the heat stress period (Figure 2).

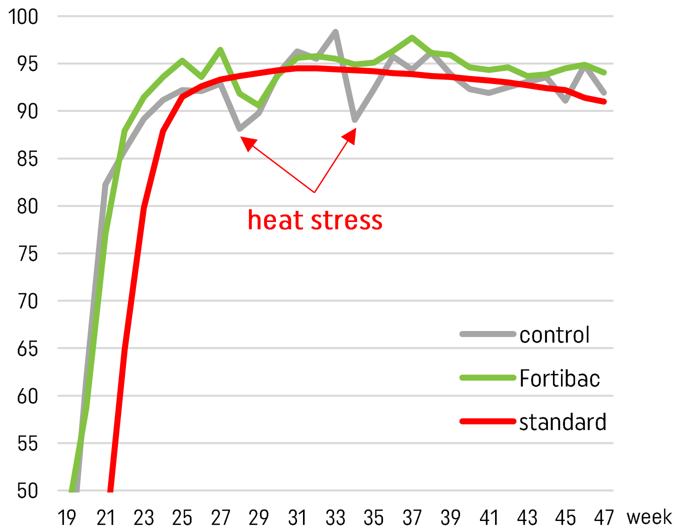

Figure 1: Egg production (%) of laying hens in individual groups during the researched period

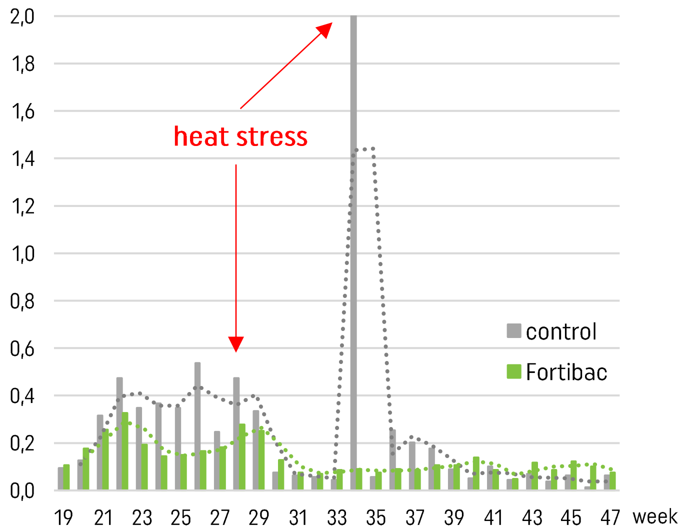

Figure 2: Mortality (%) of hens in each group during the researched period.

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This is consistent with the results from the broiler trial at the Performing Nature Research Center (CZE), where ROSS 308 genetics cockerels were enrolled and exposed to heat stress during the monitoring period. Fortibac® added to commercial feed at 700 g/t improved performance and reduced mortality in broilers despite the stress of extreme temperatures (Table 1). The trial also demonstrated improved fat digestibility by 6.7%. The results show that Fortibac® helps animals cope better with heat stress and maintain a stable feed intake, leading to better performance and lower mortality.

Groups of broilers	Daily gain (g)	Feed intake (g)	Conversion	Mortality (%)	Final weight (kg)
Control group	61.24	88.61	1.45	2.21	2.20
Fortibac®	63.72	90.60	1.42	1.23	2.29
Fortibac® vs control	+4.06%	+2.24%	-1.75%	-0.98%	+3.94%

Table 1: Comparison of performance parameters in broilers during heat stress.

Conclusions

Heat stress is a major problem in livestock production worldwide. The effect of heat stress on the gut is often underestimated, although it is well documented, and in finishing pigs the gut is even the organ most affected by heat stress. Thus, supplementing existing measures to mitigate the effects of heat stress on livestock with substances that improve gut health appears to be very effective. Similarly, the use of adaptogenic plants with a broad-spectrum beneficial effect on animals exposed not only to heat stress deserves adequate attention. The beneficial effect of Fortibac® on the performance of broilers and laying hens exposed to heat stress has been demonstrated in several experiments. Given the similar mechanisms of heat stress damage to the intestine in pigs and cattle, a beneficial effect in these categories of livestock can also be expected.

References:

Gabler, N., Pearce, S. C. The impact of heat stress on intestinal function and productivity in grow-finish pigs. Animal Production Science 2015; 55:1403-1410.

Koch, F., Thom, U., Albrecht, E., et al. Heat stress directly impairs gut integrity and recruits distinct immune cell populations into the bovine intestine. PNAS 2019; 116(21):10333-10338.

Prashanth Kumar, K., Ravinder Reddy, V., Gnana Prakash, M. Amelioration of heat stress induced oxidative damage in broilers by supplementing Ashwagandha (*Withania somnifera*) extract during summer. The Pharma Innovation Journal 2018; 7(3):591-596.

Rostagno, M. H. Effects of heat stress on the gut health of poultry. Journal of Animal Science; 98(4):1-9.

Other references are available from the authors.

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