

**Theses of doctoral (PhD) dissertation**

**THE IMPACT OF ENVIRONMENTAL FACTORS AND  
ON-FARM BIOSECURITY MEASURES  
ON THE PERFORMANCE, IMMUNOLOGICAL AND  
WELFARE INDICATORS OF  
FATTENING TURKEY FLOCKS**

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Budapest, 2025.



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## **1. Introduction and aims of research**

Since the widespread adoption of intensive livestock production over the past several decades, it has become the foundation of a secure global food supply. Only through such methods can adequate quantities of high-quality animal-derived nutrition be ensured in the face of rapid global population growth.

Within industrialized animal production, poultry farming is one of the most dynamically developing sectors. This is due to the fact that intensive production of meat-type poultry species and egg-laying chicken breeds enables the rapid and efficient generation of high-quality protein sources. Genetic progress is also most pronounced in poultry breeding. Genetic progress refers to the breeding achievements whereby the heritable traits of poultry species – such as broiler chickens, fattening turkeys, and laying hybrids – are continuously improved through targeted selection and crossbreeding.

As a result, feed conversion ratio, daily weight gain, egg production, production efficiency, and the genetic health status of the flocks are all enhanced. Therefore, genetic development enables industrial poultry farming to produce food of high biological value in an increasingly economical and time-efficient manner.

In large-scale commercial farms today, economic factors – particularly the goal of maximizing output while minimizing costs – play a pivotal role. The operation of high-capacity production units is only feasible under appropriate economic parameters.

In the poultry sector, cost reduction is often achieved through shortened service periods and increased stocking densities, resulting in higher animal numbers per barns. However, such intensive production conditions, combined with the use of modern performance-selected poultry hybrids, introduce vulnerabilities – most notably an increased susceptibility to infectious diseases and the emergence of abnormal behaviors due to reduced social space.

The breeding strategies that have prioritized ever-higher production traits have led to a situation where animals are capable of expressing their genetic potential only under ideal environmental conditions. When such conditions are compromised, these hybrids may exhibit heightened sensitivity even to mild infections. Both infectious diseases and complex, management-related conditions – arising from housing technology and referred to as production-related diseases – can result in

significant economic losses, posing a serious threat to the safety of industrial poultry farming.

Understanding and investigating the transmission routes, risk factors, and environmental survival characteristics of the major pathogens affecting poultry flocks, along with the implementation of strict biosecurity measures, are critical for effective disease prevention.

Compared to the domestic chicken, the turkey remains a less extensively studied species, despite being more frequently affected by abnormal behavioral patterns. Under today's industrial farming conditions, animal welfare considerations and non-specific disease prevention strategies – primarily biosecurity – are indispensable components of sustainable poultry production.

*“As a preliminary remark, it must be stated that profitable production is only achievable with a healthy animal population. And only that animal population can be considered healthy which products in accordance with its genetic potential”* – wrote Prof. Dr. Ferenc Kovács, late rector of the University of Veterinary Medicine, in his book *Állathigiénia* (1975). Animals can only phenotypically express their full productive potential when kept in an appropriate environment that allows the manifestation of

normal behavioral patterns and is free from infectious, obligate pathogenic agents.

Therefore, the aim of our study was to examine the welfare and immunological status of meat-type turkeys kept under intensive production conditions – a species that has received relatively little research attention. In addition, an important objective was to assess the level of biosecurity in large-scale turkey farms and to compare this with animal welfare indicators.

The significance of this research topic can be interpreted within the framework of the One Health concept. In this approach, environmental health, animal health and welfare, and food safety – i.e., public health – are closely interconnected and inseparable. When this principle is implemented, it becomes possible to achieve an environmentally sustainable poultry production system that not only yields safe, high-quality food of animal origin but is also economically viable and meets both animal welfare and animal health standards.

In the absence of proper hygiene knowledge, the prevention or eradication of various epidemics is hardly feasible. Without adherence to established hygiene protocols in livestock production, the success of biosecurity measures depends largely on chance.



Moreover, even specific disease prevention programs may prove ineffective if basic animal hygiene is neglected, as animals with insufficient immune competence are unable to mount adequate immune responses – even when vaccinated with otherwise efficacious vaccines under optimal conditions.

The environmental stability and long-term survivability of various pathogens underscore the critical importance of biosecurity, hygiene, and disinfection in preventing disease outbreaks in poultry farms. High stocking densities, inadequate ventilation, and insufficient biosecurity measures in production systems further exacerbate the risk of disease transmission. This study summarizes key mechanisms of disease transmission and emphasizes the necessity of strict biosecurity protocols and routine health monitoring to prevent both intra- and inter-farm pathogen spread.

The present research analyses the potential of farm-adapted biosecurity of infectious poultry diseases such as avian influenza, which are emerging alongside global poultry production and are causing increasing economic damage, non-specific farm-level control systems and periodically challenging the immune systems of animals. In addition, it will examine other environmental factors –

climatic, husbandry, immunological – that play an important role in the control of infectious animal diseases. The objectives of our research can be summarized as follows:

- To investigate the relationship between the level of on-farm biosecurity and animal welfare conditions in commercial turkey production establishments, using objective assessment protocols. The aim is to identify measurable correlations between farm management factors, housing technology, and the implementation of biosecurity practices.
- To assess the effects of a litter treatment product composed of *Bacillus licheniformis* and zeolite on carbon dioxide and ammonia concentrations in poultry house air, as well as on the performance parameters and animal welfare indicators of fattening turkeys.
- To examine the impact of various modified environmental management factors – including increased light intensity, elevated stocking density, and raised ambient temperature – on the performance, stress hormone levels, and immunological status of turkeys.

## **2. Overview of new scientific results**

To date, no comprehensive nationwide survey has been conducted on large-scale turkey farms in which both animal welfare parameters and the level of farm biosecurity were assessed jointly, along with the relationships between them. We were the first to carry out such a representative study in Hungary, involving 24 commercial turkey farms.

No prior study has investigated the effects of a microbial litter treatment containing *Bacillus licheniformis* and zeolite in combination, specifically assessing the bacterium's favorable effects on ammonia concentration, performance indicators, and animal welfare parameters. We conducted this research for the first time in Hungary. Until now, no study has simultaneously analyzed feather and blood cortisol levels and conducted blood-based immunocyte profiling in turkey flocks under controlled modifications of key environmental parameters. The experimental research detailed in this dissertation was the first of its kind in Hungary.

### **List of new scientific results:**

1. Among the external biosecurity elements of turkey farms, higher-level biosecurity measures related to

farm organization and personnel traffic are associated with improved animal welfare conditions.

2. Among the internal biosecurity elements, the implementation of compartmentalization and high standards of hygiene both within and between flocks are associated with improved animal welfare status.
3. The litter treatment product containing *B. licheniformis* and zeolite positively affects air quality in turkey houses by reducing ammonia concentrations, which correlates with improvements in performance parameters and welfare indicators.
4. In male fattening turkeys, feather cortisol concentrations show a significant increase 3–7 weeks following exposure to a heat stressor, returning to baseline levels by weeks 11–15, suggesting successful physiological adaptation.
5. We demonstrated that, in growing turkey flocks, certain composite animal welfare indicators – such as the "social behavior factor" and the "disease factor" – are significantly associated with stocking density. A stocking density of 3.5 birds/m<sup>2</sup> results in poorer values for both the "social behavior factor" and the "disease factor" compared to a stocking density of 2.5 birds/m<sup>2</sup>.

### **3. Own scientific publications related to the topic of the dissertation**

#### **Full text papers in peer-reviewed journals**

Kovács L, Konc G, Kutasi P, Könyves L (2020) A nagyüzemben tartott pulykák rendellenes magatartásformái. Irodalmi összefoglaló. Magyar Állatorvosok Lapja, 142:95-205

[https://univet.hu/wp-content/uploads/2020/12/2020.142.195-205\\_Kov%C3%A1cs-et-al.pdf](https://univet.hu/wp-content/uploads/2020/12/2020.142.195-205_Kov%C3%A1cs-et-al.pdf)

Kovács L, Hejel P, Farkas M, László L, Könyves L (2024) *Bacillus licheniformis* baktériumot és zeolitot tartalmazó alomkezelő készítmény hatásának vizsgálata bak hízópulyka-állományban.

Magyar Állatorvosok Lapja 146:291-305

<https://doi.org/10.56385/magyallorv.2024.05.291-305>

Kovács L, Bánáti L, Könyves L (2023) Alomkezelési módszerek a nagyüzemi állattartási gyakorlatban. Irodalmi összefoglaló. Magyar Állatorvosok Lapja 145:47-54.

<https://doi.org/10.56385/magyallorv.2023.01.47-54>

Kovács L, Klaucke C R, Farkas M, Bakony M, Jurkovich V, Könyves L (2025) The correlation between on-farm biosecurity and animal welfare indices in large-scale turkey production. Poultry Science 104:104598

<https://doi.org/10.1016/j.psj.2024.104598>

Kovács L, Domaföldi G, Bertram P-C, Farkas M, Könyves, L P (2025) Biosecurity Implications, Transmission Routes and Modes of Economically Important Diseases in Domestic Fowl and Turkey. Vet. Sci, 12, 391.

<https://doi.org/10.3390/vetsci12040391>

### **Conference presentations**

Kovács L, Farkas M, Jurkovich V, Christopher K, Könyves L (2024) A telepi járványvédelem és az állatjólléti mutatók kapcsolatának vizsgálata a nagyüzemi pulykatartásban. Akadémiai Beszámoló, Budapest, Magyarország