FACULTY OF VETERINARY MEDICINE
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INVITATION PUBLIC DEFENSE

SOUND, IMAGE AND CORTICOSTERONE ANALYSIS AS POTENTIAL WELFARE INDICATORS IN BROILER CHICKENS

Patricia Soster de Carvalho
4th May 2026

PROMOTORS

PROF. DR. GUNTHER ANTONISSEM
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PROF. DR. FRANK TUYTTENS
Faculty of Veterinary Medicine, UGent
Flanders Research Institute for Agriculture, Fisheries, and Food, Belgium

MAARTEN DE GUSSEM
Vetworks - Poulpharm, Belgium.

Curriculum Vitae

Patricia Soster de Carvalho was born in Porto Alegre (Brazil) on the 8th of July 1991. She graduated as a veterinarian from the Faculty of Veterinary Medicine at the Federal University of Rio Grande do Sul in 2018. The following two years, she completed a Master's in Animal Production from the Federal University of Rio Grande do Sul (Brazil). She conducted visiting research at the Catholic University of Leuven (Belgium), working on heat stress during incubation, and later at Auburn University (USA), where she expanded her expertise in poultry nutrition and feed mill operations. Her practical experience includes internships in hatcheries, poultry and swine farms, and meat processing plants in Brazil.

Patricia continued her studies and started in 2022 her PhD on Veterinary Medicine at Ghent University (Belgium). She is also completing a Postgraduate Diploma in Poultry Health Sciences at the same institution. Patricia works in collaboration with Poulpharm. In this role, she has participated in lesion scoring, necropsies, sample collection, histopathology support, and the preparation of technical and scientific reports. She also joins the company's welfare training program in collaboration with Vetworks.

Patricia is the first author and co-author of several studies published in international peer reviewed journals and presented her research at different national and international conferences, presenting work on broiler welfare, vocalization analysis, bioacoustics, heat stress, and precision monitoring technologies. She has received several competitive awards and travel grants from organizations such as FWO, UFAW, ISAE, and WVPA.

Where?

The defense will take place on Monday the **4th May 2026** at **17.30h.**
Auditorium **Maximum**.
Faculty of Veterinary Medicine, Ghent University, Campus Merelbeke, Salisburylaan 133.

How to attend?

If you would like to attend, please register before 30/04/2026, by email to **patricia.sosterdecarvalho@ugent.be**

Online: CLICK HERE

Members of the Jury

Prof. dr. Ann Martens
Chair of the Jury, Dean
Faculty of Veterinary Medicine, UGent

Prof. dr. Dominiek Maes
Faculty of Veterinary Medicine, UGent

Prof. dr. Richard Ducatelle
Faculty of Veterinary Medicine, UGent

Prof. dr. Tomas Norton
Division of Animal and Human Health Engineering, KU Leuven

Prof. dr. Prafulla Regmi
Department of Poultry Science, University of Georgia

Prof. dr. Manja Zupan Šemrov
Biotechnical Faculty, University of Ljubljana

Summary

The first part of this thesis focus on acoustic monitoring of broiler vocalizations. A systematic review identified 17 distinct vocalization types in broiler chickens and laying hens detected through sound analysis and relate to animal welfare indicators within the framework of the Five Domains model. An automated vocalization detection system was developed to recognize four well-described vocalization types from continuous recordings of Ross 308 broiler chicks aged 1 to 36 days: distress calls (DC), short peeps (SP), pleasure notes (PN), and warbles (W). When a vocalization did not fit one of the four categories, it was classified as another type of vocalization (OV). The model achieved a balanced accuracy of 91.1%. Recordings from the previous step were analyzed to identify sound patterns not belonging to the four predefined vocalization categories. This approach resulted in ten final clusters potentially representing previously undescribed vocalizations. Subsequent experiments applied the developed acoustic monitoring tool to investigate vocalization patterns in broilers under different environmental and management conditions. Involving 1,680 broilers, vocalizations were automatically monitored from 1 to 42 days-old under thermoneutral conditions or cyclic high environmental temperature, with or without access to multifunctional elevated platforms as environmental enrichment. Vocalization patterns were strongly influenced by age and time of day, while neither high environment temperature nor enrichment had an effect. A subsequent study evaluated whether disease challenges alter vocalization patterns. Broilers were experimentally challenged with an intestinal challenge, coccidiosis (*Eimeria spp.*), or a respiratory disease model involving infectious bronchitis virus (IBV) followed by avian pathogenic *Escherichia coli* (APEC). While clear age-related and diurnal patterns were observed again, no significant treatment effects were detected for the monitored vocalization types.

The second major component of this thesis addressed automated behavioral monitoring using computer vision. A multi-camera tracking system was developed to generate individual movement trajectories to monitor broiler activity and spatial behavior throughout the production cycle. Using this system, behavioral patterns of broilers were studied across age, environmental temperature conditions, and periods of the day. High environmental temperature increased time spent in the drinker zone and reduced time spent in the feeder zone, while overall locomotor activity declined progressively with age. High-intensity activity decreased earlier and more rapidly than medium- and low-intensity movements, resulting in an increasing dominance of low activity levels as broilers approached market weight. To further advance computer vision–based behavioral analysis, a novel annotated dataset called Big Broiler was developed. This dataset contains 92 videos and nearly seven million frame-wise behavioral annotations across 12 behaviors and four postural states. The dataset supports multi-object tracking, action recognition, and temporal action segmentation, enabling analysis of individual behaviors within group housing systems. Building on this dataset, an automated video-analysis pipeline combining multi-object tracking with deep learning–based behavior recognition was applied to evaluate behavioral responses to disease challenges. In broilers challenged with *Eimeria* spp. or with

IBV followed by APEC, the system detected significant shifts in flock-level time budgets over age and time of the day.

The final part of the thesis investigated physiological stress biomarkers by examining CORT dynamics across multiple biological matrices by using ultra-performance liquid chromatography coupled with tandem mass spectrometry (UPLC–MS/MS). The first physiological component of this thesis focused on validating CORT measurements in CORTp and CORTf of broiler chickens exposed daily to increasing exogenous CORT from 1 to 42 days of age. Samples were collected at days 14, 28, and 42 of age. By 42 days, CORTp and CORTf increased in birds receiving higher CORT doses. A moderate positive correlation was observed between CORTp and CORTf, indicating that CORTf partially reflects circulating CORT during feather growth. Prolonged CORT exposure also reduced body weight and impaired feather development. The following study evaluated corticosterone levels in droppings (CORTd) and related compounds. The experimental setup was the same as that used in the previous step. CORTd showed an age effect, with highest concentrations at 14 days and lower values thereafter, but no clear response to increasing levels of exogenously administered CORT. In contrast, some CORT-related compounds, particularly an unresolved CORT-related compound fraction, were more responsive to treatment. Although a broad panel of CORT-related and structurally similar steroids were included to optimize method selectivity, only 11-dehydrocorticosterone, 11-deoxycorticosterone, and another peak that was not identified (unresolved CORT-related compound fraction) were detected in droppings. Finally, the responsiveness of CORT across biological matrices was evaluated under practical broiler welfare conditions, including high environmental temperature, environmental enrichment through multifunctional platforms, and infectious disease models (*Eimeria spp.* and IBV). CORTp was consistently detectable at low concentrations but did not differ between treatments, while CORTf and CORTd remained below detection limits. These findings suggest that endogenous CORT, when measured with a highly specific analytical method, shows limited responsiveness to the induced welfare challenges in broilers, raising questions about its sensitivity as a welfare biomarker.

Overall, this thesis provides a comprehensive investigation of automated welfare monitoring in broiler chickens through the integration of acoustic analysis, computer vision, and physiological biomarker assessment. By developing new datasets, analytical tools, and experimental validations, the work contributes methodological advances for precision livestock farming and improves understanding of behavioral and physiological indicators relevant to broiler welfare. These approaches demonstrate the potential of automated monitoring technologies and CORT as a biomarker, while also highlighting current limitations and future research needs for implementing reliable welfare assessment systems in commercial poultry production.