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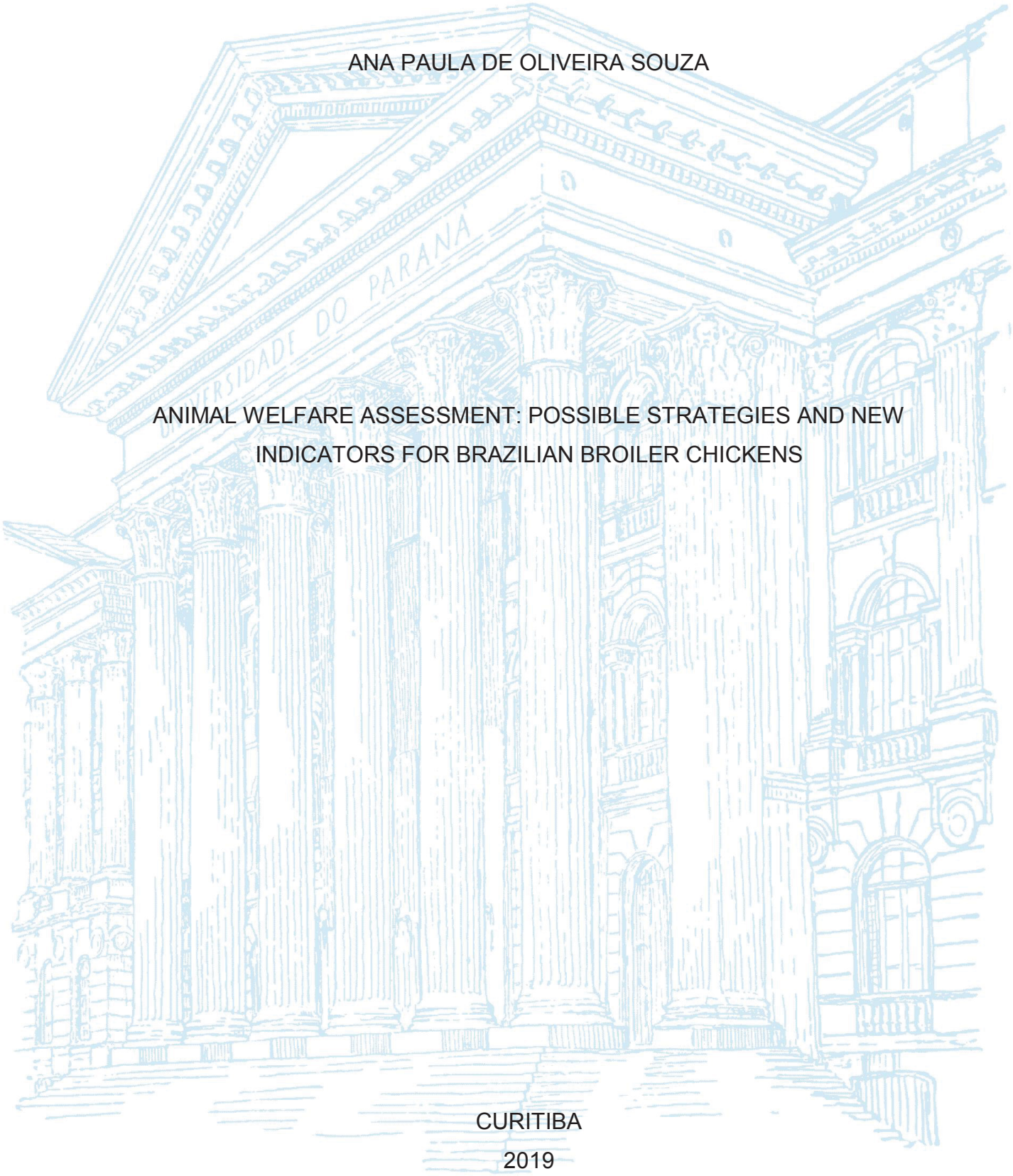

ANIMAL WELFARE ASSESSMENT: POSSIBLE STRATEGIES AND NEW INDICATORS FOR BRAZILIAN BROILER CHICKENS

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Orientadora: Profa. Dra. Carla Forte Maiolino Molento

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To the nonhuman animals.

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"Somewhere, something incredible is waiting to be known".

Carl Sagan

RESUMO

O Brasil é um importante produtor mundial de frangos de corte e a avaliação regular de bem-estar animal torna-se essencial nesse país. As avaliações podem ocorrer no âmbito das organizações, por meio do monitoramento do processo produtivo, e no âmbito Federal, por meio de um programa mais amplo de vigilância em bem-estar animal. O uso de medidas cientificamente validadas baseadas nos animais tem sido incentivado para avaliar bem-estar animal. Desta forma, este estudo objetivou o desenvolvimento de estratégias e de novos indicadores para avaliação do grau de bem-estar de frangos de corte dentro do contexto brasileiro. A tese está organizada em sete capítulos: (1) Apresentação; (2) Dados de inspeção de abate de frangos de corte no Brasil: uma abordagem inicial de bem-estar animal; (3) Proposta de um sistema de gerenciamento para desenvolver uma estratégia de bem-estar animal para a cadeia de produção animal; (4) Desenvolvimento e refinamento de três indicadores de bem-estar de frangos de corte baseados nos animais; (5) Escala ordinal ou visual analógica para avaliar aspectos de bem-estar de frangos de corte?; (6) Desenvolvimento de uma lista fixa de termos em Português do Brasil para avaliação qualitativa do comportamento de frangos de corte e (7) Considerações finais. O estudo sobre dados de inspeção de abate apresenta o potencial do uso dos dados de condenação de carcaça como indicadores em um programa de monitoramento de bem-estar, desde que o órgão competente harmonize o procedimento de inspeção entre os Estados, defina os indicadores específicos a serem monitorados e integre dados de condenação, transporte e das granjas. O capítulo sobre a proposta de criação de um sistema de gerenciamento de bem-estar animal adaptou o método de Análise de Perigos e Pontos Críticos de Controle para fins de bem-estar, com potencial para redução a médio e longo prazo de problemas por meio de ações corretivas e preventivas; bem como possibilitou a inclusão das discussões de bem-estar em níveis corporativos mais altos nas empresas. No capítulo sobre o desenvolvimento e refinamento de indicadores, sujidade de aves foi refinado como um indicador de bem-estar de frangos de corte e dois indicadores adicionais, dermatite de contato das áreas de peito e abdômen e arranhadura de carcaça, foram desenvolvidos e testados. Os indicadores foram confiáveis entre os avaliadores e os resultados identificaram que os problemas eram prevalentes entre as aves avaliadas. O capítulo sobre o uso de escalas ordinal e visual analógica evidenciou que ambas escalas eram confiáveis e que a escala ordinal não se apresenta equidistante quando é medida pela escala visual analógica para os indicadores estudados. O estudo sobre avaliação qualitativa do comportamento demonstrou que a lista é confiável para avaliar as qualidades do comportamento que expressam emoções em frangos. A presente tese contribuiu com meios para que tomadores de decisão possam planejar ações em direção a uma agenda positiva para o bem-estar de frangos de corte. O resultado desejado desta tese é a produção de dados confiáveis para informar a sociedade a respeito das condições de bem-estar de frangos de corte, promovendo transparência dos processos e permitindo reais melhorias para os animais.

Palavras-chave: Bem-estar animal. Avaliação de bem-estar animal. Estratégia de bem-estar animal. Aves. Gestão da qualidade.

ABSTRACT

Brazil is an important broiler chicken producer, and the adoption of regular animal welfare assessment seems essential in this country. Assessments may occur at organizational level, by monitoring productive process, and at Federal level, through a broader welfare surveillance program. The use of scientific-validated animal-based measures to assess animal welfare has been fully encouraged. Thus, this thesis aimed to develop strategies and new indicators for broiler chicken welfare assessment tailored for the Brazilian context. The thesis is organized into seven chapters: (1) Presentation; (2) Broiler chicken meat inspection data in Brazil: a first glimpse into an animal welfare approach; (3) Proposal of a management system to develop an animal welfare strategy for the animal food chain; (4) Development and refinement of three animal-based broiler chicken welfare indicators; (5) Ordinal or visual analogue scales for assessing aspects of broiler chicken welfare?; (6) Development of a fixed list of terms in Brazilian Portuguese for the qualitative behaviour assessment of broiler chickens; and (7) Final considerations. The study about meat inspection data presents the potential use of carcass condemnation data of broiler chicken slaughterhouses as indicators in an animal welfare monitoring program provided that the competent authority harmonizes the procedure of meat inspection among states, sets specific animal welfare outcomes to be monitored, and integrates condemnation, transport and flock data. The chapter about the proposal of an animal welfare management system adapted the Hazard Analysis and Critical Control Point for animal welfare purposes, with potential for mid to long-term reduction of animal welfare problems through planned corrective and preventive actions and inclusion of animal welfare discussions to higher corporate levels in companies. From the results of the chapter on the development and refinement of animal-based indicators, bird soiling was refined as a broiler chicken welfare indicator, and two additional indicators, contact dermatitis on the breast and abdominal areas and carcass scratches, were developed and tested. Indicators were reliable among the raters and results identified problems were prevalent on the assessed birds. The chapter on the testing of ordinal and visual analogue scales evidenced that both scales were reliable, and ordinal scale is not equidistant when measured using visual analogue scale for the studied indicators. The study about the qualitative behaviour assessment suggests the fixed list is reliable to assess the expressive qualities of broilers behaviour. This thesis contributes to provide information to empower decision makers to plan actions to move forward a positive agenda for the welfare of broiler chickens. Desirable output expected from the chapters studied in the present thesis include reliable data to inform society about broiler chicken welfare conditions, giving transparency of the production process, and allowing for real improvements to the animals.

Keywords: Animal welfare. Animal welfare assessment. Animal welfare strategy. Poultry. Quality management.

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1 PRESENTATION

Brazil is the world's second largest broiler chicken producer, with a total of 5.8 billion birds slaughtered in 2017 (ABPA, 2018; IBGE, 2018). Broiler chickens are sentient beings, capable of having feelings. Thus, it is important to know the effects of the rearing systems on birds to avoid maltreatment and unnecessary suffering, to reduce or to mitigate injuries and diseases, and to promote practices that improve their quality of life. The large number of broiler chickens reared for meat consumption in Brazil makes the adoption of regular animal welfare assessments essential in this country.

Animal welfare assessment is expected to occur at private and Federal levels, the former by monitoring productive process, and the latter by a broader animal welfare surveillance program. In both cases, desirable outputs include reliable data that allow companies and governmental bodies to operate an animal welfare management system, where conformity of processes is observed, as well as the corrective and preventive actions taken to promote continuous improvement (MAIN et al., 2014).

The use of scientific-validated animal-based measures to assess animal welfare has been fully encouraged (EFSA, 2012; OIE, 2013; VEISSIER et al., 2008) since they directly represent animal condition. Much has been done to assess broiler chicken welfare in Brazil at pre-slaughter and slaughter levels through the application of the Brazilian regulation for humane slaughter IN 3/2000 (MAPA, 2000) and the European Directive 1099/09 for the exporting companies (EUROPEAN COMMISSION, 2009). However, on farm assessments are carried out by the companies according to their own quality programs, following international standards or certification protocols since a locally adapted protocol to assess broiler chicken welfare does not exist. The Welfare Quality® protocol (2009) for broiler chickens, the most used assessment tool, is an animal welfare assessment protocol that combines resource and animal-based measures.

This thesis was developed as result of recent application of the Welfare Quality® protocol to study the impact of animal welfare certification protocols in Brazilian broiler chickens (SOUZA et al., 2015). Practical on-farm use of this protocol identified some gaps on the measures to assess bird soiling, contact dermatitis on the breast area and on the qualitative behaviour assessment in the Brazilian context,

encouraging the study to improve those indicators. Other studies in Brazilian and Belgian broiler chicken farms also suggested those measures required improvements (FEDERICI et al., 2016; TUYTTENS et al., 2015). The absence of a validated scale to assess carcass scratches was an item observed during the application of the Welfare Quality® protocol and during the literature review. It was considered an important item of broiler chicken welfare to be developed in the present thesis to allow for the assessment of catching procedures and transport of birds to the slaughterhouse. The application of the Welfare Quality® protocol also includes the use of data collected from meat hygiene inspection at the slaughterhouse. In Brazil this data is available; however, there is not a routine to analyze it as part of a broader surveillance program and lack an animal welfare view of condemnation data to be used as animal-based indicators.

According to Ingenbleek et al. (2012), solutions to improve animal welfare depend on the context of each country. Thus, it seems relevant to study animal welfare in Brazil to understand which points need to be addressed and in which timescale. Based on this, this thesis aimed to develop strategies and new indicators for broiler chicken welfare assessment tailored for the Brazilian context, some of which may be directly generalized to other locations, others may inspire similar approach rationales. Chapter 2 presents the potential use of carcass condemnation data of broiler chicken slaughterhouses in Brazil as indicators in an animal welfare monitoring program and identifies points to be addressed to increase meat inspection data reliability regarding animal welfare interpretations. There is considerable potential to improve welfare surveillance using the meat inspection structure that is already in place for food safety purposes. In addition, the same principle of hazard analysis for food safety concerns may be applied to animal welfare issues, and meat inspection data may facilitate its development. Data from this chapter was presented at the UFAW International Animal Welfare Science Symposium in York/UK in 2016 (APPENDIX I) through the provision of the grant by the Universities Federation for Animal Welfare (ANNEX I), and at the Welfare of Animals at Farm Level Congress in Wageningen/NL in 2017 (APPENDIX II). The study was fully published in the Brazilian Journal of Poultry Science (APPENDIX III).

Chapter 3 proposed general guidelines for an animal welfare management system based on the Hazard Analysis and Critical Control Point to develop an animal welfare strategy appropriate for individual organizations of the animal food chain.

Several actions were proposed to adapt this method for animal welfare purposes, with potential for mid to long-term reduction of animal welfare problems through planned corrective and preventive actions and inclusion of animal welfare discussions to higher corporate levels in companies. The development of additional validated animal-based measures seemed crucial to improve animal welfare management systems. This chapter was published in CAB Reviews journal (APPENDIX IV).

Chapters 4, 5 and 6 were related to the development of animal-based measures to assess broiler chicken welfare. In chapter 4, bird soiling was refined as a broiler chicken welfare indicator and included the poor feathering condition of birds, and two additional indicators, namely contact dermatitis on the breast and abdominal areas and carcass scratches, were developed and tested. Relevant problems were prevalent and measurement consistency was acceptable, encouraging the application of these indicators in a variety of animal welfare conditions. In chapter 5, the application of ordinal (ORS) and visual analogue (VAS) scales for the assessment of contact dermatitis and bird soiling in broiler chickens was tested, evidencing that both scales were reliable, and ORS was not equidistant when measured using VAS for the studied indicators. Chapter 6 contributed to a comprehensive assessment of broiler chicken welfare by including the behavioural component to the animal-based indicators. In this chapter, a fixed list of terms in Brazilian Portuguese for the Qualitative Behaviour Assessment of broiler chickens was developed and tested, further concluding that it is a reliable tool to add valuable information in the welfare assessment of broiler chickens. Data from chapter 4 was presented at the Welfare of Animals at Farm Level Congress in Wageningen/NL in 2017 (APPENDIX V) and it was fully published in Animal Welfare Journal (APPENDIX VI). Chapter 5 was submitted to the Applied Animal Behaviour Science Journal (ANNEX II).

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2 BROILER CHICKEN MEAT INSPECTION DATA IN BRAZIL: A FIRST GLIMPSE INTO AN ANIMAL WELFARE APPROACH

RESUMO

Os objetivos deste trabalho foram estudar o uso de dados de condenação de carcaças de frangos de corte no Brasil como indicadores em um programa de vigilância de bem-estar animal e identificar pontos para serem melhorados para aumentar a confiabilidade dos dados. Dados de 2010 a 2015 dos estados do Paraná (PR), Santa Catarina (SC) e Rio Grande do Sul (RS) foram usados. Fraturas e hematomas eram registrados juntos, representando o problema mais prevalente, seguido por lesões de pele ou inflamação. No PR, o aumento progressivo nas condenações por contusão, artrite, má sangria e aerossaculite podem revelar importantes aspectos de bem-estar animal. Altas correlações entre indicadores de bem-estar animal no PR foram observadas com mais frequência do que no RS e em SC, talvez como resultado da implementação antecipada da padronização local das atividades de inspeção no PR. A análise de componentes principais demonstrou mudanças no padrão dos dados de condenação no PR após o processo de padronização, apontando contusão e problemas ligados à contaminação por *Escherichia coli* como as maiores causas de condenação relacionadas ao bem-estar animal. Observa-se considerável potencial para melhorar o monitoramento de saúde e bem-estar animal com o uso da estrutura da Inspeção Federal atualmente em prática para fins de segurança alimentar, desde que a autoridade competente harmonize os procedimentos de inspeção entre os estados, defina os indicadores de base animal específicos a serem monitorados e integre dados de condenação, transporte e lote. É crucial atualizar a coleta de dados para estabelecer uma rotina que permita a análise de risco para fins tanto de segurança alimentar como de bem-estar animal. Neste sentido, o trabalho cooperativo entre Inspeção Federal e indústria parece ser uma abordagem interessante para promover a transparência dos processos, que beneficiará a sociedade e os animais.

Palavras-chave: Indicadores baseados nos animais. Condenação de carcaças. Análise de risco. Avaliação de bem-estar animal. Vigilância de bem-estar animal.

ABSTRACT

We aimed to study the potential use of carcass condemnation data of broiler chicken slaughterhouses in Brazil as indicators in an animal welfare monitoring program, and to identify points to be addressed to increase data reliability. Data from 2010 to 2015 in the states of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS) were used. Fractures and bruising were recorded together, representing the most prevalent welfare problem, followed by skin lesion or inflammation. In PR, progressive increases on injury, arthritis, ineffective bleeding, and airsacculitis condemnation may reveal important welfare aspects. High correlation between animal welfare indicators within PR was more commonly observed than in RS and SC, perhaps as a result of earlier implementation of local meat inspection standardization. Principal component analysis showed changes on condemnation data pattern in PR after standardization, pointing injury and *Escherichia coli* problems as main causes for condemnation related to animal welfare. There is considerable potential to improve animal health and welfare surveillance using meat inspection structure that is already in place for food safety purposes, provided that the competent authority harmonizes the procedure of meat inspection among states, sets specific animal welfare outcomes to be monitored, and integrates condemnation, transport and flock data. It seems crucial to update data collection to establish a routine that allows risk analysis regarding both food safety and animal welfare. In this regard, cooperative work between Federal Inspection and companies seems an interesting approach to promote transparency of the production processes, which would benefit society and animals.

Keywords**:** Animal-based indicators. Carcass downgrading. Risk analysis. Welfare assessment. Welfare surveillance.

2.1 INTRODUCTION

Brazil is the second largest broiler chicken producer in the world. In 2015, about 5.2 billion broiler chickens were slaughtered in establishments under Federal Inspection Service (SIF) of the Ministry of Agriculture, Livestock and Food Supply (MAPA), and there is a projection of a 46.4% increase in chicken meat production by 2023. Simultaneously, there is increasing demand for information on ethical aspects of animal production. Based on this, governmental actions are increasing worldwide. In the European Union (EU), Directive 2007/43/CE (EUROPEAN COMMISSION, 2007), on the protection of chickens kept for meat production, sets out compliance inputs for poultry farms, such as maximum stocking density, minimum lighting intensity, and air quality parameters. Additionally, outputs such as mortality and meat inspection data are considered with the purpose of establishing maximum stocking density values. Dermatitis, parasitic infections and systemic illness are also measured by the official veterinarian at the slaughterhouse to identify signs of poor welfare.

Outcomes assessed at the slaughterhouse have the potential to improve animal welfare (GRANDIN, 2017). The use of carcass condemnation data as an official monitoring program of animal welfare (AW) is expected to promote practical consequences to animals, since feedback from slaughterhouse may gradually improve practices on farm (EUROPEAN COMMISSION, 2017). However, based on the EU example, there are challenges to effectively implement such control, mainly regarding the variability of procedures among Member States (BUTTERWORTH et al., 2016). Thus, EU Members States organized a network for exchanging technical information to improve implementation of the Directive 2007/43/CE. Additionally, meat inspection data have been considered useful to investigate animal welfare (CORREIA-GOMES et al., 2017, 2016; HUNEAU-SALAÜN et al., 2015; KNAGE-RASMUSSEN et al., 2015). Thus, creation and use of a meat inspection database seems to constitute a potential tool to improve public policies related to the welfare of farm animals. This seems also a practical approach, since there is a structure already in place with the primary purpose of controlling food safety, which may benefit AW actions.

In Brazil, the SIF is responsible for sanitary inspection at slaughterhouses under federal control and it is linked to the Department of Inspection of Products of

Animal Origin (DIPOA) of the MAPA. Inspection is performed by a permanent team composed by official veterinarians and auxiliary staff. Activities performed by the SIF are regulated by the Decree 30,691, known as RIISPOA, which establishes the procedures of sanitary inspection of animal origin products (BRASIL, 2017). Additionally, there is specific regulation for the inspection of broiler chicken meat (MAPA, 1998). All carcass condemnation data obtained by SIF is recorded at the information management system (SIGSIF) and reports are publicly available.

According to Vannier et al. (2014), a set of harmonized welfare outcome indicators may be used by competent authorities in the framework of inspection and by private sector to improve transparency in the market of animal products. Food production chain provides valuable data collection that can be used to improve disease control, animal health, public health and animal welfare. However, carcass condemnation data are not used for animal welfare purposes in Brazil. Our hypotheses were that broiler meat inspection data in Brazil comprises important AW indicators, and that adjustments are required to improve data collection. Thus, we aimed to study the potential use of carcass condemnation data of broiler chicken slaughterhouses in Brazil as indicators in an AW monitoring program and to identify points to be addressed to increase data reliability.

2.2 MATERIAL AND METHODS

Publicly available official slaughter and carcass condemnation data from January 2010 to December 2015 were obtained from the SIGSIF platform, MAPA website (www.agricultura.gov.br). Reports were generated in portable document format (PDF) and we transformed them into Excel® files to be analyzed. We then selected the three main producer States, Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS), all located in Southern Brazil. We analyzed general data regarding total and partial carcass condemnation in these three States. Additionally, we identified animal welfare target indicators (AWI) to be further assessed: abscess (ABS), airsacculitis/respiratory disease (AIR), arthritis (ART), ascites (ASC), bruises, contact dermatitis, dead on arrival (DOA), emaciation (EMA), dehydration, fracture, hepatitis (HEP), inadequate bleeding (INB), pericarditis (PER) and septicaemia (SEP) (EFSA, 2013, 2012; EUROPEAN COMMISSION, 2007). Temperature (ºC) and

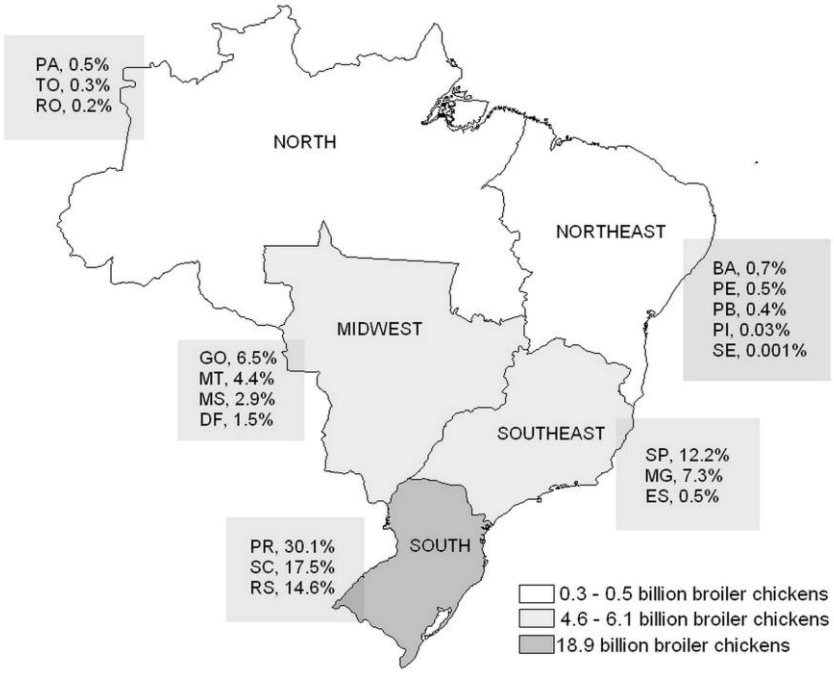
humidity (%) were collected from the National Institute of Meteorology (http://www.inmet.gov.br) for the same period to study correlations.

Meat inspection data was transformed in broiler chicken carcass condemnation per 100,000 birds. Descriptive statistics was used to verify the frequency of condemnations. Spearman rank correlation test was used to analyze correlation between carcass condemnation data and climate variables, correlation of each condemnation cause between and within States. Correlations where $R > 0.6$ were considered high, and $0.6 < R < 0.3$ were considered moderate. Nonparametric changepoint analysis (JAMES; MATTESON, 2013) was used to detected possible changepoint observed in carcass condemnation data from PR. Biplots based on Principal Component Analysis (PCA) were used to explore variance and covariance structure of data. PCA was based on the correlation matrix, using standardized data, to eliminate scale effects. The biplot was used to assess condemnation data and time simultaneously in a two-dimensional representation (RENCHER, 2003). This technique was applied to data from PR to further understand the effect of standardization of data collection within the State, to allow comparison of data in two periods, before and after the standardization procedure. Robustness of biplot was verified by identifying outlier values (LÓPEZ-DE-LACALLE, 2016) and repeating data analysis by replacing outlier with values derived from the statistical average of previous and subsequent months. Analysis were performed using R Statistical Computing Environment version 3.3.1 (R CORE TEAM, 2016).

2.3 RESULTS

The total number of broiler chickens slaughtered in Brazil under SIF, from January 2010 to December 2015, is observed in FIGURE 1. In Southern Brazil, almost 19 billion broiler chickens were slaughtered between 2010 and 2015, representing 62.2% of national broiler chicken production. Considering the 27 States in Brazil, there are 18 that produce broiler chicken meat, of which, Paraná accounts for one third of total national production.

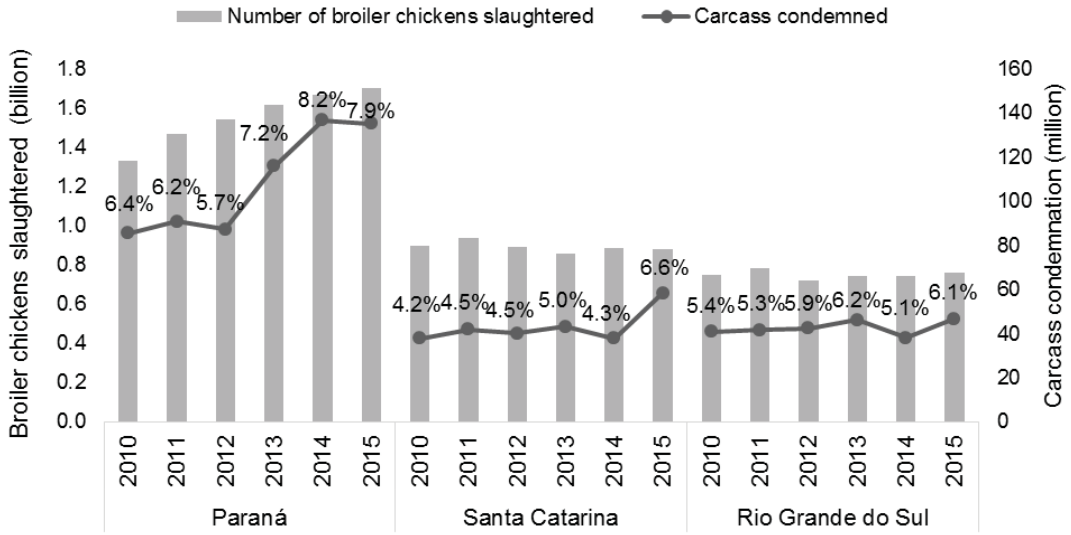
FIGURE 1 – BROILER CHICKEN SLAUGHTER IN BRAZIL, BY STATE AND REGION, FROM 2010 TO 2015. PERCENTAGES REFER TO THE PROPORTION OF THE TOTAL OF 30.4 BILLION BROILER CHICKENS SLAUGHTERED UNDER FEDERAL INSPECTION SERVICE; PR, PARANÁ; SC, SANTA CATARINA; RS, RIO GRANDE DO SUL; SP, SÃO PAULO; MG, MINAS GERAIS; GO, GOIÁS; MT, MATO GROSSO; MS, MATO GROSSO DO SUL; DF, FEDERAL DISTRICT; BA, BAHIA; PA, PARÁ; PE, PERNAMBUCO; ES, ESPÍRITO SANTO; PB, PARAÍBA; TO, TOCANTIS; RO, RONDÔNIA; PI, PIAUI; SE, SERGIPE



SOURCE: The author (2018), adapted from Ministry of Agriculture, Livestock and Food Supply, Brazil

General slaughter and carcass condemnation data for the States of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS) are presented in FIGURE 2. In PR broiler chicken slaughter increased by 27.9% from 2010 to 2015, with increased carcass condemnation rates; the moment for the changepoint was statistically estimated to be March 2013. In SC and RS, broiler chicken slaughter was stable from 2010 to 2015, and a tendency toward increasing carcass condemnation reports through these years was not observed. Higher condemnation in 2015 in SC occurred due to an unusual peak of condemnation for dermatosis in February (19,120/100,000 birds slaughtered); this was not representative of the situation in SC. Excluding data from February/2015, condemnation rate in 2015 was slightly high in SC, reaching 5.6%.

FIGURE 2 – NUMBER OF BROILER CHICKENS SLAUGHTERED, AND NUMBER OF CARCASSES CONDEMNED IN THE STATES OF SOUTHERN BRAZIL, FROM 2010 TO 2015. COLUMNS REFER TO BROILER CHICKENS SLAUGHTERED, LINES AND PERCENTAGES REFER TO CARCASS CONDEMNATION

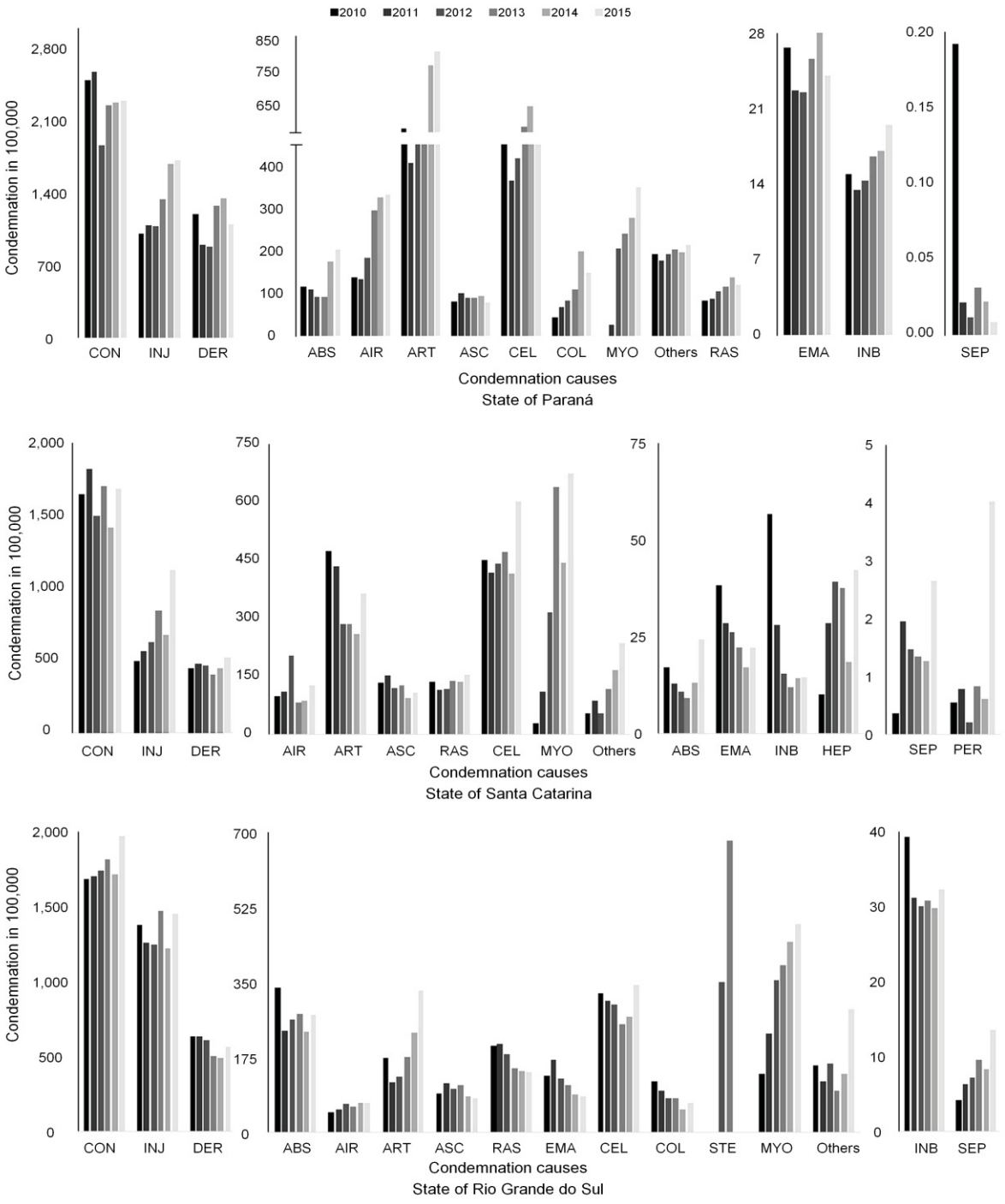


SOURCE: The author (2018), adapted from Ministry of Agriculture, Livestock and Food Supply, Brazil

Animal welfare indicators and the main causes for carcass condemnation in PR, SC and RS are presented in FIGURE 3. Causes for condemnations that were below 80/100,000 carcasses were presented as ‘others’, such as coligranuloma, over scalding, delayed evisceration, myositis, tumor, salpingitis and hemorrhagic syndrome. Paraná reported additional data for aspergillosis, hypertrophy and omphalitis; SC for colibacillosis and omphalitis; and RS for nephritis, myocarditis and enteritis. There was no record for the prevalence of contact dermatitis, DOA and dehydration.

Considering AWI, bruises and fractures were both registered as injury, with no discrimination between them. Injury was the main cause of condemnation in PR, SC and RS, representing, in 2015, 22.1% of items condemned in PR, 19.4% in SC and 23.7% in RS. Dermatosis was the second most common cause in PR (14.8%) and in RS (9.1%). Increasing occurrence of a type of myopathy, named as dorsal cranial myopathy (MYO), was observed in the three States (FIGURE 3). From 2010 to 2015, MYO increased from 0.01% to 4.4% of total of carcasses downgraded in PR, being the sixth cause of condemnation in this State in 2015. In SC, MYO was the second cause of condemnation in 2015, moving from 0.1% to 10.1% of total of carcasses downgraded; and it was the third cause of condemnation in RS, moving from 0.7% to 8.1%.

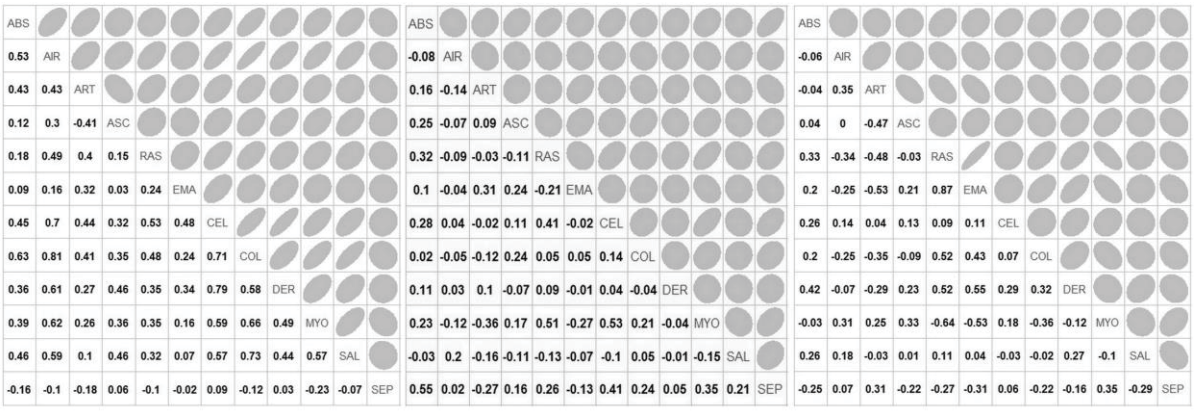
FIGURE 3 – BROILER CHICKEN CARCASS CONDEMNATION PER 100,000 BIRDS IN THE STATES OF PARANÁ, SANTA CATARINA AND RIO GRANDE DO SUL, SOUTHERN BRAZIL, FROM 2010 TO 2015. CON, CONTAMINATION; DER, DERMATOSIS; INJ, INJURY; ABS, ABSCESS; AIR, AIRSACCULITIS; ART, ARTHRITIS; ASC, ASCITES; CEL, CELLULITIS; COL, COLIBACILLOSIS; STE, STEATOSIS; MYO, DORSAL CRANIAL MYOPATHY; RAS, ABNORMAL ASPECT; EMA, EMACIATION; INB, INADEQUATE BLEEDING; SEP, SEPTICAEMIA; HEP, HEPATITIS; PER, PERICARDITIS; OTHERS INCLUDE ALL REASONS FOR CONDEMNATIONS BELOW 80/100,000 CARCASSES, EXCEPT TARGET ANIMAL WELFARE INDICATORS OF INTEREST IN THIS STUDY



SOURCE: The author (2018), adapted from Ministry of Agriculture, Livestock and Food Supply, Brazil

In PR, high correlations between condemnation causes were more commonly observed than in RS and SC (FIGURE 4). Principal component analysis in PR showed changes in the condemnation data pattern after a standardization procedure was introduced in 2012 (FIGURE 5). For example, one group of indicators was strongly related with the component 1, representing 39.4% of total data variability. The group was composed of the indicators INJ, ABS, AIR, CEL, COL and DER. Notification of indicators was strengthened in 2014 and 2015 in PR, observed by the distribution of dates in FIGURE 5. Outliers did not cause significant changes on original data.

FIGURE 4 – CORRELATION OF BROILER CHICKEN CARCASS CONDEMNATION INDICATORS IN THE STATES OF PARANÁ, SANTA CATARINA AND RIO GRANDE DO SUL, SOUTHERN BRAZIL, FROM 2010 TO 2015 (BROILER CHICKEN CARCASS CONDEMNATION PER 100,000 BIRDS). ABS, ABSCESS; AIR, AIRSACCULITIS; ART, ARTHRITIS; ASC, ASCITES; RAS, ABNORMAL ASPECT; EMA, EMACIATION; CEL, CELLULITIS; COL, COLIBACILLOSIS; DER, DERMATOSIS; MYO, DORSAL CRANIAL MYOPATHY; SAL, SALPINGITIS; SEP, SEPTICAEMIA; HEP, HEPATITIS; PER, PERICARDITIS; ELLIPSE SHAPE IS DIRECTLY PROPORTIONAL TO CORRELATION STRENGTH, HIGHER CORRELATIONS APPEAR CLOSE TO AN ELLIPSE FORMAT; THE ORIENTATION OF THE ELLIPSE INDICATE POSITIVE (UPWARDS TO THE RIGHT) OR NEGATIVE (UPWARDS TO THE LEFT) CORRELATIONS

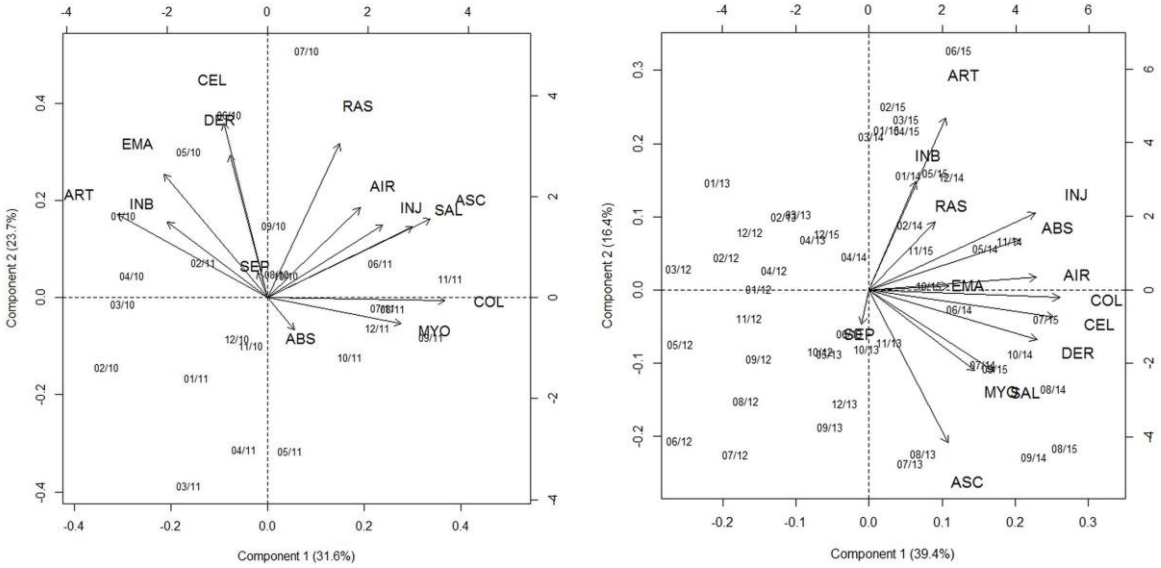


SOURCE: The author (2018).

We observed disparate values among the three States. As an example, condemnation data for abscess in RS and PR were, respectively, 21.0 and 8.8 times greater than the reported value in SC; and there was almost double the rate of condemnation for dermatosis in PR as compared to SC and RS. There was poor correlation in respect to condemnation rates among the three States. High correlation was observed for arthritis between PR and RS ($P < 0.001$; $R = 0.86$), injury between

PR and SC (P < 0.001; R = 0.62), and for ascites between PR and SC (P < 0.001; R = 0.66), PR and RS (P < 0.001; R = 0.81) and between SC and RS (P < 0.001; R = 0.83). Ascites was the only AWI that presented high correlation with a climate variable (Temperature; SC, P < 0.001, R = -0.71; RS, P < 0.001, R = -0.76; PR, P < 0.001, R = -0.61). Other correlations between condemnation data and climate variables were moderate and low.

FIGURE 5 – PRINCIPAL COMPONENT ANALYSIS OF BROILER CHICKEN CARCASS CONDEMNATION INDICATORS IN THE STATE OF PARANÁ, SOUTHERN BRAZIL, FROM 2010 TO 2011, AND FROM 2012 TO 2015. DER, DERMATOSIS; ABS, ABSCESS; AIR, AIRSACCULITIS; ART, ARTHRITIS; ASC, ASCITES; CEL, CELLULITIS; COL, COLIBACILLOSIS; MYO, DORSAL CRANIAL MYOPATHY; RAS, ABNORMAL ASPECT; EMA, EMACIATION; SAL, SALPINGITIS; SEP, SEPTICAEMIA; NUMBERS INSIDE THE BIPLOT REPRESENT MONTH/YEAR OF THE DATA DERIVED FROM THE DATABASE



SOURCE: The author (2018).

2.4 DISCUSSION

2.4.1 Broiler chicken condemnation data in Brazil

High prevalence of injury, skin problems and arthritis observed in Southern Brazil had already been observed in carcass condemnation data from 2006 to 2011 (OLIVEIRA et al., 2016); thus, these items have been important animal welfare

issues in Brazil for a decade. Discrimination between bruises and fractures is described in scientific literature (GRANDIN, 2010) and is an important point to be improved with regard to meat inspection data in Brazil. Bruising and fractures used to be controlled separately as part of the MAPA Circular 294/2006, which established that companies had to implement self-monitoring programs, including animal welfare, and determined SIF as responsible for verifying those programs. Circular 294/2006 was repealed, and current regulation about self-monitoring, Normative 01/2017, does not include the requirement for assessing injuries. In addition, data provided by self-monitoring programs were not recorded in the national database, and remain under used or even unused. Moreover, recognition of the relevance of injuries as a food safety problem may be variable amongst official veterinarians. Consequently, low values may be reported due to the acceptance of injured meat by less demanding markets or to be used as raw material in processed products. In this case, the inclusion of an AW concept to carcass condemnation data is encouraged to provide a standard procedure within all Brazilian States.

According to MAPA, dermatosis is a generic term used to record any skin or meat lesion without inflammation; and inflammatory processes, such as cellulitis and dermatitis, must be recorded as specific indicators (MAPA, 1998). There was no record of condemnation for contact dermatitis. In the case of footpad dermatitis, absence of records occurred because broiler chicken feet with contact dermatitis are exported as lower grade product authorized by DIPOA to China and Hong Kong. In other cases, feet that were not marketed were discarded before inspection by the competent authority. Thus, since feet were not condemned, there was no official record about the incidence of footpad dermatitis. Since dermatosis includes a wide range of occurrences, it may contribute to high variability between SIF records, and is a potential item to be improved on data collection. In addition, considering that contact dermatitis is relevant to broiler chicken welfare (EFSA, 2012; EUROPEAN COMMISSION, 2017), the implementation of an official monitoring program covering this issue seems crucial in Brazil.

Dorsal cranial myopathy (MYO) has been observed in Brazil since 2006, and it was reported as a lesion of the anterior latissimus dorsi (ALD) muscle (ZIMMERMANN et al., 2012). Zimmermann et al. (2012) suggested that MYO is related to fast growing breeds, whose body is unbalanced and may cause intermittent interruption of blood flow of ALD when wings move over the large

pectoral muscle of birds. Information about causes of MYO and its impact on animal welfare is scarce. Other studies about similar myopathies in broiler chickens have discussed the influence of genetics (PETRACCI et al., 2015) and both genetics and environment (BAILEY et al., 2015). Due to the possible correlation of MYO with items that impact broiler chicken welfare and its intrinsic welfare impact, it seems an interesting indicator to be recorded and further studied.

In PR, where both percent condemnation and number of carcasses slaughtered increased, progressive increase in condemnation rates for injury, inadequate bleeding, arthritis and airsacculitis may indicate important welfare aspects to be considered. For example, injury may increase if employees are not adequately trained to handle live birds and if structure to transport live birds or staff responsible for catching and shackling birds is undersized (GRANDIN, 2010). In the case of PR, the competent authority at each slaughterhouse may accept carcasses or parts of carcass with small bruises. Nevertheless, condemnation for injury increased. Thus, we consider it important to assess whether the whole production chain structure, including activities where live birds are handled, presented a proportional increase as that observed in the number of broiler chickens slaughtered.

The extent of blood loss is affected by stunning, type of neck cut, time between stunning and bleeding and time for bleeding (BILGILI, 1988). All causes mentioned are controlled by SIF, by the national Ordinance 210/1998 and the Normative Instruction 3/2000. In addition, modification of the processing line speed must be approved by SIF regarding food safety concerns and proper post-mortem inspection. However, higher line speed combined with expansion of Halal meat exportation in PR may have affected bleeding efficiency. In PR, exportation of broiler chicken products to Middle East countries increased 70.0% from 2010 to 2015. Faster line speed requires more staff to perform neck cut during religious slaughter, thus space on the slaughter line and/or number of employees for neck cutting may potentially be insufficient. An indicator of bleeding efficiency based on the ratio between line speed and number of employees for manual slaughter may be an interesting approach to be studied in Brazil.

Condemnation for ART and AIR suggest that changes promoted in the broiler chicken industry in PR in the last six years, like migration from natural lit poultry houses to those working exclusively with artificial lighting (SOUZA et al., 2015), had negative impacts on animal welfare and should be scrutinized from this perspective.

Even though genetics has been pointed as the main cause for skeletal disorders in fast growing breeds, the lack of bird activity aggravates the problem (BRADSHAW et al., 2002; EFSA, 2010). In the case of PR, broiler activity may have been reduced by both increased stocking density and low lighting, contributing to higher levels of skeletal disorders. High stocking density is also correlated to reduced air quality, increased heat stress and increased transmission of infectious diseases. Thus, higher condemnation for airsacculitis may indicate worse managing practices on farm since factors associated to the etiology of air sac disease are poor air quality, mainly high levels of dust and ammonia, associated with *Mycoplasma gallisepticum* or *Escherichia coli* infection (EFSA, 2012; GROSS, 1961). Additionally, thermal conditions have the potential to cause stress and, thus, to decrease the immune response in poultry (LARA; ROSTAGNO, 2013), predisposing birds to disease.

Dead on arrival is controlled by SIF for each batch slaughtered and data may be recorded at SIGSIF. In addition, DOA higher than 1% must be reported to the Animal Health Service of each State, according to the MAPA Normative Instruction 17/2006. However, these data were not available for consultation and were not presented on SIGSIF condemnation reports, which prevented us to further study this indicator. In Brazil, both staff and a database to register this information are already in place. Thus, it seems feasible to standardize the procedure of registering and analyzing DOA, as well as making it publicly available, representing a structural advancement for the meat chain and public policies.

Correlations of ascites and temperature, as well as the correlation of ascites data among the three States in Southern Brazil, suggest it is a well-established health indicator at SIF. Disparate results in other indicators may be caused by several factors. Specific characteristics of each company, such as orientation to broiler chicken farmers, infrastructure, management policies, export market and labor will directly affect carcass condemnation data. Thus, it is possible that weak correlations between condemnation categories in certain states could be a consequence of combining data from companies with heterogeneous management practices and health problems, which may be further explored in future studies. However, lack of standardization is one weakness of meat inspection as health and animal welfare surveillance system (HUNEAU-SALAÜN et al., 2015). Based on our data, difference on carcass evaluation among SIF seemed to be the core point to improve quality of meat inspection data.

The specific Brazilian regulation about broiler chicken slaughter, Ordinance no. 210/1998, includes a list of condemnation causes to be reported by the SIF of each plant (MAPA, 1998). It is not an exhaustive list; however, it covers most of the selected AWI. In general, States in Southern Brazil recorded items demanded by national ordinance; however, each local SIF personnel may provide additional information and each State may standardize which items will be informed in the SIGSIF. This has created variations across States. Since 2009, MAPA has demanded States to set guidelines for the management of inspection service, including the standardization of post-mortem procedures. As example, in PR, a group of official veterinarians met in 2012 to discuss about criteria for carcass evaluation and destination, and outputs from this meeting oriented SIF personnel in each slaughterhouse within the State. We observed that the standardization of procedures in PR took about one year to be fully visible, clearly dividing general condemnation data into two levels, before and after 2013 (FIGURE 2) and changing condemnation data pattern (FIGURE 5). It may be the result of strengthened training performed with SIF staff, in addition to possible problems related to broiler chicken chain. In RS, the memorandum 048/SICAO/014 and a manual were published in 2014 and 2015, respectively, to guide official veterinarians within the State. As result, since 2014 data from RS seem better organized regarding terms used to describe cause and type of condemnation; however, information about downgrading of parts and giblets, including condemnation for hepatitis and pericarditis, was suppressed. Similarly, in PR condemnation of liver for hepatitis and heart for pericarditis have been recorded as carcass partial condemnation for colibacillosis since 2012, with the loss of valuable information. Thus, the standardization procedure adopted in Southern Brazil may lead to unreported indicators, reducing power of condemnation data as a surveillance system for animal health and welfare.

Higher coherence of indicators presenting high correlation in PR, as compared to SC and RS (FIGURE 4) may be a result of the standardization of meat inspection procedure. In contrast to PR, lack of high correlation among condemnation data in SC (FIGURE 4) may point variance on carcass judgment. The development and maintenance of a robust system of meat inspection data collection at national level is challenging. Regional organization of SIF proposed in Brazil may be more dynamic and improve activities within each State as compared to a national guidance; however, it may result in increased variation among States, creating uncertainty

about the efficiency of Competent Authority in delivering reliable data. It seems advisable that standardization be either centralized at federal level by MAPA or that the regional organization be indirectly guided by MAPA.

2.4.2 Federal Inspection Service potential to improve animal welfare in Brazil

Brazilian Federal Inspection Service has been working to push companies to higher sanitary status to prevent foodborne diseases. This has been achieved through the implementation of hazard analysis and critical control points program (HACCP). In Brazil, since 1998 animal product processors are demanded to implement HACCP, but in broiler chicken slaughterhouses implementation has been strengthened since 2006, with the publication of Circular 668/2006. The same principle of hazard analysis for food safety concerns may be applied to animal welfare issues (ALGERS et al., 2009; SMULDERS, 2009). This is a new research area, and meat inspection data may facilitate its development. Potential AWI may be chosen as critical control points to be monitored, including the proposal of setting critical limits for AWI. Self-monitoring programs by companies may be an interesting approach to increase AW data collection, in addition to condemnation data collected by the competent authority. As stated by Short and Toffel (2008), success of self-monitoring depends on the continued involvement of regulators with coercive powers. Thus, SIF supervision on food safety and animal welfare issues to support activities on animal production seems essential.

Brazilian government was moving to pass responsibility of meat inspection to industry. Reducing SIF operation will also affect surveillance in AW at the slaughterhouse, because it is part of the official veterinary activities. Similarly, in 2016 the Department of Environment, Food and Rural Affairs tried to put the welfare code on chicken farming under the control of the poultry industry in the United Kingdom. This process was interrupted mainly due to public opinion and pressure from non-governmental organizations. Recent disclosure of Brazilian Federal Police investigation related to meat inspection revealed high public concern about meat quality. Thus, it is advisable that the MAPA take public opinion into consideration, since consumers represents a powerful stakeholder in the food chain. In the case of Brazil, society was not inquired about the changes on food inspection system

proposed by MAPA, which may be detrimental to the relation between society, government and industry.

2.5 CONCLUSION

The inclusion of an AW view on meat inspection data is a new concept that seems applicable to Brazil, since the data present information with potential use as AW indicators. Our results indicate a need to harmonize SIF procedures among States, to set specific AW outcomes to be monitored and to integrate condemnation, transport and flock data. Points to be improved include differentiation of bruising from fracture when recording these lesions; refined assessment of skeletal disorders and contact dermatitis; and monitoring the ratio of line speed and number of employees for neck cutting. Results suggest a need to update data collection to keep pace with modern animal production, as well to establish a routine of data analysis as part of risk analysis for both food safety and animal welfare. Overall, there is considerable potential to improve animal health and welfare surveillance using the structure of meat inspection that is already in place for food safety purposes, provided that MAPA addresses issues related to the weakness of data collection process. In this regard, cooperative work between Federal Inspection and companies seems to be an interesting approach to increase public information about animal welfare and to promote transparency of production process, which would benefit society and animals.

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3 PROPOSAL OF A MANAGEMENT SYSTEM TO DEVELOP AN ANIMAL WELFARE STRATEGY FOR THE ANIMAL FOOD CHAIN

RESUMO

Este estudo teve como objetivo propor diretrizes gerais para um sistema de gerenciamento de bem-estar animal baseado na Análise de Perigos e Pontos Críticos de Controle (APPCC), de modo a desenvolver uma estratégia de bem-estar para a cadeia de produção animal. As principais adaptações para os passos anteriores à análise de perigos incluíram a descrição da espécie animal e seu uso pretendido, e o desenvolvimento de um fluxograma detalhando as operações onde os animais vivos são manejados, focando em procedimentos de manejo animal em cada etapa da produção animal ou do processo produtivo. A análise de perigos incluiu considerações de todos os tipos de problemas de bem-estar que podem ocorrer em cada etapa ou estágio de produção listados no fluxograma. A duração do perigo, incluindo a duração de suas consequências, foram adicionadas na caracterização do perigo. As principais mudanças no estabelecimento de limites críticos para pontos críticos de controle incluíram a proposição de se estabelecerem metas iniciais de indicadores baseados nos animais enquanto dados cientificamente validados são produzidos. Ações corretivas consideraram o conceito de implementação de procedimentos em tempo real para prevenir o sofrimento animal, bem como a possibilidade de redução dos perigos identificados para futuros animais. Com a implementação de um sistema baseado no APPCC, as organizações serão estimuladas a reduzirem os níveis de problemas de bem-estar animal identificados, com potencial de redução de médio a longo prazo por meio de ações corretivas e preventivas planejadas. A aplicação do sistema de gerenciamento pode promover o bem-estar animal em níveis corporativos mais altos nas organizações, o que é necessário para o desenvolvimento de uma estratégia de bem-estar animal, promovendo transparência dos processos na produção animal.

Palavras-chave: APPCC. Avaliação de bem-estar animal. Indicadores baseados nos animais. Gerenciamento da qualidade.

ABSTRACT

This study aimed to propose general guidelines for an animal welfare management system based on the Hazard Analysis and Critical Control Point (HACCP) to develop an animal welfare strategy appropriate for individual organizations of the animal food chain. Main adaptations for steps within pre-hazard analysis included description of the animal species and its intended use, the development of a flow diagram detailing operations where live animals are handled and focusing on animal handling procedures for each stage of animal production or process step. The hazard analysis step included considerations of all kinds of welfare problems that may occur in each step or production stage listed at the flow diagram. Hazard duration, including duration of its consequences, were added to the hazard characterization step. Main changes on establishing critical limits for critical control points included a proposal to set initial thresholds for animal-based measures while scientific-validated data are obtained. Corrective actions considered the concept of implementing real time procedures to avoid animal suffering, as well as the possibility of reducing identified hazards for future animals. By implementing the HACCP-based system, companies will be prompted to reduce levels of identified animal welfare problems, with potential for mid to long-term reduction of animal welfare problems through planned corrective and preventive actions. Application of the management system may take broader animal welfare discussions to higher corporate levels in companies, needed for the development of an animal welfare strategy, and may promote transparency of processes in animal production.

Keywords: HACCP. Animal welfare assessment. Outcome-based indicator. Quality management.

3.1 INTRODUCTION

There seems to be an interesting trend in promoting animal welfare (AW) strategies as mechanisms for the implementation of concrete actions, optimizing the incorporation of the many factors and complexities involved in AW management. Good examples are The World Zoo and Aquarium Animal Welfare Strategy (MELLOR; HUNT; GUSSET, 2015) and The Global Strategy on Animal Welfare (OIE, 2017). The Hazard Analysis and Critical Control Point (HACCP) is a science-based food safety management system widely implemented in the food industry. The aim of the HACCP is to stimulate improvement in food safety practices through the establishment of targets or standards to be implemented by the industry (HULEBAK; SCHLOSSER, 2002). Following the well-established HACCP rationale as part of an animal welfare management system (AWMS), a strategy for the animal food chain may be designed with the goal of stimulating and supporting organizations in the development of AW-oriented plans to improve AW on farm, during transport and at slaughterhouses. The relevance of an AW strategy for the animal food chain relates to the growing public concern regarding farm animals (VANHONACKER; VERBEKE, 2014; VERBEKE, 2009). Additionally, the management of AW risks has been discussed worldwide as a tool to help government and companies in improving the conditions in which animals are kept or handled (SMULDERS; ALGERS, 2009). The European Food Safety Authority (EFSA) conducted several AW risk analyses, with different approaches (EFSA, 2006, 2007a, 2007b, 2007c, 2008, 2009). In this regard, the EFSA published a guide on AW risk assessment (EFSA, 2012a) to harmonize future activities. Recently, the International Organization for Standardization published the technical specification ISO/TS 34700:2016, about general requirements and guidance of AW management for organizations in the food supply chain (ISO, 2016).

As evidenced on the EFSA report (EFSA, 2012a), risk assessment is expected to be conducted to support decisions or changes on animal production that may impact AW, such as changing transportation or choosing between different stunning methods. In this case, both harms and benefits to AW may be evaluated. The HACCP is process-specific and is expected to be conducted in an existing process and to deal with existing hazards that, in the context of our goal, may lead to poor AW. However, risk assessment and HACCP may work as feedback systems to each other, since outputs from risk assessment may result in new information to update

the HACCP plan (SUMNER; ROSS; ABABOUCH, 2004), and the HACCP plan may provide valuable information to risk analysis or may motivate the conduction of a risk analysis to address a specific problem.

The HACCP-based system has already been recommended to monitor critical procedures related to AW at the slaughterhouse (FAO, 2001; GRANDIN, 2000). However, the use of HACCP on farm for both food safety and AW purposes is challenging. The European Commission encourages application of HACCP principles on farm by stating that food safety hazards present at the level of primary production should be identified and adequately controlled (EUROPEAN COMMISSION, 2004). Thus, organizations should not only perform hazard analysis to identify and classify potential hazards. They should implement a management system that links hazards to monitoring procedures, control measures and corrective actions.

Several studies have been carried out in the last decade to fully or partially implement a HACCP-based system for different purposes at farm level, such as food safety, animal health and welfare (BELL et al., 2009; HEGELUND; SORENSEN, 2007; HORCHNER et al. 2006; HORCHNER; POINTON, 2011; LIEVAART et al. 2005; MCALOON et al. 2015; METZ et al., 2015; NOORDHUIZEN; BOERSEMA 2008; VON-BORELL et al., 2001). Additionally, there are proposals for food safety, animal health and AW to be integrated into a HACCP-based program (DE PASSILLÉ; RUSHEN, 2005; NOORDHUIZEN; METZ, 2005). Since animal health is part of AW (BROOM; FRASER, 2015), the development of a HACCP-based program covering the former will also reach important issues of the latter. However, this association may be complex and addressing certain diseases may require broader welfare approaches. As example, lameness in broiler chickens causes animal suffering and is closely related to genetic selection for fast growing and weight gain (EFSA, 2010), which makes its resolution difficult and poorly discussed at farm level. Perhaps an HACCP-based system will stimulate organizations to be more proactive, inducing close monitoring of processes and the required work on solutions to AW challenges.

Expert analysis to develop generic HACCP plans for each production chain is important to identify main risk factors to AW; however, the complete development of a HACCP-based system will include a process-specific approach (HEGELUND; SORENSEN, 2007). Based on this, application of a HACCP-based system needs to be done by each organization, considering the characteristics of each process. It is

important to consider that the use of a HACCP plan to build an AWMS requires many adaptations. Based on this, the aim of this study was to propose general guidelines to develop an animal welfare management system based on the Hazard Analysis and Critical Control Point to develop an animal welfare strategy appropriate for individual organizations of the animal food chain. Specific objectives include to propose adaptations to the HACCP system to AW purposes and to identify points to be addressed to strengthen the application of an AWMS.

3.2 REVIEW METHODOLOGY

We reviewed academic papers using the terms animal health, animal welfare, HACCP and risk assessment. We followed the reference guide about HACCP for food safety from the Codex Alimentarius Commission of the World Health Organization and the Food and Agriculture Organization of the United Nations to propose adaptations towards an animal welfare HACCP system. In addition, we used references from scientific reports on animal welfare from the European Food Safety Authority.

3.3 TERMINOLOGY OF THE ANIMAL WELFARE MANAGEMENT SYSTEM

The terminology of the HACCP for food safety originated from the Codex Alimentarius Commission (CAC) of the World Health Organization (WHO) and Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE) and the International Plant Protection Convention (IPPC) (EFSA, 2012b). For AW purposes, it is necessary to adapt the original terminology (SMULDERS, 2009). Definitions for AW risk assessment have already been published (EFSA, 2012a; SMULDERS, 2009), which are in part reproduced in TABLE 1. We provided additional suggestions of terms to include all steps of the HACCP system, following the CAC (2003) (TABLE 1).

TABLE 1 – TERMINOLOGY FOR THE APPLICATION OF AN ANIMAL WELFARE MANAGEMENT SYSTEM BASED ON THE HAZARD ANALYSIS AND CRITICAL CONTROL POINT

Term	Description
Critical control point	A step at which control can be applied and is essential to prevent, reduce to an acceptable level or eliminate *an animal welfare* hazard (CAC,

Term	Description
	2003).
Critical limit	A criterion which separates acceptability from unacceptability (CAC, 2003).
Control measure	Any action and activity that can be used to prevent, reduce to an acceptable level or eliminate *an animal welfare* hazard (CAC, 2003).
Corrective action	Any action to be taken when the results of monitoring at the critical control point indicate a loss of control (CAC, 2003). *For animal welfare purposes, the corrective action may be effective for the next batch or animal.*
Factor	Any aspect of the environment of the animal in relation to housing and management, animal genetic selection, transport and slaughter, which may have the potential to impair or improve their welfare (EFSA, 2012a).
Hazard	A factor with the potential to cause poor welfare (EFSA, 2012a).
Hazard analysis	The process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for *animal welfare* and therefore should be addressed in the *HACCP-based plan* (CAC, 2003).
Hazard characterization	The qualitative and quantitative evaluation of the nature of the adverse effects associated with the hazard. Considering the scope, the concerns relate exclusively to animal welfare (SMULDERS, 2009).
Hazard identification	The identification of any factor, from birth to slaughter or the end of the animal's life, capable of causing adverse effects on animal welfare (SMULDERS, 2009).
Monitor	The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a critical control point is under control (CAC, 2003).
Organization	Person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives (ISO, 2016).
Plan	A document prepared to ensure control of hazards which are significant for *animal welfare* in the segment of the food chain under consideration (CAC, 2003).
Risk	A function of the probability of an adverse effect and the severity of that effect, consequent to a hazard for animal (SMULDERS, 2009).
Verification	The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan (CAC, 2003).

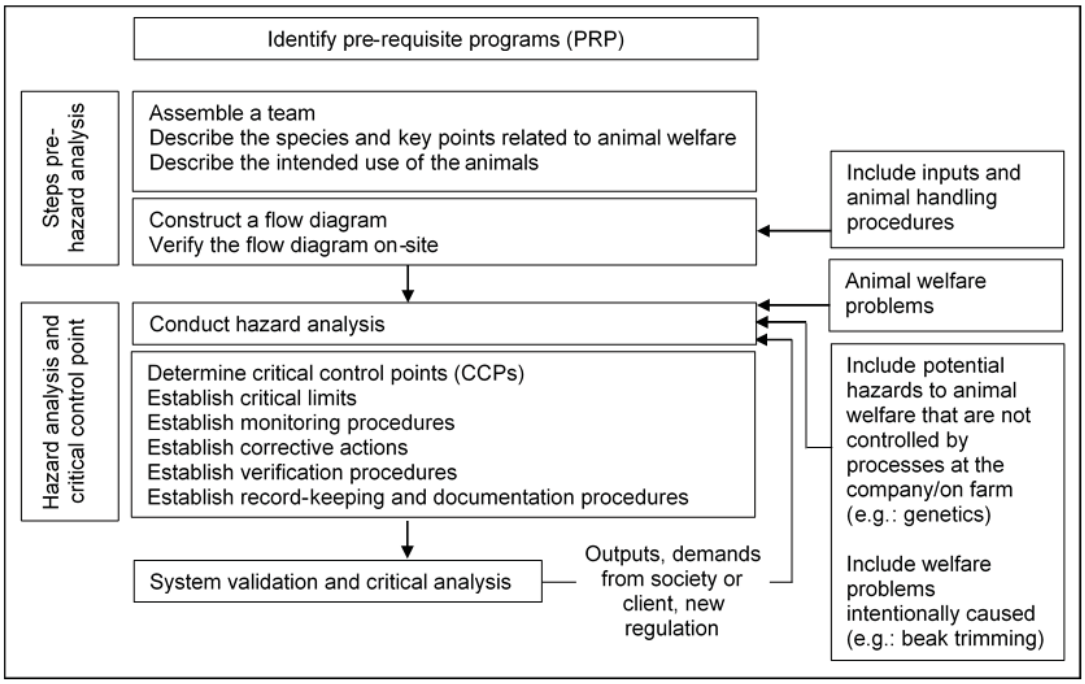
SOURCE: The author (2018), adapted from CAC (2003), EFSA (2012a) and SMULDERS (2009).
NOTE: adapted terminology is marked in italics.

3.4 PRE-REQUISITE PROGRAMS

HACCP concept has been described as very promising to control processes on farm (NOORDHUIZEN; ELPELO, 1996; PAPADEMAS; BINTSIS, 2010). However, successful development of a HACCP-based system will depend on the fully implementation of pre-requisites programs (PRP) (CAC, 2003), which in the case of animal production are the good agricultural practices (GAP). Many controls applied

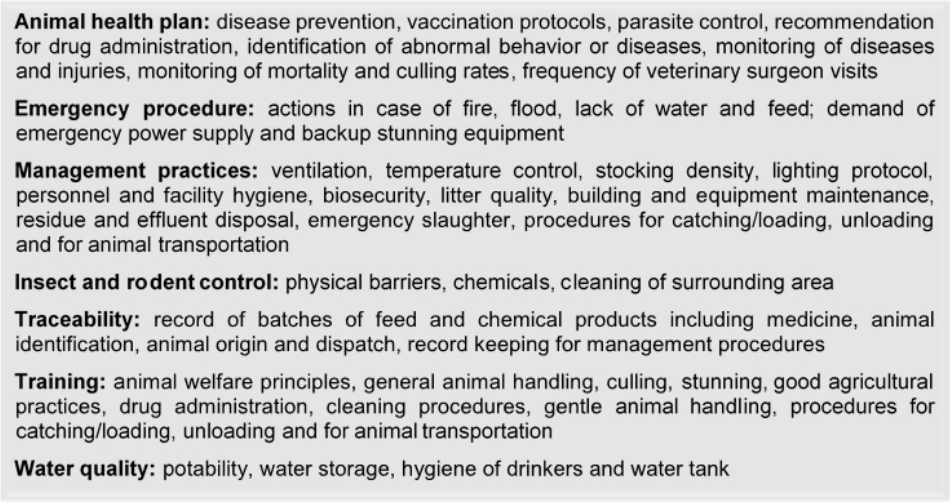
on primary production will be supported by GAP and will not become critical control points (CCP) (BROWN, 2000; CERF, 2011). Thus, implementation of PRP is mandatory prior developing a HACCP plan (FIGURE 6). As example, rodents may be considered a risk to farm animal health due to the spread of pathogens, but if there is a robust rodent control procedure in place, the hazard to animal health will be controlled and monitored by GAP and not by an additional CCP. In other example, power outage may be a risk to broiler chicken welfare, since birds will suffer from thermal discomfort and may die. However, if the farmer has a contingency plan in which an emergency power supply is mandatory, this risk will be safely controlled. When the organization fails to implement GAP, application of HACCP will be impractical since there will be too many CCP. In addition, adherence of farmers to an AWMS may be strengthened by previous knowledge and development of GAP, mainly because farmers may feel that most controls are part of their daily activity (CERF, 2011). Guidelines and standards for best practices on primary production are available from FAO and OIE (FAO; FIC, 2004; FAO; OIE, 2010), and also from certification protocols (GLOBALGAP, 2017a, 2017b, 2017c, 2017d, 2017e). Examples of PRP are given in FIGURE 7, which it is not an exhaustive list.

FIGURE 6 – GENERAL SCHEME OF AN ANIMAL WELFARE MANAGEMENT SYSTEM BASED ON HAZARD ANALYSIS AND CRITICAL CONTROL POINT



SOURCE: The author (2018), adapted from CAC (2003).

FIGURE 7 – EXAMPLES OF PRE-REQUISITES PROGRAMS AND THEIR MAIN TOPICS IN AN ANIMAL WELFARE MANAGEMENT SYSTEM BASED ON HACCP



SOURCE: The author (2018).

3.5 STEPS PRE-HAZARD ANALYSIS

Once the PRP are in place, the first step is to form the HACCP team, which should be multidisciplinary, with appropriate knowledge on the process (CAC, 2003) and preferably directly related to daily activities of the scope of the plan. Expertise of members may be adapted according to the needs of each plan (HORCHNER; POINTON, 2011). For AW purposes, it is expected at least a member with deep knowledge on behavior of the specific species, general AW principles and assessment, as well welfare issues related to the specific production process. It is important to point a coordinator with leadership ability and good communication with both operational staff and senior management of the organization, preferably experienced on the development of HACCP plans. In addition, all team members must be trained on HACCP concepts to facilitate the implementation of steps of hazard analysis and management.

According to the CAC (2003), a full description and the intended use of the product should be given. For AW purposes, the word ‘product’ may be replaced by the particular animal species (SMULDERS, 2009). In this case, the team may describe the specific species, providing information about its natural behavior ranked by motivational strength, the breed and strain in use, origin and destination of animals; the intended use of the animals, such as reproduction, slaughter or other; final consumer or clients and markets with specific requirements on animal

production, such as special AW requirements by some retailers. Depending on the scope of the plan, the description may include information about the rearing system, transport, pre-slaughter and slaughter processes. Full description of these items is expected to be part of PRP, but specific key points related to welfare may be briefly pointed. For example, for the production of broiler chickens, key points may include information about types of poultry houses, stocking density, lighting program, bird to drinker and bird to feeder ratios, feed and temperature programs (GLOBALGAP, 2017d). For general animal transportation, information may include stocking density on crates/truck, description of the truck, maximum time allowed for water and feed deprivation, maximum distances/times of animal transportation and special care on extreme temperatures.

The team should construct a production process flow diagram (CAC, 2003), considering that there may be two types of flow charts. In industrialized process, such as operations in slaughterhouses and broiler chicken hatcheries, flow diagrams may be divided by each step of the production process, following the same rationale of a flow chart applied on HACCP for food safety in the industry. In these cases, for AW purposes, the team needs to be careful in detailing the flow diagram for operations in which live animals are handled. On the other hand, on primary production, the team may focus on stages of animal production. For example, on dairy cattle production, stages on farm may include calves, heifers, pre-calving cows, post-calving cows, cows in lactation and dry cows. It is important to identify husbandry practices or animal handling procedures for each stage of the primary production flow diagram (HORCHNER et al., 2006), such as vaccination, litter management, etc. In addition, for each step or stage identified on the flow diagram, the team is responsible for listing all inputs, such as water, feed, chemical products for hygiene, rodent and insect control; medicines, vaccines, litter or bedding material (HORCHNER; POINTON, 2011; NOORDHUIZEN; BOERSEMA, 2008). The flow diagram must be confirmed on-site by the team (CAC, 2003) to guarantee that all relevant items were covered.

3.6 HAZARD ANALYSIS

Hazard analysis (FIGURE 6) is the first principle of HACCP and is repeated in case of changes of the production process, such as the incorporation of new

facilities, equipment, procedure, technology, etc. From this step on, it is expected that hazards that may prevail on production system despite high adherence of organizations to GAP, be evaluated and properly addressed. The team should list all hazards that may occur at each step of the flow diagram, according to the scope of the plan (CAC, 2003). For food safety purposes, hazards are classified as biological, physical and chemical, and can be identified through the process; however, hazards related to AW may be organized following the rationale proposed by the Five Freedoms. For example, AW hazards often comprise housing conditions and animal interactions (HEGELUND; SORENSEN, 2007), as well as length of feed and water withdrawal, disease, injuries, pain, failure to employ humane management and behavioral limitations. In this regard, the team may focus on identifying welfare problems that may occur on each step or production stage listed on the flow diagram. Hazards to AW may be identified from analysis of records of each organization and from scientific literature. The EFSA has published scientific reports about welfare problems for the main farm animals, as example for broiler chickens (EFSA, 2012c), which may provide additional guidance to hazard identification. The Welfare Quality® protocols for cattle, pig and poultry (WELFARE QUALITY, 2009a, 2009b, 2009c) also provide information about AW measures. In addition, for each hazard identified, the team should list preventive control measures in place (CAC, 2003).

As the HACCP is a quality management system (BARNETT et al. 2008), the hazard identification process may be a tool to push organizations to higher welfare levels. In this regard, the team may consider procedures that are intentionally caused to animals, such as mutilations and surgical procedures without anesthesia (beak trimming, tail docking, dehorning, etc.) and any procedure or housing condition that may lead to poor welfare. Requirements to avoid these intentionally caused welfare problems have not been fully achieved, even in countries with higher levels of AW regulation (VEISSIER et al., 2008). Although it is not likely that such problems will be immediately solved by the implementation of an AWMS, they may be included and planned to be addressed in a mid- or long-term time scale. The HACCP system may also be applied to prevent animal abuse, a form of maltreatment consisting of acts of aggression with the intention to harm the victim (MCMILLAN, 2005). When animal abuse is detected, it shall be immediately remedied (ISO, 2016). Other forms of maltreatment, such as neglect (MCMILLAN, 2005), are also relevant for HACCP monitoring. Additionally, the team may list hazards not caused by the process, which

come from preceding steps in the production chain. For example, lameness in broiler chickens is highly correlated to genetic selection for fast growing (EFSA, 2010), and may not be properly reduced even in farms with high level of implementation of GAP. According to the OIE, genetic selection should always take into account the health and welfare of animals (OIE, 2013). In this case, the team will identify control measures to avoid increased levels of lameness in severely affected batches, such as lighting program, and will plan the use of strains less affected by lameness.

The use of animal-based measures to assess AW, as opposed to resource-based ones, has been fully encouraged on technical reports, scientific papers and code of practices (EFSA, 2012c; OIE, 2013; RUSHEN et al., 2011; VEISSIER, 2008). The OIE provides examples of animal-based measures for dairy and beef cattle, broiler chickens and for the slaughter of animals (OIE, 2013). They are preferably used as control points on farm since they directly represent animal condition (DE PASSILLÉ; RUSHEN, 2005; METZ et al., 2015) and may be used to improve management and housing conditions (DE PASSILLÉ; RUSHEN, 2005). In addition, according to the ISO/TS 34700, the use of animal-based measures should be prioritized when an AW issue is of multifactorial origin (ISO, 2016). Previous reports linked hazards to AW resource- and animal-based measures, all listed from scientific literature, aiming to study the interaction between different factors affecting AW (EFSA, 2012d, 2014). A similar approach may be used during hazard analysis since AW problems are normally multifactorial. Thus, it is important that hazard identification includes not only the justification for the hazard being considered on the plan, but scientific validated animal-based measures related to the hazard, when applicable (TABLE 2).

The hazard characterization includes the likely occurrence of hazards and the severity of their adverse effects (CAC, 2003). For AW purposes, it is important to consider hazard duration (EFSA, 2012a, SMULDERS, 2009), including the duration of consequences (EFSA, 2012a), in addition to severity (BROOM; JOHNSON, 2000) and likelihood. For example, if an animal slips and falls because of inadequate flooring conditions, duration of the event will be short, but the consequence, such as traumatic injuries, may last for weeks or months. In this case, we suggest considering the one with longer duration. Determination of risk of each hazard aims to identify potential items to be included in the next steps of hazard management. The CAC (2003) considers qualitative and quantitative approaches to conduct hazard analysis,

and the EFSA (2012a) added the semi-quantitative method to AW risk assessment. All methods seem valid, and the choice will depend on type of data and purpose of investigation (EFSA, 2012a). Quantitative method increases complexity of hazard analysis and requires more time and reduction in scope (BROOM; JOHNSON, 2000). A qualitative approach is recommended to determine if the problem merits further investigation (FAO; WHO, 2009). Thus, we propose a qualitative two-stage matrix with three levels of severity, duration and likelihood, which are integrated into a final risk to AW (FIGURE 8). The first stage includes the determination of magnitude, which is the combination of intensity and duration (EFSA, 2012a), and the second stage is the combination of magnitude and likelihood.

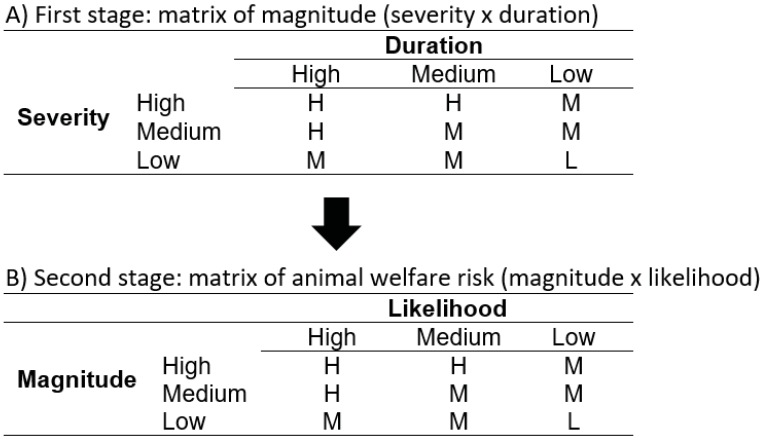
Classification of level of severity is expected to be scientific-based, and it will determine how harmful the identified hazard is to the animal by assessing the hazard and its related animal-based measures. Likelihood of occurrence of the hazard may be based on scientific literature, but a record review of each organization may add accurate information about the specific process. Duration is normally expressed in time units, such as seconds, minutes, days or weeks (SMULDERS, 2009), and determination as low, medium or high still requires further study. In this case, a semi-quantitative approach may be useful to set a quantitative meaning to terms used in qualitative analysis (FAO; WHO, 2009). For example, the EFSA report about AW aspects of the killing of seals (EFSA, 2007d) set four categories of duration of pain and distress during seal killing, ranging from 1 (< 5 seconds) to 4 (> 60 seconds). In a subsequent step, a matrix of duration and intensity was used to assess the magnitude of the adverse effect. Following the same rationale, threshold for the percentage of total animal life time impacted by a hazard may be developed. For broiler chickens, the hazard ‘poor litter quality’ may be classified as high duration, since the animal will spend the entire life in that condition; but the hazard ‘animals not adequately stunned’ may be classified as low duration, since both hazard and its consequence will affect a few minutes of animal’s life (Table 2).

TABLE 2 – EXAMPLE OF HAZARD ANALYSIS STEP IN AN ANIMAL WELFARE MANAGEMENT SYSTEM FOR THE ANIMAL FOOD CHAIN BASED ON HAZARD ANALYSIS AND CRITICAL CONTROL POINT FOOD SAFETY SYSTEM

Production step or animal production stage	Hazard identification			Hazard characterization[1]				Preventive control measures
	Hazard to animal welfare	Justification	Related animal-based measure	Severity	Duration[2]	Likelihood	Risk to animal welfare	
Broiler chicken housing	Poor quality litter	Birds in contact with poor quality litter may develop contact dermatitis	Foot pad dermatitis Hock born Breast irritation	M	H	H	H	Litter must be kept dry and friable. Procedure to reuse litter.
	Power outage	Fail on ventilation system and increase on temperature inside the poultry house	Birds panting Mortality	H	L	L	M	Backup power supply. Audible alarm to the occurrence of power outage.
Stunning	Birds not adequately stunned	Animal will be conscious during bleeding	Tonic seizure, breathing, spontaneous blinking, corneal reflex, vocalisations	H	L	L	M	Training. Procedure to stun.
Transport	Animals injured	Pain caused by injury	Fractures, bruising	H	L	H	H	Training. Procedure to load and transport animals.

SOURCE: The author (2018).
NOTES: [1]Qualitative values in the table are hypothetical. [2]Refers to time in which the animal is under an adverse condition or the time of the adverse condition consequence, considering the longer duration.

FIGURE 8 – EXAMPLE OF A TWO-STAGE MATRIX TO ASSESS RISK OF ANIMAL WELFARE HAZARD; H, HIGH RISK; M, MEDIUM RISK; L, LOW RISK



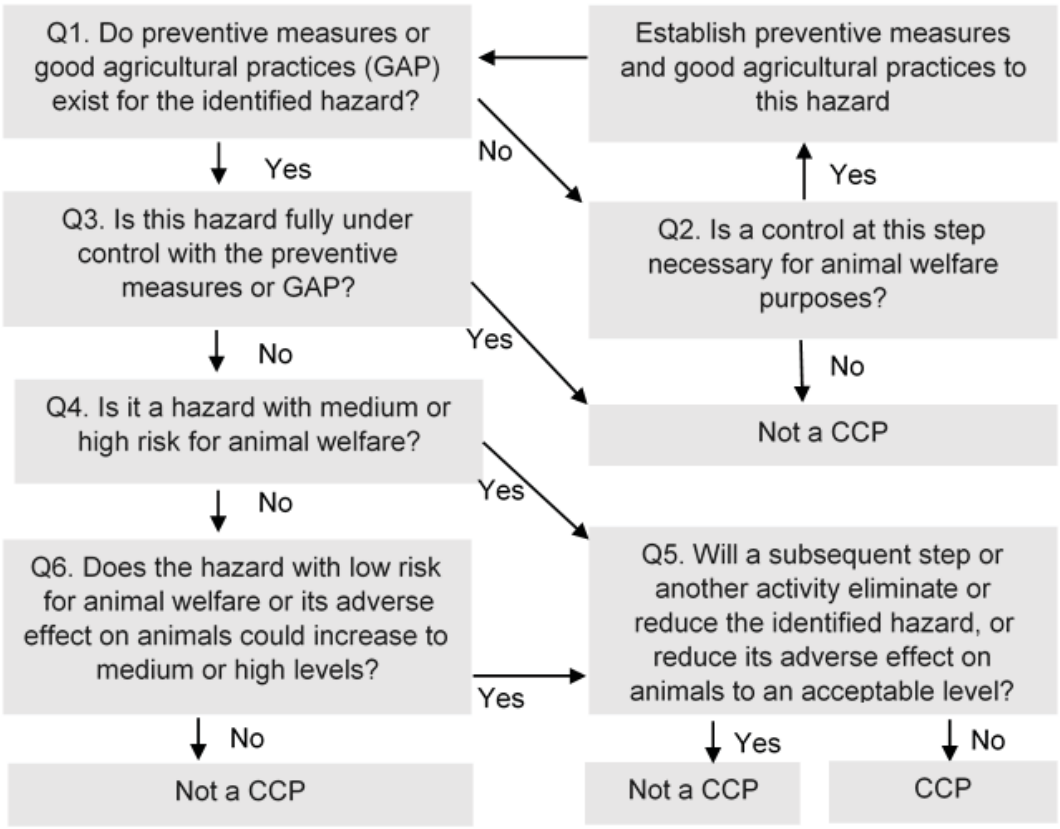
SOURCE: The author (2018), adapted from EFSA (2007) table 6.

Hazard analysis is the core step in a HACCP system and in any AWMS, since failures may lead to unreported and underestimated hazards to AW. Constraints to correctly perform hazard analysis includes inadequate training, skills and experience of the team; as well lack of specific guidance to perform the hazard analysis (WALLACE, 2014). We observed difficulties to set a guide to perform hazard analysis in a production system, where several hazards are expected to occur. Difficulties were related to reducing subjectivity of qualitative approach and keeping it user-friendly. Hazard analysis methods that are practical and easy to interpret are likely to be more suitable to HACCP (ROPKINS; BECK, 2000) and, consequently, to the management system here proposed. It is our perception that successful adherence and application of the AWMS on primary sector depends on making hazard analysis both scientific and simple.

3.7 DETERMINATION OF CRITICAL CONTROL POINTS

Hazards identified as essential to be reduced to acceptable levels or eliminated will be addressed in this section, as determined by the CAC (2003). The second principle of HACCP is to determine CCP, which may be facilitated by the application of a decision tree (CAC, 2003) (FIGURE 9). Previous studies have used literature review and expert panel (BELL, 2009; PAPADEMAS; BINTSIS, 2010) or an adapted decision tree (HORCHNER et al., 2006; HORCHNER; POINTON 2011) to establish PCC on primary production. There are concerns to the use of a HACCP-based system on primary production because most of problems are managed through GAP, and application of HACCP would not be feasible due to the difficulty to set measurable limits to handling procedures (CERF, 2011). In this case, question Q3 was added to the decision tree (FIGURE 9). For example, power outage, identified on TABLE 2 as a hazard with medium risk to AW, is fully controlled by the PRP that demands a backup power supply, and will not become a CCP. Conversely, there may be PRP for the hazards ‘animals injured’ or ‘not adequately stunned’ (TABLE 2), but it is unlikely that they will be fully controlled by PRP alone and that there will be no cases of these AW problems; thus, they will probably become CCP.

FIGURE 9 – EXAMPLE OF A DECISION TREE TO IDENTIFY CRITICAL CONTROL POINTS (CCP) IN AN ANIMAL WELFARE MANAGEMENT SYSTEM BASED ON HAZARD ANALYSIS AND CRITICAL CONTROL POINT



SOURCE: The author (2018), adapted from CAC (2003).

3.8 ESTABLISHMENT OF CRITICAL LIMITS

In the third principle, the team must specify and validate measurable critical limits for each CCP (CAC, 2003). It is expected that validated critical limits be based on scientific literature (ISO, 2016), legislation and code of practices. Some items may be specified on regulation, such as maximum levels of mortality for broiler chickens on farm (EUROPEAN COMMISSION, 2007); as well on scientific literature, such as outcomes during pig production (PAIRIS-GARCIA et al., 2016) and during pre-slaughter and slaughter (GRANDIN, 2000; 2010; 2013). However, although there is sufficient information on primary production regarding hazard analysis and determination of CCP to begin the initial steps of the HACCP, the definition of critical limits for AW still requires further studies (BARNETT et al. 2008; DE PASSILLÉ; RUSHEN, 2005). Since critical limits must be measurable, the team may focus preferably on animal-based measures identified for each hazard. In case of an absence of scientific-validated critical limits, the team may set initial thresholds based

on relevant database for each animal-based measure (ISO, 2016), such as maximum levels of occurrence of diseases or injuries. The thresholds may be reduced in a planned timeframe, as part of a continuous improvement program. This approach is in line with recent literature about AW management (ISO, 2016; MAIN et al., 2014).

Critical control points in a HACCP-based system to AW must be accompanied by management activities to ensure the desired outcomes (BARNETT et al., 2008). In this regard, measurable parameters of process and husbandry practices related to a hazard, which are part of GAP, may be included in a process control testing program, working as a 3-class system together with critical limits. Thus, when operating limits are exceeded, corrective actions are taken in the process or husbandry practices to keep critical limits under control (ICMSF, 2011). As example, critical limit for the hazard 'birds inadequately stunned' may include zero tolerance of birds presenting signs of consciousness after stunning, and process control may include the allowed variation of electrical stunning parameters. In other case, maximum levels of chicken footpad dermatitis may be established as critical limits, and the desirable grade for litter quality assessment on farm may be used as process control.

3.9 ESTABLISHMENT OF MONITORING SYSTEM AND CORRECTIVE ACTION

Fourth and fifth principles of HACCP determine, respectively, that a monitoring system must be in place to detect loss of control of a CCP, and corrective actions must be developed to each CCP to deal with deviations (CAC, 2003). Monitoring procedures may be applied to both critical limits and process or animal husbandry procedures (CAC, 2003), and they are expected to include information about which parameters, frequency and how they have to be measured. Examples of monitoring procedures for resource- and animal-based measures may be observed on the Welfare Quality® protocols (WELFARE QUALITY, 2009a, 2009b, 2009c). The HACCP for food safety requires immediate actions on the affected product and on bringing the CCP under control (CAC, 2003). These actions may not be fully applicable to hazards related to AW and may require adaptation to be effective in an AW context. For some AW hazards, the detection of deviations of CCP induces corrective actions for the next animals or batches, as for example the detection of problems related to contact dermatitis and injuries in broiler chickens at the

slaughterhouse. In addition, considering that some problems related to AW are multifactorial, complete eradication of the hazard may not be achieved by applying corrective actions in one CCP; however, reduction in the prevalence of the problem is achievable (BONDE; SORENSEN, 2004) and represents a significant advancement for AW. It is also important to consider hazards that should be monitored continuously, such as problems related to animal stunning. Any animal presenting signs of consciousness after stunning and before bleeding, or presenting signs of being alive after bleeding requires immediate intervention (EFSA, 2013a, 2013b, 2013c, 2013d). Based on this, it is desirable that the team be committed on establishing corrective actions to avoid animal suffering on real time, where possible, and to reduce the identified hazards on next animals or batches by incorporating corrective procedures on the process.

3.10 ESTABLISHMENT OF VERIFICATION PROCEDURES AND RECORD KEEPING SYSTEM

Sixth and seventh principles are to establish verification procedures and documentation and record keeping (CAC, 2003). The verification may include internal audits, review of records, and any activity to evidence that the HACCP-based plan is effective to identify and to manage hazards to AW. Certain items monitored on farm, such as contact dermatitis, may also be verified at the slaughterhouse, as part of quality control or meat inspection systems. Verification should be carried out by staff not responsible for performing monitoring procedures (CAC, 2003). Record keeping may include not only records of monitoring and verification procedures, but all documentation used on the determination of CCP and during hazard analysis, such as hazard identification or scientific base of analysis of severity, likelihood and duration. Considering the multifactorial characteristic of most AW problems, we suggest organizing the summary of the HACCP plan by animal-based measure (TABLE 3). This will allow a general view of causes affecting each hazard and how they have been handled by the organization.

The aim of developing documentation in a quality management system is to demonstrate the commitment of the industry or farmer to AW (BARNETT et al., 2008), which may be achieved by implementing HACCP concepts on animal production. Engagement of senior management is fundamental to develop policies

for the improvement of the quality of life of animals (GRANDIN, 2013b) and of the efficacy of the AWMS in each organization. Based on this, data obtained during monitoring and verification of the HACCP are valuable information to be included as inputs on management review, and to promote AW discussion at higher corporate levels in companies (SOUZA; MOLENTO, 2015). Therefore, outputs from management review, including new demands from society or clients, new regulation and new challenges will act as feedback to hazard analysis update, promoting the continuous improvement of AW throughout the organization (FIGURE 6).

TABLE 3 – EXAMPLE OF SUMMARY TABLE OF AN ANIMAL WELFARE MANAGEMENT SYSTEM FOR THE ANIMAL FOOD CHAIN BASED ON HAZARD ANALYSIS AND CRITICAL CONTROL POINT

Animal-based measure	Preventive control measure	Limits of process/ husbandry practices	Critical limit	Monitoring	Corrective action[2]
Foot pad dermatitis	Litter must be kept dry and friable. Procedure to reuse litter.	Maximum 1 location presenting litter quality classification higher than 0 in a 5-point scale, considering the sampling of 6 locations inside the poultry house; 0 means litter completely dry and flaky and 4 means the litter sticks to boots once the compacted crust is broken[1]	Maximum of 'x%' of foot pad dermatitis per batch	Observation of three recording periods of 5 minutes at the slaughterhouse, following a 5-point scale[1].	Improve litter management. Review stocking density. Review drinker maintenance. Review ventilation. Review birds' diet. Top litter with fresh material. Removal of litter for the next batch.

SOURCE: The author (2018).
NOTES: [1]Based on the Welfare Quality® assessment protocol for poultry (2009). [2]General recommendations given as example, do not represent an exhaustive list.

3.11 SUPPORTING THE DEVELOPMENT OF AN ANIMAL WELFARE MANAGEMENT SYSTEM

The HACCP seems an appropriate method for the development of an AWMS for its well-established characteristics, as for example the demand of PRP implementation and hazard control techniques. Based on this, the HACCP is a potential tool to foster organizations to work on basic measures to protect the

animals, by implementing robust good agricultural and AW practices, which are aligned with the scope of the ISO/TS 34700. However, as a process-specific system, the HACCP-based method may be challenging in the case of primary production, mainly for small and independent farmers. In these scenarios, the initiative of class entities, preferably with the support of producer associations, rural extension and governmental bodies, may facilitate HACCP implementation by providing training and expert consultation.

The development of an AWMS based on HACCP analysis depends on the use of welfare measures which are scientifically valid, practical and low in time consumption. These are also bottlenecks to increase adherence of organizations to on-farm AW assessment protocols. In this regard, recent studies aimed the development of automated assessment tools to facilitate real time monitoring (DAWKINS et al., 2013; NASIRAHMADI et al., 2017; VANDERHASSELT et al., 2013). Other strategies to improve AW assessment include reducing sampling through the use of iceberg indicators (HEATH et al., 2014) and sequential sampling (HEATH et al., 2016). Future research may advance knowledge on correlations between on farm and slaughterhouse data (DE JONG et al., 2015), as well as amongst measures (BUIJS; AMPE; TUYTTENS, 2016), perhaps allowing for decisions regarding more economical and efficient approaches in terms of number of measures needed for the AWMS.

3.12 CONCLUSION

This study provided an AWMS based on the concept of the HACCP, which may be applied to primary production, transportation of live animals and slaughterhouses. Considering the characteristics of the HACCP, it seems suitable as an important component of an AWMS for animal food chain organizations. The HACCP method provides the identification of problems throughout the production chain and the establishment of planned corrective actions, thus leading to good agricultural and AW practices. Adaptations suggested to establish CCP and to set critical limits and corrective actions may facilitate the implementation of the HACCP for AW purposes. In addition, data from monitoring procedures may be important to develop scientific-validated thresholds for animal-based measures. Application of the AWMS may favour take broader AW discussions to higher corporate levels in organizations and may promote transparency of processes in animal production.

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4 DEVELOPMENT AND REFINEMENT OF THREE ANIMAL-BASED BROILER CHICKEN WELFARE INDICATORS

RESUMO

Este estudo teve como objetivo refinar sujidade das aves como um indicador de bem-estar de frangos de corte (*Gallus gallus domesticus*) e desenvolver e testar dois outros indicadores, dermatite de contato das áreas de peito e abdômen e arranhadura de carcaça. Foi desenvolvido um questionário com fotos de aves apresentando ausência, baixa moderada ou severa ocorrência de cada indicador. O questionário foi enviado para 146 especialistas convidados para a primeira rodada e 88 para a segunda rodada em um processo usando o método Delphi. Ao final do processo, foram construídas escalas visuais para cada indicador, sendo posteriormente testadas por três avaliadores em dez lotes em granjas de frangos de corte (n = 1.303 aves) e em um abatedouro (n = 1.631 aves). Observou-se alta concordância entre os grupos de especialistas do processo Delphi e entre os avaliadores. Das aves avaliadas, 90,7% estavam moderadamente ou severamente sujas, 99,9% estavam com mau empenamento, 73,4% e 90,0% apresentavam eritema e arranhadura de carcaça, respectivamente. As correlações entre qualidade de cama e todos os indicadores baseados nos animais avaliados nas granjas, e entre sujidade das aves e dermatite de contato das áreas de peito e abdômen foram moderadas. Os resultados sugerem que a adoção das escalas propostas pode melhorar a habilidade de avaliação de bem-estar de frangos de corte, uma vez que os problemas eram prevalentes e a consistência das medidas foi aceitável. O nível de concordância observado entre os avaliadores incentiva a aplicação dos indicadores desenvolvidos neste estudo para avaliar o bem-estar de frangos em uma variedade de galpões e em diferentes países, permitindo desta forma que sejam testados em diversas condições de bem-estar animal.

Palavras-chave: Bem-estar animal. Indicadores baseados nos animais. Limpeza de penas. Irritação de pele. Avaliação de bem-estar animal. Medidas de bem-estar animal.

ABSTRACT

This study aimed to refine bird soiling as a broiler chicken welfare (*Gallus gallus domesticus*) indicator, and to develop and test two additional indicators, namely contact dermatitis on the breast and abdominal areas and carcass scratches. We constructed a questionnaire with pictures of birds presenting different indicator levels for classification as absent, low, moderate or severe. The questionnaire was sent to 146 invited experts for the first round and 88 for the second round, in a Delphi process. Visual scales were built for the target indicators, which were tested by three assessors in ten flocks on farm (n = 1,303 birds) and at the slaughterhouse (n = 1,631 birds). High concordance was observed among groups of Delphi respondents and among assessors. A total of 90.7% of the birds were either moderately or severely soiled, 99.9% were poorly feathered, 73.4% and 90.0% presented erythema and carcass scratches, respectively. The correlations between litter quality and all outcomes assessed on farm, and between bird soiling and contact dermatitis on the breast and abdominal areas, were moderate. Results suggest that the adoption of the proposed scales may improve our ability to assess broiler chicken welfare, since relevant problems were prevalent and measurement consistency was acceptable. Substantial concordance observed among assessors encourages application of these animal-based indicators to assess broiler chicken welfare in a wide range of poultry houses in a variety of different countries, thereby allowing the scales to be tested in a host of animal welfare conditions.

Keywords: Animal welfare. Outcomes. Plumage cleanliness. Skin irritation. Welfare assessment Welfare measures.

4.1 INTRODUCTION

Animal welfare assessment may include animal-based and resource-based indicators. The use of animal-based indicators to assess animal welfare has been encouraged (VEISSIER et al., 2008; RUSHEN et al., 2011; EFSA, 2012; OIE, 2013) and applied for regulatory purposes (EUROPEAN COMMISSION, 2017). The Welfare Quality® project proposed to standardize animal welfare assessment through the application of predominantly animal-based, scientifically validated measures (BLOKHUIS et al., 2010) and it has been considered a robust tool to assess animal welfare (WEBSTER, 2009). The protocol for poultry includes measures of welfare related to four principles, i.e. good feeding, good housing, good health and appropriate behaviour (WELFARE QUALITY®, 2009).

Recent studies applying the Welfare Quality protocol® (2009) to assess broiler chicken (*Gallus gallus domesticus*) welfare suggested a need for refinement of some animal welfare measures. As an example, Federici et al. (2016) reported difficulties in assessing plumage cleanliness using the scoring system available in the Welfare Quality protocol®, since birds assessed on farm were poorly feathered on the breast. The visual 8-point scale developed by Wilkins et al. (2003) to assess plumage cleanliness at the slaughterhouse was transformed in a 4-point scale in the Welfare Quality protocol® to be assessed on farm. However, type of soiling and bird feathering presented in the protocol pictures are not representative of conditions observed in commercial farms for fast growing broiler chickens. Previous studies have assessed bird cleanliness (WEEKS et al., 1994; ELWINGER, 1995; DAWKINS et al., 2004); however, details on the method used were often missing (ARNOULD et al., 2009), suggesting the need for an updated scoring system.

A possible shortcoming in current broiler welfare assessment protocols is the absence of an effective measurement for contact dermatitis in the ventral body area for broiler chicken flocks, especially considering the high prevalence of contact dermatitis reported for other body parts such as the footpads and hocks (SOUZA et al., 2015; TUYTTENS et al., 2015; FEDERICI et al., 2016). The Welfare Quality protocol® (2009) provides a scoring system to assess the presence or absence of breast blisters. According to GREENE et al. (1985), flocks showing a high prevalence of footpad dermatitis are expected to present other forms of contact dermatitis as well. Contact dermatitis is an inflammatory skin reaction caused by contact with an

offending substance (MULLER, 2001). Patches of erythema and papules represent primary lesions and, as the inflammatory changes progress, crusting develops (MULLER, 2001). However, breast lesion scoring in broiler chickens has, instead, tended to focus on hyperkeratosis and ulcerations (STEPHENSON et al., 1960; GREENE et al., 1985; ALLAIN et al., 2009; GOUVEIA et al., 2009; SARAIVA et al., 2016). Contact dermatitis leads to poor animal welfare because of the pain caused by the lesions and the inflammatory process (BERG, 2004). DE JONG et al. (2014) published the first study including the observation of erythema on the breast during broiler chicken welfare assessment, evidencing the occurrence of primary signs of contact dermatitis on commercial farms. Thus, there is a need to develop a uniform scoring system including the earlier stages of development of contact dermatitis on the breast.

Some broiler chicken production procedures, for example, moving birds from one place to another and exposing birds to non-familiar human beings may increase fear and distress (JONES; ROPER, 1997; JONES et al., 2002). In these cases, the assessment of carcass scratches seems to be a relevant welfare indicator (DE JONG et al., 2014), since birds experiencing panic and escape attempts frequently pile on top of each other, causing body lesions (WAIBLINGER et al., 2006). Different scoring systems to assess carcass scratches have been used (HARGIS et al., 1989; ELFADIL et al., 1996; PILECCO et al., 2012; ALLAIN et al., 2013), but no visual scale has been presented in previous studies on broilers. Considering that carcass scratches are not included in current broiler welfare assessment protocols, and that the lack of a standardized scoring method prevents comparison between studies, it seems important to further explore the potential use of this indicator.

The three indicators previously reviewed could be valuable contributors to existing welfare assessment schemes. This study aimed to refine bird soiling (BS) as a broiler chicken welfare indicator, and to develop and test two additional indicators, namely contact dermatitis on the breast and abdominal areas (CD) and carcass scratches (CS).

4.2 MATERIAL AND METHODS

The first part of our study consisted of employing the Delphi method to develop the visual scales for the three indicators, with a basic description of each

level of severity. Scales were then tested on farm and at the slaughterhouse in order to study inter-rater reliability as well as correlation with other animal welfare indicators (AWI).

4.2.1 Delphi methodology

Three broiler chicken farms were visited in January 2016 to take pictures of birds presenting different levels of BS and CD. Birds were male and female Cobb 500® broilers, at 37 and 42 days of age. Carcasses with different levels of scratches were sampled in a slaughterhouse, immediately prior to chilling. Pictures were analysed by one experienced researcher, who pre-classified them as examples of absence, low, moderate and severe levels of each indicator. At least two pictures representative of each level to be included in the questionnaire were selected. The online questionnaire (https://www.onlinepesquisa.com) was developed in Portuguese and English and tested by three senior academic researchers in Brazil, the United Kingdom and Spain, with a deep knowledge of broiler chicken welfare and/or production.

The Delphi technique, ie a process to obtain consensus from a group of expert respondents (DAJANI et al., 1979; HSU; SANDFORD, 2007) was closely adhered to. The questionnaire was sent to 146 experts in March 2016. Respondents were selected based on their experience and/or publications related to animal welfare and/or broiler chicken production, including university lecturers and researchers, professionals from the government, meat industry and animal welfare certification schemes.

The questionnaire was divided by indicator, with the first 10 pictures showing different examples of BS, followed by nine pictures of CS and 10 pictures of CD. On the first page of each indicator, all pictures were presented to make the respondent familiarized with the range of picture variation. Thereafter, each picture was presented individually, and respondents were asked to choose the best descriptor from absent, light, moderate and severe. Respondents could also give another descriptor in an open-ended text box. For each picture, a short explanatory text on the indicator was provided. As respondents may not have been familiar with all the indicators, we added the alternative ‘prefer not to answer this question’. A field to justify the score was provided. One picture of a soiled bird was repeated and

respondents were asked whether poor feathering affects BS score. If the answer was yes, respondents were presented with four options that included (1) to propose a mathematical model for BS that considers general feathering, (2) to propose a model that considers the proportion of body area presenting poor feathering, (3) to consider the worst BS score when poor feathering is observed, and (4) other.

In the first round, respondents not answering all questions of at least one indicator, or those whose answers were considered inconsistent were excluded. Data were analysed using descriptive statistics. Following the method proposed by Rayens and Hahn (2000), the interquartile deviation (IQD) for each picture to verify consensus among respondents was calculated. When IQD=0 or IQD=1 with a proportion equal to or higher than 60% in one level, consensus was deemed adequate for that picture; when IQD=1 with a proportion lower than 60% in one level or IQD>1, consensus was not adequate, and the picture was considered for inclusion in the second round. Groups of respondents were tested using the Kendall's coefficient of concordance corrected for ties (Wt).

In the second round, a new questionnaire was sent to the 88 respondents who had completed the first round, in September 2016. It included a preview of the main results from the first round and new questions to further study each indicator. For BS, again a question related to the correlation between poor feathering and soiling was included. In CD, we presented two scales including erythema, based on justification given by respondents for each level of severity in the first round. The 3-point scale included absence of erythema, intermediate (levels light and moderate together, since there was no consensus within these levels in the first round; details in APPENDIX VII) and severe erythema. The 4-point scale included erythema and the presence of brown spots and breast blisters, adapted from De Jong et al. (2014). Our intention was to observe whether erythema should be assessed separately or be part of a scale including other breast lesions caused by prolonged contact with litter. In CS, we asked participants to quantify their maximum accepted levels according to depth and length of lesion for each category, and we considered median values reported for each point. We also asked participants whether old scratches should be considered during the assessment. After the second round, a visual scale was defined for each indicator, including a basic description of each level of severity.

4.2.2 Testing of the visual scales on farm and at the slaughterhouse

The testing of visual scales was performed on farm in January 2017 (25°17'49.1"S, 54°05'41.7"W) and at the slaughterhouse in April of the same year (24º 55' 04" S, 50º 05' 50" W) in the State of Paraná, Southern Brazil, for each case in ten flocks. The sampling size of 1,300 birds was calculated considering a maximum error of 5% and 95% confidence interval. Two veterinarians (APOS and MAS) and one animal scientist (VSS) performed all assessments on farm and at the slaughterhouse; APOS is experienced in auditing poultry farms and slaughterhouses. Assessors scored the animals simultaneously but independently. They underwent training, initially via picture observation, to learn how to assess each indicator as shown in TABLE 4. The second step involved a training session at the Federal University of Paraná farm and in a slaughterhouse.

Two barns were visited each day, the first from 8h to 12h and the second from 13h to 17h. Poultry barns had sidewalls with wire mesh covered by blackout curtains working as a dark house (n = 1) and covered by yellow curtains, with natural lighting (n = 9), chosen as convenient samples according to our objective, to observe ranges of variation for each indicator rather than describing or comparing specific barn types or other factors. Birds were male and female Cobb 500®, assessed at 41.3 ± 2.0 days of age and weighing 2,147.3 ± 99.5 g at 35 days. All units had automatic feeders, nipple drinkers, sprinklers, exhaust fans and wood shaving litter; nine units maintained evaporative cooling systems. Indoor mean temperature in the units at time of the visit was 27.7 ± 1.4 °C. Average broiler house area was 1,540 ± 187 m^2 and the number of birds per house was 18,904 ± 2,604, with a stocking density of 36.4 ± 0.9 kg/m^2. At the slaughterhouse, birds were Cobb 500, Hubbard H1 and Ross 408, assessed at 27 ± 1 days of age and weighing 1,354 ± 35 g. To collect data on farm a questionnaire on the QuickTapSurvey® website as developed and made available on a cell phone application to be used offline. Data from QuickTapSurvey® were downloaded into an Excel® database and checked for errors prior to use.

TABLE 4 – INDICATORS AND DEFINITIONS FOR THE ASSESSMENT OF BROILER CHICKEN WELFARE

Indicator	Place	Sampling
Contact dermatitis on the breast and abdominal areas (CD)	On farm	Visual inspection of 130 birds in five locations in each poultry house, following the scale developed in this study
Bird soiling (BS)	On farm	Visual inspection of 130 birds in five locations in each poultry house, following the scale developed in this study
Footpad dermatitis (FPD)	On farm	Visual inspection of 130 birds in five locations in each poultry house, following a 5-point scale[1]
Hock burn (HB)	On farm	Visual inspection of 130 birds in five locations in each poultry house, following a 5-point scale[1]
Feathering condition (FC)	On farm	Visual inspection of ventral body area of 130 birds in five locations in each poultry house, according to the following 3-point scale: good feathering (complete or nearly complete feathering), moderate feathering (one or more featherless area < 5 cm in diameter), poor feathering (at least one featherless area ≥ 5 cm in diameter)[2]
Litter quality	On farm	Visual inspection of six locations in each poultry house, following a 6-point scale[1]
Carcass scratches (CS)	Slaughterhouse	Visual inspection on slaughter line of 130 birds/flock after plucking, following the scale developed in this study

SOURCE: The author (2018).
NOTES: [1]According to the Welfare Quality® (2009) for broiler meat chickens, [2]adapted from Welfare Quality® (2009) for laying hens.

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During the training at the slaughterhouse to assess CS, initially the sampling procedure described in the Welfare Quality® protocol (2009) for injuries, bruising and wing damage was followed, which demanded the observation of carcasses passing the line for five to 10 minutes. As the occurrence of scratches was higher than the occurrence of injuries, observation of all carcasses was not feasible for the paired sampling required in our study. Thus, a specific procedure was performed to allow for the line speed: one assessor randomly established a carcass every 8, 9 or 10 carcasses on the slaughter line to be evaluated by assessors simultaneously. This skipping method allowed for the assessment to be performed at a slower rhythm as compared to line speed and it was needed for adequate assessment and synchronization across assessors.

4.2.3 Statistical analysis

Reliability between assessors was tested using Kendall's coefficient of concordance corrected for ties. Based on our perception during assessment, concordance was also tested by grouping light and moderate levels of CD; and moderate and severe levels of BS. Bird soiling did not present ordinal distribution after grouping; thus concordance was tested using the Fleiss' kappa coefficient. Coefficients from 0.61 to 0.80 were considered as substantial concordance, and from 0.81 to 1.0, almost perfect concordance (LANDIS; KOCH, 1977). The proportion of identical answers was calculated for feathering condition. Data were tested for normality using Henze-Zirkler test followed by Spearman's rank correlation coefficient to test correlation between indicators. Correlation from 0.3 to 0.6 was considered moderate, and higher than 0.6 was considered high (DE JONG et al., 2015). Analyses were performed using R Statistical Computing Environment software version 3.3.1 (2016).

4.2.4 Ethical approval

This project was approved by the Human Research Ethics Committee of the Health Science Sector n. 1,377,497, December 21st, 2015 (ANNEX III), and by the Animal Use Ethics Committee of the Agricultural Campus n. 079/2015, November 12th, 2015 (ANNEX IV), both of the Federal University of Paraná.

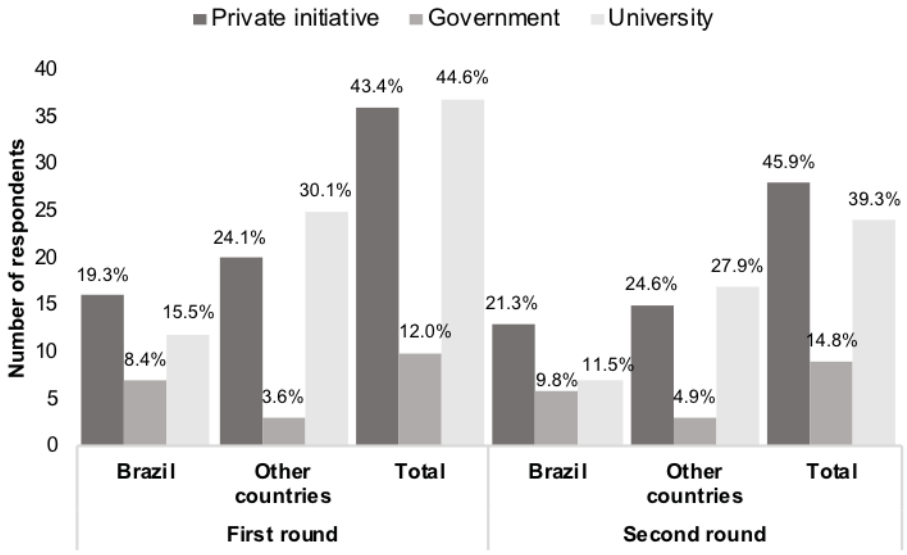
4.3 RESULTS

4.3.1 Delphi methodology

In the first round, 60.3% (88/146) of invited experts answered the questionnaire. There were 56.8% (83/146) complete and relevant responses for BS, 55.5% (81/146) for CD, and 56.1% (82/146) for CS. In the second round, a total of 73.5% (61/88) of experts participated, and 68.7% (57/88) completed the questionnaire. Origin and number of respondents, presented as first followed by second round, were Brazil (35, 26), United States of America (14, 11), Canada (13, 10), United Kingdom (7, 6), Germany (3, 3), Belgium (2, 2), Sweden (2, 2), The Netherlands (2, 1), France (2,0), Italy (2,0) and Chile (1, 0). Proportion of

respondents by category is presented in FIGURE 10. Answers were highly correlated among groups of respondents (P <0.001, Wt = 0.916).

FIGURE 10 – NUMBER, ORIGIN AND CATEGORY OF RESPONDENTS IN FIRST (N = 83) AND SECOND (N = 61) ROUNDS OF THE DELPHI QUESTIONNAIRE ON THREE BROILER CHICKEN WELFARE INDICATORS, FROM MARCH TO OCTOBER 2016



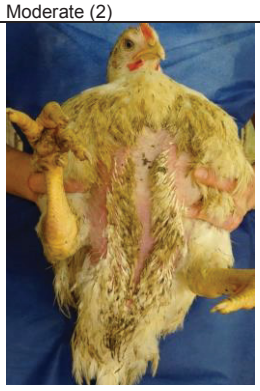
SOURCE: The author (2018).

4.3.1.1 Bird soiling

Consensus was achieved for 8/10 pictures in the first round. The visual scale presented in FIGURE 11 was constructed to be applied on broiler chicken farms. The question about the relation between feathering condition and BS score did not reach consensus in the first round. Respondents indicated that poor feathering affected BS assessment (57.8%; 48/83), most of them justifying that dirt appears to adhere more on feathers than on skin, thus, lack of feathers prevents clumps from being retained. A total of 36.1% (30/83) considered to be no relation between BS and feathering, and 6.1% (5/83) gave other answers. In the second round, we presented one justification representative of each main theme cited by respondents in the first round, both for and against the relationship between feathering condition and BS, and we asked respondents to think again about this relationship. Results differed from the first round, and 83.6% (51/61) of respondents considered that poor feathering affected BS assessment. There was no consensus about the best option to integrate BS and

poor feathering scores. Results clearly indicated that feathering is an issue and should be considered when assessing broiler chicken welfare. Based on this, feathering condition assessment during the on-farm testing of visual scale was included to further study this indicator (see TABLE 4).

FIGURE 11 – VISUAL AND DESCRIPTIVE SCALE TO ASSESS BIRD SOILING ON FARM, DEVELOPED USING THE DELPHI METHODOLOGY, FROM MARCH TO OCTOBER 2016

Bird soiling			
Absence (0)	Light (1)	Moderate (2)	Severe (3)
			
Dry skin and feathers. Absence of soiling and brown staining. → Dry and light-yellow feathers are considered as absence of soiling.	Superficial soiling in few areas on abdomen and/or breast. Most of feathers are white and fluffy, and/or Small and few clumps adhered to skin and/or feather. Dry feathers.	General light brown staining on breast feather, with dry aspect, and/or Large clumps adhered to skin and/or feathers on abdomen, with light or no soiling on the breast. Feathers on the abdomen looks wet. → Soiling on feet and legs may occur.	Bird presenting general soiling on breast and abdominal feathers, and/or Top breast feathers are dark brown stained, and may look wet. → Clumps may be adhered to the skin and/or feathers on the abdomen. → Soiling on feet and legs may occur.

SOURCE: The author (2018).

4.3.1.2 Contact dermatitis on the breast and abdominal areas

Consensus was achieved for 2/10 pictures, being the most extreme cases, absence and severe CD. In the first round, 3.5% (3/83) of respondents did not consider the pictures representative of CD, and in the second round, a total of 64.9% (37/57) of respondents chose the 4-point scale, most of them (62.2%, 23/37) because of the highest level of detail and information provided by the scale. A total of 31.6% (18/57) of respondents chose the 3-point scale, most of them (61.1%, 11/18) justifying it was more practical and simpler. The scale presented in FIGURE 12 was chosen to be applied on farm.

FIGURE 12 – VISUAL AND DESCRIPTIVE SCALE TO ASSESS CONTACT DERMATITIS ON THE BREAST AND ABDOMINAL AREAS ON FARM, DEVELOPED USING THE DELPHI METHODOLOGY, FROM MARCH TO OCTOBER 2016

Contact dermatitis on the breast and abdominal areas			
Absence (0)	Light (1)	Moderate (2)	Severe (3)
			
Skin without lesion, inflammation or erythema.	Light pink local- or generalized erythema, or Skin may present different degrees of erythema, from dark pink to red (up to 25% of ventral body area).	Skin may present different degrees of erythema, from dark pink to red (from 25% to 50% of ventral body area), or Presence of small brown spots.	Large area inflamed (more than 50% of ventral body area), dark pink or red colour, or Large brown spots or breast blister.
		If moderate or severe, are there brown spots or breast blisters? ( )Yes ( )No	

SOURCE: The author (2018).

4.3.1.3 Carcass scratches

During the first round, consensus was achieved for 5/8 pictures. Although information was collected for descriptions of the four proposed levels of CS, answers were too generalised, using terms such as ‘multiple scratches in one side’, ‘large area affected’ and ‘there are some deep scratches’. Answers were based on the following items: area affected (uni- or bilateral), quantity, depth (light or deep), length (small or long) and age (new or old) of scratches. In the second round, we aimed to quantify these items to establish clear thresholds between each CS level.

In the first round, respondents spontaneously presented different justifications based on age of scratches: some respondents considered recent scratches as more severe, some did not consider old scratches as a welfare problem, and some were concerned about the presence of old and new scratches simultaneously. As it was a new subject, in the second round answers given by respondents about age of scratches were presented and opinions sought. As a result, 98.2% (56/57) of respondents considered old scratches should be assessed as an AWI. Most of them (89.3%, 50/56) clearly stated CS was a welfare problem regardless of when it occurred. Other respondents also included a justification based on economic loss

due to slaughter condemnation of scratched carcasses (12.5%, 7/56) and food safety concerns (3.6%, 2/56). Considering the first and the second rounds, the scale presented in FIGURE 13 was developed to be applied at the slaughterhouse.

FIGURE 13 – VISUAL AND DESCRIPTIVE SCALE TO ASSESS CARCASS SCRATCHES AT THE SLAUGHTERHOUSE, DEVELOPED USING THE DELPHI METHODOLOGY, FROM MARCH TO OCTOBER 2016

Carcass scratch (back, lateral and thigh)			
Absence (0)	Light (1)	Moderate (2)	Severe (3)
			
Intact skin, no visible scratches.	Up to 3 small or long superficial scratches combined, and/or Up to 1 small or long deep scratch. → Scratches may be uni- or bilateral; new or old.	Up to 5 small or long superficial scratches combined, and/or Up to 2 small or long deep scratches. → Scratches may be uni- or bilateral; new or old.	More than 5 small and long superficial scratches combined, and/or 3 or more small or long deep scratches. → Scratches may be uni- or bilateral; new or old.
- Small scratches: up to 3 cm (1.2 inch); long scratches: larger than 3 cm (1.2 inch) - Superficial scratches: light scratches, affecting the epidermis; deep scratches: affect the dermis, they may achieve muscle tissue - Old scratches: brown or yellow scratches, indicative of healing process; new scratches: pink or red scratches			

SOURCE: The author (2018).

4.3.2 Testing of visual scales on farm and at the slaughterhouse

Substantial concordance on AWI was observed among assessors (TABLE 5). Difficulties were found scoring some birds, mainly differentiating between low and moderate levels of CD, and between moderate and severe soiling of BS. However, our perception was not confirmed statistically, since concordance among assessors did not increase when we grouped answers (TABLE 5). During assessments, the inflamed skin on the breast and abdominal areas was observed to become pale within a few seconds after bird restraint, followed by a strong hyperemia. No brown spot or breast blister was observed on the assessed birds.

TABLE 5 – LEVEL OF CONCORDANCE AMONG THREE ASSESSORS, AND CORRELATION OF BROILER CHICKEN WELFARE INDICATORS MEASURED ON FARM OR AT THE SLAUGHTERHOUSE, JANUARY AND APRIL 2017

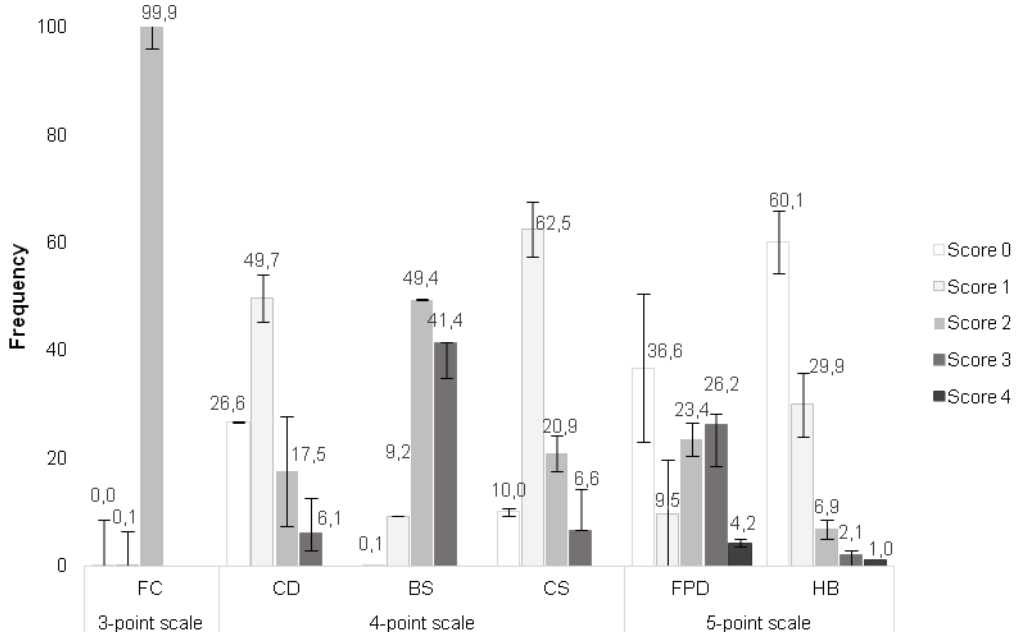
Indicator	Concordance among assessors		Correlation between indicators			
	Kendall's coefficient of concordance	Fleiss' Kappa	Spearman rank correlation			
	A1xA2xA3	A1xA2xA3	BS	FPD	HB	Litter
Bird soiling (BS)	0.739*			0.08*	0.25*	0.43*
BS scores 2+3	-	0.334**				
Contact dermatitis on the breast and abdominal areas (CD)	0.781*		0.34*	0.06*	0.24*	0.33*
CD scores 1+2	0.709*					
Footpad dermatitis (FPD)	0.941**				0.17*	0.35*
Hock burn (HB)	0.76**					0.31*
Carcass scratches (CS)[1]	0.74**					

SOURCE: The author (2018).
NOTES: A1, assessor 1; A2, assessor 2; A3, assessor 3; * P < 0.0001, ** P < 0.00001, [1] at the slaughterhouse.

A total of 90.7% of the birds presented moderate and severe plumage soiling and 73.4% presented CD (FIGURE 14). Moderate correlation was observed between litter quality and all AWI assessed on farm, and between BS and CD (TABLE 5). Almost all broiler chickens were scored as poorly feathered as they presented at least one featherless area ≥ 5 cm in diameter on the breast and abdominal areas (FIGURE 14), therefore no correlation between feathering and the other indicators could be calculated.

Line speed varied from 5,520 to 10,080 birds/hour at the slaughterhouse because three batches were severely affected by dermatosis, which is the denomination given by the Meat Inspection Service to general skin problems in the absence of inflammation. Mean time required to assess birds was 21:23 (± 2:04) minutes per flock. There were difficulties assessing birds affected by dermatosis because the CS scale includes old scratches, which are characterised by lesions that resemble dermatosis in that they can present as crusts and are yellowish to brownish colour. Thus, it is advisable to ensure assessors are trained to differentiate between old scratches and other skin problems. Calculation of number of deep and superficial scratches was challenging on higher line speeds.

FIGURE 14 – MEAN FREQUENCY OF SIX BROILER CHICKEN WELFARE INDICATORS MEASURED BY THREE ASSESSORS IN 1,303 BIRDS ON FARM (10 FLOCKS) AND IN 1,631 BIRDS AT THE SLAUGHTERHOUSE (10 FLOCKS), 2017; POOR FEATHERING (FC) RANGING FROM 0 (ABSENCE) TO 2 (SEVERE); CONTACT DERMATITIS ON THE BREAST AND ABDOMINAL AREAS (CD), BIRD SOILING (BS) AND CARCASS SCRATCHES (CS) RANGING FROM 0 (ABSENCE) TO 3 (SEVERE); FOOTPAD DERMATITIS (FPD) AND HOCK BURN (HB) RANGING FROM 0 (ABSENCE) TO 4 (SEVERE)



SOURCE: The author (2018).

4.4 DISCUSSION

4.4.1 Delphi methodology

The present study aimed to refine BS as a broiler chicken welfare indicator, and to develop and test two additional indicators, CD and CS. As indicated by Blokhuis et al. (2010), involvement of stakeholders during protocol development increases its acceptability. Adherence of respondents from different groups, as well as high correlation among groups of respondents, suggest we succeeded in including relevant and knowledgeable stakeholders in this study to discuss target AWIs.

Bird soiling is presented in the Welfare Quality® (2009) protocol as plumage cleanliness. Since birds in our study were poorly feathered, and considering that, in our experience, it is common for fast growing broiler chickens in intensive systems to be poorly feathered, we suggested the term ‘bird soiling’ to encourage assessors to

assess not only the feathers, but the whole bird, including skin and feet. The use of BS instead of bird cleanliness is proposed to increase coherence between the title of the indicator and the assessment scoring system, which increases with dirtiness increases. When we consider the suggestion of BS and CD being scored together, it is worth noting the association between wet litter and plumage soiling and contact dermatitis (DE JONG et al., 2014). However, AWI may be more objective and consensual if they are scored separately, followed by an integration of indicators as a second step.

Our results suggest that CD has been poorly studied and therefore was not included in welfare assessment systems. The choice for the 4-point scale, which included the observation of erythema, brown spots and breast blisters, suggests that the redness observed on birds was recognized by respondents as a sign of skin irritation, and should be assessed in conjunction with other established indicators of breast lesions.

Different interpretations regarding the age of scratches in the first and second rounds probably occurred due to the notion that the animal could have experienced multiple aversive events during its life. According to Allain et al. (2009), a broiler suffering from several lesions undoubtedly has a lower standard of welfare than one with a single lesion. Allain et al. (2009) referred to different lesions, such as breast blisters, footpad dermatitis, hock burns and scratches; but it is our assumption that multiple occurrences of the same type of lesion is also indicative of a welfare problem and increased suffering.

4.4.2 Testing of visual scales on farm and at the slaughterhouse

Substantial concordance observed among assessors using the 4-point visual scales developed in our study suggests that these are reliable for application on farm and at the slaughterhouse. In the case of BS and CD, when scores of some categories were grouped, the number of ordinal categories was reduced to three classes. According to Nalon et al. (2014), a scoring scale with fewer ordinal categories did not increase inter-rater reliability, and the same was observed in our study. The inclusion of a descriptive text was probably crucial in increasing the concordance among assessors, by describing thresholds across levels of severity,

which may not have been clear had the information been restricted merely to pictures.

The lack of variability on bird feathering scores prevented further understanding of the correlation between plumage covering and BS. Factors influencing feather growth and feather loss in broiler chickens have been studied. Dahlke et al. (2005) suggested a negative correlation between high environmental temperature and feather coverage of fast growing broiler chicken breeds. Poultry houses in our study had indoor temperatures higher than the recommended 18°C (COBB-VANTRESS, 2013), which may have contributed to general poor feathering. As early as 1978, Harris et al. observed that poor feathering on the thigh and hip area of broiler chickens was correlated to high stocking densities, since there would be increased contact between birds, resulting in rubbing action and feather breakage. Following this rationale, greater levels of contact between the ventral body area of birds and litter may predispose to poor feathering in this area. Bird's activity may be reduced in commercial poultry houses due to high stocking densities, skeletal disorders, low lighting intensity, and the barren environment (EFSA, 2010, 2012), which will lead to increased contact time between the ventral area of the body and the litter. Poor feathering increases skin exposure and, thus, is likely related to breast and abdomen skin irritation. Based on the prevalence of poorly feathered birds, we consider feathering condition as a relevant indicator to be further studied and included in broiler chicken welfare assessments. It may be an earlier indicator of welfare compared to CD. Further research is warranted to better understand correlation between feathering condition and CD, and to study whether both indicators are needed, and, if not, which of the two best promotes an understanding of animal welfare status.

The observed change in skin colour during bird restraint is an important item to be addressed during assessment of CD. Since handling is stressful to birds (HERBORN et al., 2015), causing an immediate rise in blood catecholamine levels (KORTE et al., 1997), the resultant peripheral vasoconstriction may have caused skin colour changes during assessment of CD. The hyperemia observed after vasoconstriction may have been caused by reactive hyperemia due to the accumulation of vasodilators from existing cutaneous inflammatory processes (MARTINEZ LEMUS; LAUGHLIN, 2015). Based on this, the assessment of CD must be performed immediately after birds are restrained and prior to any other AWI.

Change of skin colour did not seem to prevent the use of the scale or to cause low inter-rater reliability. However, we suggest further research to establish the recovery period for normal cutaneous circulation after restraint, which may contribute to maintain best agreement between assessors for this indicator.

Moderate correlation between litter quality and all AWI measured on farm suggested an important environmental impact on the prevalence of all types of contact dermatitis and BS. Moderate correlation between FPD and litter quality (HASLAM et al., 2007), as well the negative impact of poor litter quality on the skin of broiler chickens (DE JONG et al., 2014), have been demonstrated previously. We expected greater correlations between CD and FPD or HB, since Greene et al. (1985) reported that contact dermatitis appears mainly on feet, followed by hock burn and breast, because hocks and breasts will increase their contact with litter as bird activity decreases (DE JONG et al., 2014). However, disagreement with regards to correlation between different types of skin lesions was also observed in other studies. For example, de Jong et al. (2015) did not observe correlation between breast blisters and contact dermatitis; and Allain et al. (2009) observed negative correlation between breast blisters and severe FPD and HB. Considering the early age of modern fast-growing broiler chickens at slaughter, and depending on the litter quality, levels of FPD, HB and CD will vary and may not always be correlated. Since results concerning most correlations seem controversial, we believe it remains important to measure different animal-based indicators to assess broiler chicken welfare.

According to our data, the number of birds affected by CD was higher than birds affected by FPD and HB (FIGURE 14). The percentage of birds presenting CD was also higher than the mean occurrence of 0.0% to 15.8% of breast blisters and breast burns reported previously (HASLAM et al., 2007; ALLAIN et al., 2009; SOUZA et al., 2015), which have been the only indicators considered for the health of broiler chicken breast skin. The higher percentage of skin problems reported here is a consequence of the inclusion of breast irritation, compatible with earlier signs of contact dermatitis on the breast, and seems highly relevant to bird welfare assessment due to its high prevalence. We employed the term contact dermatitis for the occurrence of erythema, which may be understood as a primary sign of contact dermatitis, especially when viewed in context with what birds were exposed to: poor abdominal feathering and the prolonged contact of skin with offending substances from excreta present on litter. According to De Jong et al. (2014), slight redness of

the breast was commonly observed in broiler chickens kept on dry litter, and skin irritation progressed towards large red areas and the presence of small brown spots as litter quality decreased. Additionally, erythema observed in birds was considered by Delphi respondents as an unhealthy condition of the skin. However, it is our perception that histopathological studies are required to further characterize each level of macroscopic alteration described in the CD scale.

Recent studies have sought to simplify poultry welfare assessment, in an attempt to reduce assessment time and increase application of animal welfare protocols (BASSLER et al., 2013; DE JONG et al., 2015). One strategy to simplify the protocols is the correlation between assessments performed on farm and at the slaughterhouse. Footpad dermatitis and hock burns have been successfully validated for fast growing broiler chickens (DE JONG et al., 2015); and FPD has been accepted by the industry and competent authorities as a suitable indicator for identifying problems on-farm (EUROPEAN COMMISSION, 2017). In the case of BS, de Jong et al. (2015) did not identify a correlation between contact dermatitis at slaughter and BS on farm for fast growing broiler chickens. In addition, as observed by Wilkins et al. (2003), cleanliness of birds assessed at the slaughterhouse may be affected by pre-slaughter conditions, therefore it may not reflect litter quality or BS on farm. Thus, we suggest that data collection on farm remains necessary to better understand period of occurrence, prevalence and causes of certain welfare indicators, as well the correlation between animal welfare outcomes on commercial broiler chickens.

For CS assessment, modification of the carcass sampling procedure for injuries described in the Welfare Quality® (2009) protocol allowed more detailed observation of birds, including thighs, back and both sides of carcasses on the slaughter line. In addition, assessment of CS considering different size, age and depth of scratches may have contributed to high prevalence of this indicator. Allain et al. (2009) already observed a high prevalence of CS (79.7% ± 13.1). It seems, therefore, to be an important AWI to be included during broiler chicken welfare assessment, not only because of the pain caused to birds, but also due to its high occurrence. High line speed was not a constraint to assess CS; however, observation of lesion depth was exhausting because of the different quantities of deep and superficial scratches allowed in each scoring level. Allain et al. (2009) suggested that future studies should consider severity of CS, thus simplification of

CS scale by not discriminating between deep and superficial scratches may not be adequate, and there is a risk of underestimating scratches. In fact, high line speed may complicate assessment when an indicator may be classified at many different levels. In contrast to de Jong et al. (2015), who reduced levels of severity of the hock burn scale due to high line speed, our preference was to increase space between birds to be assessed. Consequently, more time was required to complete the assessment; thus, CS sampling methods require further work.

4.5 CONCLUSION

Results suggest that the adoption of scales for BS, CD and CS may improve our ability to assess broiler chicken welfare, since these welfare problems were prevalent and measurement consistency was acceptable. The BS scale required whole bird assessment and it included pictures of birds presenting poor feathering conditions, facilitating assessment when loss of plumage is observed; a situation showing almost complete prevalence. The CD scale included hyperemia of the breast and abdominal areas, highlighted by experts as being an unhealthy condition of skin, which used to be overlooked and not scored during animal welfare assessments. The CS scale allowed assessment considering age, depth and length of lesions. The proposed scales for the three indicators provide both visual and descriptive information, establishing more objective thresholds between scores, which tend to increase confidence in results. Substantial concordance observed among assessors encourages application of these animal-based indicators to assess broiler chicken welfare in a wide range of poultry houses and in different countries, thereby testing the scales in a variety of animal welfare conditions.

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5 ORDINAL OR VISUAL ANALOGUE SCALES FOR ASSESSING ASPECTS OF BROILER CHICKEN WELFARE?

RESUMO

O desenvolvimento de protocolos de avaliação de bem-estar animal (BEA) tem aumentando, sendo importante graduar certos indicadores ao invés de registrar sua ausência ou presença. Para problemas de bem-estar que variam em uma escala contínua, importantes informações podem ser perdidas quando a graduação é realizada utilizando-se escala ordinal. Desta forma, tem sido defendido o uso de escalas contínuas, as quais podem incluir marcadores internos. Observa-se o uso de marcadores equidistantes nas escalas visuais analógicas, no entanto, alguns estudos em indicadores específicos têm demonstrado que os espaços entre os marcadores tendem a não ser equidistantes. O presente estudo testou a aplicação de escalas ordinal (ORS) e visual analógica (VAS) para a avaliação de dermatite de contato das áreas de peito e abdômen (CD), pododermatites (FP), dermatite de jarrete (HB) e sujidade da ave (BS) em frangos de corte, por meio de estudo de confiabilidade interavaliador, correlação entre VAS e ORS e entre os indicadores de BEA medidos com ambas as escalas. Adicionalmente, foi testada a equidistância das categorias ORS em relação aos valores medidos usando VAS. Um total de 1.303 frangos de 10 lotes foram avaliados nas granjas por três avaliadores treinados usando uma ORS e uma VAS de 100 mm com marcadores somente nas pontas, representando os valores mínimos e máximos. A confiabilidade interavaliador de CD (0,68 vs 0,77, P<0,001) e de HB (0,67 vs 0,72, P<0,001) foi maior, mas a de FP (0,91 vs 0,88, P<0,001) foi menor quando usando VAS em comparação com ORS. As correlações entre ORS e VAS variaram entre 0,90 – 0,97 e 0,77 – 0,95 (P<0,001), considerando os valores médios e individuais dos três avaliadores, respectivamente. Correlações similares baixas a moderadas foram observadas entre os quatro indicadores quando se usou ORS e VAS. Para todos os indicadores, os marcadores em VAS que melhor representaram ORS não eram equidistantes. Os resultados sugerem que as duas escalas são confiáveis para avaliar os indicadores selecionados de bem-estar de frangos de corte. VAS tem potencial para adicionar sensibilidade à avaliação de BEA e pode ser usada para procedimentos de validação e protocolos de certificação. A adoção de VAS com marcadores pode permitir maior confiabilidade durante a avaliação e pode ser uma ferramenta para estudos em que se necessita de maior sensibilidade. A especificação clara dos marcadores e a determinação de seus exatos pontos ao longo da VAS são decisões importantes e parte do treinamento dos avaliadores, uma vez que resultados precisos e acurados de avaliações de BEA têm implicações diretas aos animais e às demais partes interessadas.

Palavras-chave: Bem-estar animal. Medidas baseadas nos animais. Escala categórica. Escala contínua. Aves.

ABSTRACT

The development of animal welfare (AW) assessment protocols has increased worldwide, and it seems useful to score the gradations of certain indicator as opposed to presence or absence. For welfare issues that vary along a continuous scale, important information may be lost when gradation is scored through ordinal scales. Therefore, some advocate the use of continuous scales, which may be tagged with internal anchors. Equidistant tags have been used; however, some studies on specific indicators have demonstrated that empirical data for the space between tags tend to be non-equidistant. We tested the application of ordinal (ORS) and visual analogue scales (VAS) for the assessment of contact dermatitis on the breast and abdominal areas (CD), footpad dermatitis (FP), hock burns (HB) and bird soiling (BS) in broiler chickens, by studying inter-rater reliability, the correlation between VAS and ORS and amongst the welfare indicators measured with both scales. In addition, we tested the equidistance of ORS categories in relation to values measured using the VAS. A total of 1,303 broiler chickens from 10 flocks was assessed on-farm by three trained raters using an ORS and a 100 mm VAS anchored only with the minimum and the maximum scores at each end. Inter-rater reliability of CD (0.68 vs 0.77, $P<0.001$) and HB (0.67 vs 0.72, $P<0.001$) was higher, but that of FP (0.91 vs 0.88, $P<0.001$) was lower, when using VAS compared with ORS. Correlations between ORS and VAS varied between 0.90 - 0.97 and 0.77 - 0.95 ($P<0.001$), considering mean and individual values of the three raters, respectively. Similar low to moderate correlations were observed between the four indicators when using ORS and VAS. For all indicators, tags on VAS that best represented ORS were not equidistant. Results suggest both scales were reliable to assess the selected broiler chicken welfare indicators. VAS presents potential to add sensitivity to AW assessment and may be used for validation procedures and certification protocols. The adoption of tagged VAS may enable raters to score more reliably and may become a tool for studies in which higher sensitivity is prioritized. Clear specification of tags and determining their exact position along the VAS, are important decisions and part of the training of raters, since precise and accurate results from AW assessments have direct implications to the animals and other stakeholders.

Keywords: Animal welfare. Animal-based measures. Categorical scale. Continuous scale. Poultry.

5.1 INTRODUCTION

The development and application of protocols to assess animal welfare (AW) has increased worldwide. In addition to registering absence and presence of AW issues, it is often useful and informative to score gradations of these issues. Assuming equal reliability, the more the scoring of these gradations is refined, the more sensitive becomes the detection of relevant AW aspects, such as AW progress over time, differences between the welfare of groups of animals or effects of AW or other interventions on the lives of animals. There are some initiatives for the welfare assessment of broiler chickens, like the Welfare Quality® (2009), the AssureWel (2014) and the Global Animal Partnership® (2018). These protocols include measures, predominantly presented as ordinal scales (ORS) ranging from 2- to 6-point scales. Raters can be trained to score reliably using ORS, and much of advances in knowledge of broiler chicken welfare are due to the application of ORS in experimental and commercial flocks. Descriptors, photos and videos may be used for illustrating, and training step-wise increases in severity, thereby increasing consistency within and between observers. This also implies that data from different studies can be compared if the same ORS are used. However, assessing continuous welfare traits by using discontinuous scales may be disadvantageous (TUYTTENS et al., 2009). The use of ORS may result in reduced sensitivity when raters are able to discriminate more levels of the assessed indicator than the number of categories allow for and are forced to group gradations they perceive as different into the same category.

A different type of scale, the visual analogue scale (VAS), is largely used to assess pain in humans and non-human animals (DE GRAUW; VAN LOON, 2016; HJERMSTAD et al., 2011). In AW assessment, VAS has also been applied to assess expressive qualities of animal behaviour (FLEMING et al., 2016; GROSSO et al., 2016; MINERO et al., 2016) and lameness (FLOWER; WEARY, 2006; NALON et al., 2014; TUYTTENS et al., 2009; VIEIRA et al., 2015) in different species. VAS is a continuous scoring system that consists of a line, which varies usually from 100 to 125 mm in length, anchored by the minimum and the maximum score at each end. Thus, VAS removes the constraint of grouping information into discrete units and enables raters to achieve greater sensitivity in their scoring for aspects that vary along a continuum. The downside of the conventional VAS is the difficulty to train

raters to score different gradations consistently, and as observed by De Grauw and Van Loon (2016), the inter-rater reliability may be negatively affected. In this case, the tagged VAS (tVAS), which is a VAS with internal anchors, has been investigated as a tool to combine the advantages of both ORS and VAS (NALON et al., 2014; TUYTTENS et al., 2009). The tags add information to guide raters through different gradations thereby increasing reliability and facilitating the training of raters (TUYTTENS et al., 2009).

Previous studies assumed equidistant tags to VAS to assess specific indicators of animal welfare based on existing categories used in ORS (MEEREMANS et al., 2017; NALON et al., 2014; RUFENER et al., 2018; TUYTTENS et al., 2009). However, Vieira et al. (2015) challenged this rationale by presenting a non-equidistant characteristic of tags in VAS when assessing lameness in dairy goats. In this case, tags that are based on existing categories from ORS are expected to be checked what their correct positions are on the VAS and whether these are spaced equidistantly or not. As lameness, many other relevant welfare problems vary continuously and could be assessed by a continuous scale rather than an ORS. For broiler chickens, contact dermatitis and related measures are considered important animal welfare indicators. They have been systematically scored using ORS in a variety of scoring scales: contact dermatitis (ALLAIN et al., 2009; DE JONG; GUNNINK; VAN HARN, 2014; EKSTRAND et al., 1998; HASLAM et al., 2007; MARTLAND, 1985; SOUZA et al., 2018; WELFARE QUALITY®, 2009) and bird soiling (DAWKINS; DONNELY; JONES, 2004; ELWINGER, 1995; WEEKS et al., 1994; WELFARE QUALITY®, 2009; WILKINS et al., 2003), as examples. Potential improvement in the use of VAS to assess these indicators seems to warrant further studies, especially testing for reliability. It may be interesting to study the correlation between these indicators when measured with VAS, to verify whether VAS use results in a different general data interpretation when compared to ORS.

Recent studies have compared ORS and VAS, including tVAS, in animal welfare assessment. For example, Vogt et al. (2017) considered VAS reliable to assess the temperament of animals, and either VAS and ORS were considered reliable scales to assess lameness in dairy cattle (FLOWER; WEARY, 2006). Considering the use of tags in VAS, tVAS and 5-point ORS presented similar interobserver repeatability for the assessment of sows, but both were better than for 2-point ORS (NALON et al., 2014), or interobserver reliability was better for the tVAS

than for the ORS (TUYTTENS et al., 2009) when assessing dairy cow welfare. Differently, Meeremans et al. (2017) observed that use of tVAS did not improve assessment of fish vitality as compared to categorical scoring.

Scientific research has encouraged the study towards new techniques to assess AW in field conditions. Reliability between raters is an important criterion in the selection of AW indicators, since there is high probability of single person assessments due to manpower costs of animal-based monitoring schemes (TUYTTENS et al., 2014). Regarding the decision on the best type of scale, the determinant seems to rely on how observers are able to discriminate between the levels of the indicator (ENGEL et al., 2003). Based on this, we aimed to test the application of ORS and VAS for four broiler chicken welfare indicators, namely contact dermatitis on the breast and abdominal areas (CD), footpad dermatitis (FP), hock burns (HB) and bird soiling (BS), by studying inter-rater reliability, the correlation between the VAS and ORS and amongst the welfare indicators measured with VAS and ORS, and by testing the equidistance of ORS categories in relation to values measured using the VAS.

5.2 MATERIAL AND METHODS

5.2.1 Ethical statement

This project was approved by the Animal Use Ethics Committee of the Agricultural Campus n. 079/2015, November 12th, 2015 (ANNEX IV) of the Federal University of Paraná.

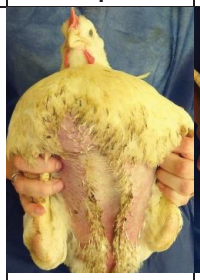
5.2.2 Animals, housing and data collection

A total of 1,303 broiler chickens, randomly selected from 10 flocks, was assessed in the State of Paraná, Southern Brazil, from January 9th to 13th 2017. The sampling size of 1,300 birds was calculated considering a maximum error of 5% and 95% confidence interval; sample was not selected to be representative of bird welfare in Brazilian industrial broiler chicken units. Poultry barns had sidewalls with wire mesh covered by blackout curtains working as dark house (n = 1) or covered by yellow curtains, with natural lighting (n = 9), chosen as convenient samples according

to our objective, to test the ordinal and analogue scales; thus, sampling did not aim for a representative sample to describe AW conditions of the studied flocks. All units had automatic feeders, nipple drinkers, sprinklers, exhaust fans and wood shaving litter; nine units maintained evaporative cooling systems. Indoor mean temperature in the units at time of the visit was 27.7 ± 1.4 °C. Average broiler house area was 1,540 ± 187 m^2 and the number of birds per house was 18,904 ± 2,604, with a stocking density of 36.4 ± 0.9 kg/m^2. Birds were male and female Cobb 500®, assessed at 41.3 ± 2.0 days of age. The raters were one animal scientist and two veterinarians, one of them experienced in auditing poultry farms. Non-experienced raters underwent a 4 h classroom instruction about the indicators via picture observation, followed by a 4 h training session at the Federal University of Paraná farm. The scales used on training sessions were obtained from Souza et al. (2018) and Welfare Quality® (2009). One month after the training, the raters were asked to score 13 pictures for FP and 15 pictures for CD and BS to check concordance among them and solve any doubts before the experiment. Kendall's coefficient of concordance corrected for ties among raters were 0.89 (P=0.002), 0.79 (P=0.004) and 0.93 (P=0.001) for FP, CD and BS, respectively, and were considered adequate (LANDIS; KOCH, 1977).

Raters scored each bird simultaneously but independently. They performed visual inspection of in total 130 birds from five locations in each poultry house, following the original ORS for CD and BS obtained from Souza et al. (2018), which included a colour picture and a description of each level of the scale; and for FP and HB obtained from the Welfare Quality® (2009), which included a colour picture representative for each level of the scale (FIGURE 15). To collect data, a questionnaire was developed at the QuickTapSurvey® website to be used as a mobile phone application. Raters scored each bird using both the ORS and the VAS for each indicator. The application presented the ORS followed by VAS, thus the raters usually scored ORS first. In the ORS, the raters had to choose the option in a 4- or 5-point scale. The VAS consisted of a line of 10 cm anchored only with the minimum and the maximum score at each end (absence or severe CD, FP, HB and BS), in which the rater could move a marker along the line to register the level of severity observed in the bird for each indicator. Data from QuickTapSurvey® were downloaded into an Excel file and checked for errors before use.

FIGURE 15 – ORDINAL SCALES FOR THE ASSESSMENT OF FOUR BROILER CHICKEN WELFARE INDICATORS

Indicator	0	1	2	3	4
Contact dermatitis on the breast and abdominal areas[1]					--
Bird soiling[1]					--
Footpad dermatitis[2]					
Hock burn[2]					

SOURCE: The author (2019), adapted from [1]SOUZA et al. (2018) and [2] WELFARE QUALITY® (2009).

5.2.3 Statistical analysis

Aiming to estimate inter-rater reliability, linear mixed models were fitted. Inter-rater reliability was assessed using the Intraclass Correlation Coefficient (ICC). Confidence intervals for ICC were obtained by the bootstrap method, using 5,000 simulations. Total data variability (TDV) was decomposed into variability attributed or not attributed to the raters (VNA). ICC values were calculated based on the

VNA:TDV ratio, adjusting for variability between poultry farms. Thus, for an animal welfare indicator, indicated as Y, the following model was defined:

$$Y_{ijkl} = n + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_k + \epsilon_{ijkl}$$, in which

Y_{ijkl} is the *l-th* assessment of the rater *j* in the animal *k* of the poultry farm *i;*

$\alpha_i \sim Normal(0, \sigma_\alpha^2)$ is the random effect of the poultry farm;

$\beta_j \sim Normal(0, \sigma_\beta^2)$ is the random effect of the rater;

$\gamma_k \sim Normal(0, \sigma_\gamma^2)$ is the random effect of the animal;

$(\alpha\beta)_{ij} \sim Normal(0, \sigma_{\alpha\beta}^2)$ is the random effect of the interaction between rater and poultry house;

η is the model intercept;

$\epsilon_{ijkl} \sim Normal(0, \sigma^2)$ is the random error.

Based on this, the ICC was defined as:

$$ICC = \frac{(\sigma_\alpha^2 + \sigma_\gamma^2)}{(\sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\gamma^2 + \sigma^2)}$$

P-values of ICC were obtained by $(ICC\ ORS) - (ICC\ VAS)$, where ICC ORS is the intraclass correlation value of the ordinal rating scale, and ICC VAS is the intraclass correlation value of the visual analogue scale for each indicator.

Spearman's rank correlation coefficient for the mean of values given by the three raters and for the individual values of each rater was used to test correlations between ORS and VAS for all indicators, as well as correlations amongst all indicators measured using the ORS. Pearson Correlation Coefficient was used to test correlations amongst all indicators measured using the VAS. Correlations from 0.3 to 0.6 were considered moderate, and higher than 0.6 were considered high (DE JONG et al., 2015).

Linear mixed models were used to test equidistance of ORS categories according to values measured using the VAS. VAS values were considered as response variables, and ORS values as covariables, including random effects of animal, rater, poultry house and interaction between rater and poultry house. Two models were fitted for each indicator, assuming (Model 1) or not assuming

equidistance (Model 2) between the scores. In Model 1, ORS was included as a numerical variable, defined by p+1 different values. In Model 2, ORS was included as a categorical variable, not assuming a fixed increment across scores. So, the following models were considered:

Model 1: $Y_{ijkl} = n + ORS_{ijkl} + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_k + \epsilon_{ijkl}$,

in which Y_{ijkl} and ORS_{ijkl} correspond to the rater *j* in the animal *k* of the poultry farm *i* for the *l-th* time in the scales VAS and ORS, respectively;

Model 2:

$$Y_{ijkl} = n + \tau_1 \times I(ORS_{ijkl} = 1) + \tau_2 \times I(ORS_{ijkl} = 2) + \tau_3 \times I(ORS_{ijkl} = 3) + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_k + \epsilon_{ijkl}$$

in which $I(ORS_{ijkl} = x)$ is the indicator function, assuming value zero when ORS score is different of an x value, and assuming value one when ORS score is equal to x; τ_1, τ_2 and τ_3 are the effects that reflect the association between ORS and VAS.

To investigate the equidistance hypothesis, the fitted models were compared using the Akaike Information Criterion (AIC), following the method of Burnham and Anderson (2002), based on the strength of evidence, defined by:

$$W_i = \frac{exp(-0.5(AIC_i - AIC_{min}))}{exp(-0.5(AIC_2 - AIC_{min})) + exp(-0.5(AIC_1 - AIC_{min}))}$$

In which $_i$ =1.2, with AIC_{min} the lowest AIC value obtained by the models. W_i is the probability of model $_i$ be the best model.

For each indicator in which the AIC confirmed the non-equidistance, the determination of tags on VAS was performed using the classification tree, being VAS the predictor of ORS. The classification tree method proposed by Breiman et al. (1984) employs successive partitions of a sample to constitute subsamples that are homogeneous in relation to response values, in our case ORS. The rules for partition were $VAS < x$ versus $VAS \geq x$, being x a value sampled from VAS, so that the observations were allocated to different subsamples according to the rule they complied to. The final number of subsamples was defined based on a cross validated process, in which data was divided into two bases, one for adjustment and one for validation. In addition, the number of categories in each ordinal scale was considered during the subsample determination to better establish the tags for each indicator.

Analyses were performed using R Statistical Computing Environment software version 3.3.1 (R CORE TEAM, 2016), packages ANGELO CANTY and BRIAN RIPLEY (2016), BATES et al. (2015), THERNEAU, ATKINSON and BRIAN RIPLEY (2015).

5.3 RESULTS

Estimated inter-rater reliability was higher for CD and HB using VAS, and higher for FP using ORS (TABLE 6).

TABLE 6 – ESTIMATES OF INTER-RATER RELIABILITY AND CONFIDENCE INTERVAL, 5,000 BOOTSTRAP SAMPLES, FOR ANIMAL WELFARE INDICATORS FROM 1,303 BROILER CHICKENS ASSESSED ON FARM BY THREE RATERS USING BOTH ORDINAL SCALE (ORS) AND VISUAL ANALOGUE SCALE (VAS)

Welfare indicator	Scale	Intraclass correlation	Confidence interval (95%)	P-value*
Contact dermatitis on the breast and abdominal areas	ORS	0.68	(0.58 - 0.77)	<0.001
	VAS	0.77	(0.67 - 0.85)	
Footpad dermatitis	ORS	0.91	(0.87 - 0.93)	<0.001
	VAS	0.88	(0.83 - 0.92)	
Hock burns	ORS	0.67	(0.55 - 0.76)	<0.001
	VAS	0.72	(0.60 - 0.80)	
Bird soiling	ORS	0.61	(0.46 - 0.73)	0.447
	VAS	0.54	(0.36 - 0.69)	

SOURCE: The author (2019). NOTE: *ORS x VAS intraclass correlation.

High correlation was observed between ORS and VAS for each welfare indicator, considering mean and individual values (TABLE 7). When indicators were correlated amongst them, within each scale, we observed similar level of correlation of data using ORS and VAS (TABLE 7).

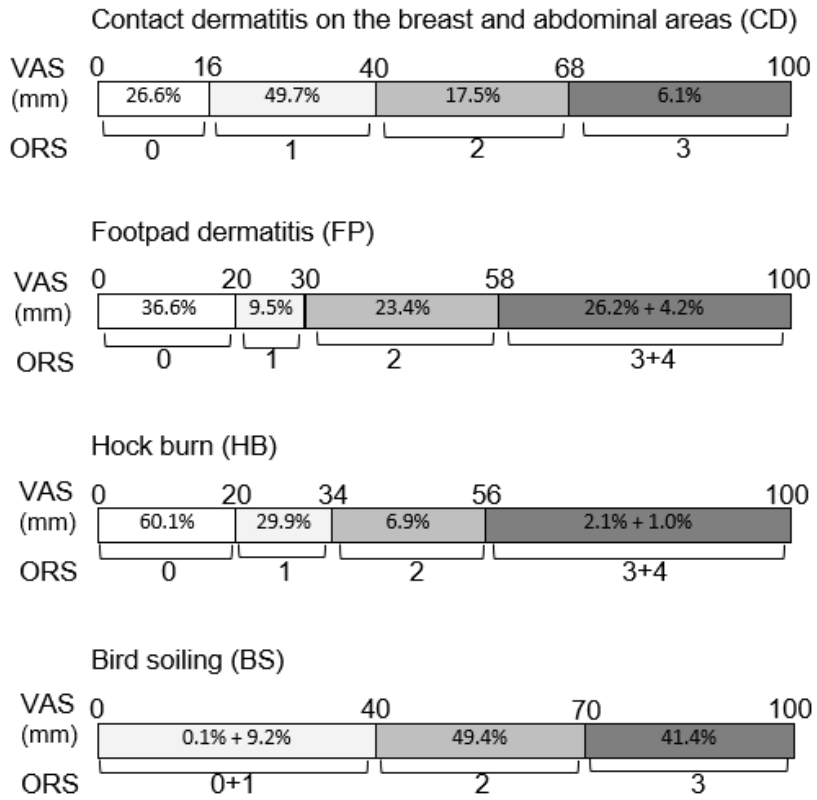
TABLE 7 – CORRELATION OF ORDINAL SCALE (ORS) AND VISUAL ANALOGUE SCALE (VAS) FOR THE MEAN OF VALUES GIVEN BY THE THREE RATERS AND FOR THE INDIVIDUAL VALUES OF EACH RATER, AND CORRELATION OF BROILER CHICKEN WELFARE INDICATORS MEASURED ON FARM USING ORS AND VAS, 1,303 BIRDS

Indicator	Spearman rank correlation between ORS and VAS*		Correlation between indicators* (ORS, Spearman correlation; VAS, Pearson correlation)				
	Mean	Individual	Indicator	Scale	FP	HB	BS
Contact dermatitis on the breast and abdominal areas (CD)	0.96	0.89	CD	ORS	0.06	0.24	0.34
				VAS	0.09	0.35	0.34
Footpad dermatitis (FP)	0.97	0.95	FP	ORS		0.17	0.08
				VAS		0.26	0.12
Hock burn (HB)	0.90	0.77	HB	ORS			0.25
				VAS			0.24
Bird soiling (BS)	0.94	0.81					

SOURCE: The author (2019). NOTE: * P < 0.0001.

For all indicators, the strength of evidence for the Model 2, which does not assume equidistance between tags, was higher than 0.99. Thus, the tags on VAS that better represent ORS are not evenly spaced. The calculated tags for each indicator are shown in FIGURE 16. Broiler chickens assessed in our study presented 0.1% of absence of soiling (score 0); 1.0% and 4.2% of severe HB and FP (score 4), respectively. Since these frequencies did not allow an adequate tag calculation, scores 0 and 1 were aggregated for BS, as well as scores 3 and 4 for HB and FP (FIGURE 16).

FIGURE 16 – TAGS FOR ORDINAL SCALE (ORS) FOR BROILER CHICKEN WELFARE INDICATORS CALCULATED BY THE CLASSIFICATION TREE CONSIDERING VISUAL ANALOGUE SCALE (VAS) AS PREDICTOR; PERCENTAGES REFER TO THE NUMBER OF BIRDS CLASSIFIED IN EACH ORS CATEGORY, DATA FROM 1,303 BIRDS ASSESSED ON FARM BY THREE RATERS



SOURCE: The author (2019).

5.4 DISCUSSION

Higher ICC for CD and HB using VAS, and for FP using ORS were observed; however, general ICC values suggest both scales were reliable to assess the animal-based indicators proposed in this study. This warrants further research comparing a

greater number of raters. Direct comparison across studies using ORS and VAS was not possible due to different methods employed to estimate reliabilities; however, for those studies in which the reliability was given by a value between 0 and 1, the range of values reported considered as reliable was similar to the range observed in our study (FLOWER; WEARY, 2006; MEEREMANS et al., 2017; NALON et al., 2014). As a general guideline, ICC reliability coefficient may be considered good when between 0.60 and 0.74, and excellent when higher than 0.75 (CICCHETTI, 1994). In the case of BS, lack of difference between ORS and VAS seems related to high data variability. FP is observed as a clearer indicator, perhaps as consequence of a simpler scale. In the case of CD and BS, pictures needed to expose other animal parts, like skin, foot and feathers, which may induce raters to reflect more about animal condition. In this case, data obtained may be influenced by something else, like experience or personal views (MEAGHER, 2009).

Inter-rater reliability may have been affected by other factors, such as place of assessment, training and quality of the descriptive textual and photographic material to support the assessment, and the limited number of raters. Studies comparing ORS and VAS for animal welfare purposes frequently combine video recordings and a large group of raters. In our study, on-farm assessment may have been positive to improve inter-rater reliability, even with three raters, since they could choose the best angle and touch the birds during the physical assessment. Touching the bird was important specially to remove dirt to confirm the presence and size of FP and HB. Since only one rater was experienced in broiler chicken welfare assessment, training, rather than experience, may have played an important role in helping raters to discriminate between the levels of each indicator (MEEREMANS et al., 2017). In addition, successful learning depends on a scoring system with clear definitions and photographs (GIBBONS et al., 2012). In our case, training was done with the available scientific-validated materials to score the four proposed indicators. These materials were related to the use of ORS, which means that raters were trained to recognize four or five different levels of severity, depending on the indicator. Nevertheless, raters were able to coherently score birds using the VAS. The quality of the scoring system is important to provide all information required by the raters before and during the assessment and clear definitions are essential to make scoring systems less dependent on personal experience or any factor that reduces inter-rater reliability (MEAGHER, 2009). In this regard, it is expected that more comprehensive

training materials, with pictures of various gradations in severity along the VAS, will increase inter-rater reliability.

Indicators kept the same level of correlation between them, regardless of the type of scale. The exception was the correlation between CD and HB, which was slightly higher when using the VAS compared with the ORS. Both CD and HB had higher inter-rater reliability using VAS, thus probably there was a refinement on data using VAS, which impacted on correlation between CD and HB. We expected higher correlation between CD, FP and HB, since contact dermatitis has been reported as to be developed in a sequence, initially on feet, followed by hocks and breast, as far as bird activity decreases and contact of body parts with litter increases (DE JONG; GUNNINK; VAN HARN, 2014; GREENE; MCCRACKEN; EVANS, 1985). Other factors, such as early age of modern fast-growing broiler chickens at slaughter and litter quality, may challenge the rationale with regards to correlation between different types of skin lesion (SOUZA et al., 2018). Despite low to moderate correlation between indicators, the type of scale did not affect data interpretation for the selected outcomes in this study, suggesting both scales could be used to assess birds.

Results of inter-rater reliability and correlations observed on TABLES 6 and 7 may reduce skepticism about the subjectivity of VAS, especially considering that VAS was anchored only at the endpoints. High correlation between ORS and VAS for all indicators may suggest applicability of both scales, and is aligned with results of comparisons between ORS and VAS for pain assessment (HJERMSTAD et al., 2011). Similar to Flower and Weary (2006), raters were able to coherently transpose ordinal scores into continuous scores even in the absence of internal tags on VAS. One possible limitation of this study was the application of both scales concomitantly, which may have motivated raters to virtually divide the VAS according to the ORS. Equidistant data would support this rationale, as observed by Engel et al. (2003). However, data obtained in our study were not equidistant. The lack of equidistance was observed in other studies using VAS to assess lameness (THOMSEN; MUNKSGAARD; TØGERSEN, 2008; VIEIRA et al., 2015; WELSH; GETTINBY; NOLAN, 1993) and in a study to determine cut-off points in a VAS for pain in patients with chronic musculoskeletal pain (BOONSTRA et al., 2014). Our results show that the decision regarding the location of tags had direct implication on the number of animals classified in each level of severity. As example, some birds who were scored as 0 using ORS, meaning absence of CD, FP and HB, received grades up to 16 or

20 mm using the VAS. These results are probably indicating that birds presented slighter lesions than the ones described on level 1 of the ORS, and the rater had to choose between 0 and 1. In this case, the VAS was more sensitive to allow the rater to choose the best position between 0 and 1. In this example, the number of birds considered clinically absent of CD, FP and HB differed between ORS and VAS.

There is a recommendation to insert internal tags on VAS, with the advantage of combining characteristics of the ORS, such as improving uniformity of interpretation, with the flexibility of VAS to identify small changes between the tags (AVERBUCH; KATZPER, 2004; NALON et al., 2014). Although the VAS had a high reliability in this study, it is expected that the internal anchors of a tVAS will enable raters to score even more reliably. The position of the internal tags in a tVAS is important because it affects the number of animals in each level. For example, if tags are equidistant, more animals will be considered zero as compared to a tVAS were tags for zero and one are set closer to each other. As observed in FIGURE 16, categories 0 and 1 were often shorter than the more severe categories. Perhaps the ORS over-emphasizes the milder cases, which were the most common for three indicators, while the VAS allows raters to better differentiate between the scores. Thus, to compare ORS and tVAS, it is important to have clear definitions about the position of different ORS categories along the continuous scale, and raters should be clearly instructed and trained on how to use the scale. This issue deserves more attention and seems especially relevant depending on the goal of the assessment, which may be to provide best practice recommendations or may be associated with sanctions (MAIN; MULLAN, 2012) or bonuses for certification processes.

Many studies have been done to encourage the adoption of regular broiler chicken welfare assessment worldwide. This permanent monitoring of welfare may include the use of correlations, such as of contact dermatitis on farm and at the slaughterhouse (DE JONG et al., 2015), as well as the use of technology to automate assessment on farm or at the slaughterhouse (SASSI; AVERÓS; ESTEVEZ, 2016). FP has been accepted as an important welfare indicator for surveillance purposes (EUROPEAN COMMISSION, 2017), and automation of this assessment seems a priority. For automated assessment through image analysis, the ORS are commonly used, and in the case of FP they seem adequate. When both VAS and ORS work well, the choice of the scale will include a critical analysis of the conditions related to their use (HJERMSTAD et al., 2011). In this case, adoption of an animal welfare

indicator by organizations will depend on reliability, validity, sensitivity and power, but also feasibility and efficiency. VAS, including tVAS, presents potential to be considered for different animal welfare strategies, in addition to animal welfare assessment. As example, it may be used to validate automated monitoring of indicators showing higher inter-rater reliability using VAS or, since VAS is more sensitive (WELSH; GETTINBY; NOLAN, 1993), application may include its use during inspections for certification processes and as part of a verification procedure in an animal welfare management system (SOUZA; MOLENTO, 2018), in studies in which high sensitivity is needed; or tVAS may be used as a silver standard for automated monitoring tools, since it is more likely to detect small differences and changes along time.

5.5 CONCLUSION

This is the first study to compare ORS and VAS for the selected broiler chicken welfare indicators. Both ORS and VAS were considered reliable to assess the broiler chicken welfare indicators CD, FP, HB and BS, despite some differences on inter-rater reliability. Results suggest that using the scale with higher inter-rater reliability may promote refinement on correlation studies; however, interpretation of correlation did not differ between VAS and ORS. VAS, including tVAS, presents potential to add sensitivity on animal welfare assessment, and is a tool to be further explored in validation and certification protocols, especially in studies in which high sensitivity is needed. In this case, considering that results from animal welfare assessment may have direct implications to the animals and other stakeholders, the use of tVAS will demand clear specification about the position of tags on the continuous scale as well as the training of raters.

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6 DEVELOPMENT OF A FIXED LIST OF TERMS IN BRAZILIAN PORTUGUESE FOR THE QUALITATIVE BEHAVIOUR ASSESSMENT OF BROILER CHICKENS

RESUMO

A avaliação qualitativa do comportamento (QBA) é um método para analisar o animal em sua totalidade, usando termos para descrever as qualidades do comportamento que expressam emoções e integrando informações para serem analisadas estatisticamente. O QBA para frangos foi inicialmente desenvolvido em inglês pelo método de perfil livre, sendo posteriormente refinado em uma lista fixa de termos. O sucesso do QBA está relacionado ao reconhecimento dos termos pelos avaliadores. Deste modo, este estudo objetivou desenvolver e testar uma lista fixa de termos em português do Brasil para a avaliação qualitativa do comportamento de frangos de corte, estudando concordância inter- e intra-avaliadores e e componentes principais. Frangos de corte foram filmados em dez granjas comerciais e uma experimental em situações de estado emocional positivo e negativo, de alta e baixa intensidade. Catorze especialistas participaram de uma oficina para desenvolver a lista fixa por meio de análise de vídeo e discussão em grupo, sendo a lista posteriormente analisada por pesquisadores experientes. Quarenta alunos de graduação testaram a lista avaliando 18 vídeos de 1 minuto cada, usando uma escala visual analógica de 125 mm. A análise de componentes principais (PCA) foi conduzida. Os escores dos componentes principais (PC) atribuídos aos quatro primeiros PC e as concordâncias individuais de cada termo foram avaliados pelo coeficiente de correlação intraclasse (ICC). Um total de 136 termos distintos foram gerados, dos quais 88 foram considerados apropriados ao QBA. Ao final do processo, na lista fixa constavam 25 termos distribuídos no modelo dimensional de valência e intensidade. O PCA identificou quatro PC com autovalor maior que 1, explicando 69.4% da variância dos dados. O PC1 variou de incomodados e frustrados a confortáveis e com vitalidade, sugerindo ser um componente de valência; PC2 variou de calmo e entediado a agitado e ativo, sugerindo ser um componente de intensidade. Quando os termos foram testados em conjunto em cada componente, PC1 e PC2 apresentaram boa concordância inter e intra-avaliador (ICC de 0.63 a 0.73) e PC3 apresentou excelente concordância intra-avaliador (0.76).Quando os termos foram testados individualmente, cinco obtiveram boa ou excelente concordância interavaliador (ICC de 0.65 a 0.81) e nove foram classificados como boa concordância intra-avaliador (ICC de 0.61 a 0.72). Este estudo demonstra a importância de produzir a lista de termos ao invés de traduzir listas pré-existentes na literatura científica, talvez contribuindo para aumentar o uso do QBA em países cuja língua nativa não seja o Inglês. Os resultados sugerem que a lista é confiável para avaliar as qualidades do comportamento que expressam emoções em frangos; no entanto, incentiva-se que seja testada em granjas e por avaliadores experientes, bem como que se refine a lista em relação aos termos referentes aos estados de baixo grau de bem-estar animal. Dado o poder de diferenciação entre os níveis positivo e negativo, bem como entre os níveis alto e baixo de qualidades do comportamento animal que expressam emoção, a lista de

termos desenvolvida neste estudo é uma ferramenta que soma importante informação na avaliação de bem-estar de frangos de corte.

Palavras-chave: Bem-estar animal. Indicadores baseados nos animais. Aves. Protocolo Welfare Quality®.

ABSTRACT

The Qualitative Behaviour Assessment (QBA) is a methodological approach to assess the whole animal using terms to describe the emotionally expressive qualities of behaviour and integrating information to be statistically analyzed. The QBA for broiler chickens was initially developed in English using the free choice profiling method and further refined into a fixed list of terms. The success of QBA is closely related to the recognition of terms by the raters. Based on this, our study aimed to develop a fixed list of terms in Brazilian Portuguese for the Qualitative Behaviour Assessment of broiler chickens, and to test it by studying inter- and intra-rater reliability and principal components. Broiler chickens in ten commercial and one experimental poultry barns were video-recorded in situations of positive and negative emotional states, both in high and low intensities. Fourteen experts participated in a workshop to develop the fixed list of QBA terms through video assessment and group discussion. The fixed list was evaluated by experienced researchers. Forty undergraduates tested the list by scoring 18 video clips of 1 minute each, using a 125 mm visual analogue scale. Principal Component Analysis (PCA) was conducted. Intra and inter-rater agreement for the principal component (PC) scores attributed to the first four PC and also for separate terms were assessed by intraclass correlation coefficient. A total of 136 distinctive terms were generated, of which 88 were considered QBA terms. At the end of the workshop and final revision, the fixed list had 25 terms balanced through the valence and arousal dimensional model. The PCA identified four main components with Eigenvalue greater than 1, together explaining 69.4% of the variance. PC1 ranged from disturbed and frustrated to comfortable and lively, suggesting this PC is important to describe the valence. PC2 ranged from calm and dull to agitated and active, suggesting this PC describes the level of arousal of the birds. When the terms were jointly tested in each principal component, PC1 and PC2 presented good inter- and intra-rater reliability (ICC varying from 0.63 to 0.73), and PC3 presented excellent intra-rater reliability (0.76). When the terms were individually tested, five achieved good or excellent inter-rater reliability (ICC varying from 0.65 to 0.81), and nine terms were classified as good intra-rater reliability (ICC varying from 0.61 to 0.72). This study demonstrates the importance of producing lists bottom-up as opposed to translating pre-existing lists in the scientific literature, perhaps contributing to increase the use of the QBA in countries where English is not the native language. Results suggest the fixed list is reliable to assess the expressive qualities of broilers behaviour; therefore, it is fully encouraged to test it on farm, by experienced raters, as well to further refine it concerning poor welfare related terms. Given the power to differentiate between positive and negative as well between high and low emotionally expressive qualities of animal behaviour, the list of terms developed in this study is a tool to add valuable information in welfare assessment of broiler chickens.

Keywords: Animal welfare. Animal-based indicator. Poultry. Welfare Quality® protocol.

6.1 INTRODUCTION

Brazil is the world's second largest producer of broiler chicken meat (ABPA, 2018), with a total of 5.8 billion birds slaughtered in 2017 (IBGE, 2018), which means that regular assessment of broiler chicken welfare in this country is essential. Local regulation has emphasized monitoring procedures at pre-slaughter and slaughter levels by the inclusion of training and control programs demanded by the European Directive 1099/09 for the exporting companies (EUROPEAN COMMISSION, 2009), and through the application of the Brazilian regulation for humane slaughter IN 3/2000 (MAPA, 2000). At farm level, there is no specific regulation for the protection of broiler chickens in this country, and some recent studies have applied the Welfare Quality® protocol (WELFARE QUALITY®, 2009) to investigate broiler chicken welfare in Brazil (FEDERICI et al., 2016; SANS et al., 2014; SOUZA et al., 2015a; TUYTTENS et al., 2015). The Welfare Quality® protocol has been chosen because it comprises scientifically validated indicators, predominantly animal-based (BLOKHUIS et al., 2010). It also allows behavioural assessment of the animals, in addition to housing, nutritional and health conditions (WELFARE QUALITY®, 2009), something that is essential for a complete welfare evaluation.

The Qualitative Behaviour Assessment (QBA) is the measure for positive emotional state of the appropriate behaviour principle at the Welfare Quality® protocol. It is a methodological approach to assess the whole animal, integrating information of how animals behave, and capturing it into numbers allowing for statistical analysis (FLEMING et al., 2016; WEMELSFELDER et al., 2001). The QBA uses terms to describe the emotionally expressive qualities of animal behaviour, such as relaxed, agitated, scared and comfortable. These terms reflect animal's own experience in the situation the animal is facing (WEMELSFELDER et al., 2000, 2001). A dimensional model of valence and arousal, like the one proposed by Russell and Bullock (1985), has been increasingly used in animal studies to classify emotions (BURN, 2017), and is considered a feasible framework to study and assess affective states in animals (MENDL; OLIVER; PAUL, 2010). In studies about the expressive qualities of animal behaviour, the dimensional model helps to align and interpret QBA dimensions, delivering information about animal mood and energy, which are relevant to animal welfare assessment (DE BOYER DES ROCHES et al., 2018).

The expression of an animal may provide important information about its welfare state. Some advocate that welfare could be improved by understanding how animals feel, and that animal welfare is not just the absence of negative emotions, but the presence of positive ones (BOISSY et al., 2007). In this case, the QBA provides information about an animal's affective state, contributing to a complete welfare assessment and going beyond the traditional assessment of health, nutrition and housing. As for chickens, there are scientific findings evidencing that they experience complex positive and negative emotions combined with cognition and sociability (MARINO, 2017); thus, it seems interesting to further study tools to assess the affective states of these animals.

There are two QBA approaches, one allowing the raters to create their own list of terms through the Free Choice Profiling (FCP) method (WEMELSFELDER et al., 2000, 2001), and the other using a fixed list of previously validated terms. The fixed list is more practical for on-farm assessments and, provided that raters are adequately trained, it may be more feasible (FLEMING et al., 2016). The QBA has been tested using both FCP and fixed list in different scenarios and species, like dairy and beef cattle, dairy buffalo, dogs, horses, pigs and sheep (FLEMING et al., 2016); donkeys (MINERO et al., 2016) and dairy goats (BATTINI et al., 2018; GROSSO et al., 2016). For broiler chickens, the fixed list was used generally at group level to test correlation with other indicators (BASSLER et al., 2013; MURI et al., 2019), or as part of application of the Welfare Quality protocol® in broiler chicken farms (BUIJS; AMPE; TUYTTENS, 2016; DE JONG et al., 2015; FEDERICI et al., 2016; SANS et al., 2014; SOUZA et al., 2015a; TUYTTENS et al., 2015). More specifically, for broiler chickens the fixed list has been useful to understand fear of humans (MURI et al., 2019) and the effect of dark period (BASSLER et al., 2013), while its correlation to other animal-based measures like contact dermatitis, lameness and mortality remains unclear; however, QBA results are complementary to the assessment of the whole animal welfare state (MURI et al., 2019). The QBA for broiler chickens was initially developed by Wang (2004) using the Free Choice Profiling method (FCP), and further refined by Wemelsfelder et al. (2009) into a fixed list of terms. Besides the QBA for broiler chickens is part of Welfare Quality® protocol, there is still a demand for inter- and intra-rater reliability tests to validate this method (JONG; GUNNINK; HINDLE, 2014; MURI et al., 2019).

The success of QBA is closely related to the recognition of terms by the raters. The fixed list proposed in the Welfare Quality® protocol was developed in English and has required translation to Portuguese to be applied in Brazil. According to Meagher (2009), terms used in an assessment scale are expected to be clear and understood by the raters, and words in vernacular are more appropriate. However, the translation of English QBA terms to Brazilian Portuguese does not seem to be the best approach, since the translation may not properly address issues such as spontaneity of term usage by native speakers and regionalisms, especially in big countries as Brazil. The need for developing the chicken QBA terms in Portuguese has already been proposed in a previous study (FEDERICI et al., 2016). Based on this, our study aimed to develop a fixed list of terms in Brazilian Portuguese for the Qualitative Behaviour Assessment of broiler chickens, and to test it by studying inter- and intra-rater reliability and principal components.

6.2 MATERIAL AND METHODS

6.2.1 Development of the fixed list of descriptive terms

6.2.1.1 Animals and video recording

Ten commercial and one experimental poultry farms were visited to make video recordings in January and April 2017, respectively. Commercial poultry barns had sidewalls with wire mesh, one covered by blackout curtains working as dark house and nine covered by yellow curtains with natural lighting, all equipped with automatic feeders, nipple drinkers, sprinklers, exhaust fans and wood shaving litter. Average commercial broiler chicken barn area was 1,540 ± 187 m^2 and the number of birds per house was 18,904 ± 2,604. Birds were male and female Cobb 500®, 41.3 ± 2.0 days of age. The experimental barn had 560 m^2 of area divided in 116 boxes of 2.06 m^2, with 21 birds each. The experimental barn had sidewalls with wire mesh covered by blue curtains with natural lighting, manual feeders, cup drinkers, brooders, exhaust fans and wood shaving litter. Birds were male and female Ross 308, 16 days of age.

Video recording sessions aimed at covering examples of emotionally expressive qualities of broiler chicken behaviour, recording birds in situations

associate to positive and negative emotional states, both in high and low intensities. Birds were recorded in groups during regular situations inside the poultry barns, thus clips presented images of birds while they were resting, sleeping, walking, standing, scratching the litter, feeding, drinking, interacting with the environment and with each other, in the presence of a familiar and a non-familiar human being, in thermal comfort and discomfort, and performing comfort behaviours like preening and dust bathing. On the experimental farm, items like straw, wooden platform and coloured plastic pieces were added to the boxes to record exploratory behaviours. Two birds were recorded in situations of low welfare level, one bird experiencing fear during the isolation test and one severely lame. A total of 21 videos was selected to be representative of the four quadrants in a two-dimensional model of arousal and valence (RUSSELL; BULLOCK, 1985). All the video clips were recorded in high definition using a Sony Cyber-shot® DSC-W320 camera with stock Carl Zeiss® lens on a tripod, without filters and preserving the surrounding sound.

6.2.1.2 Term generation session

In August 2018, 24 experts were invited to participate in a session of 4 h duration, to develop the descriptive terms of QBA. Participants were selected based on their academic or professional knowledge on animal welfare or broiler chicken production, and included postgraduate students in veterinary and animal sciences, as well professionals from the government and the broiler chicken meat industry, all in the State of Paraná, Southern Brazil.

The session began with a brief introduction about the QBA and two practice videos to discuss any doubt presented by the participants and the type of terms that were expected to be developed. Participants were instructed to write down terms to describe how birds behave rather than what birds were doing. The session comprised four steps, identified as S1, S2, S3 and S4, and described as follows. (S1) Individual term generation: participants watched 21 video clips of 1 minute each. Following Phythian et al. (2013), video clips were ordered to contrast in valence or, in the same valence but contrasting in intensity to stimulate participants to observe the differences and to improve the generation of terms. To avoid contagion between video clips, more extreme videos, like birds experiencing fear, pain and in playful situation were put further to the back. Based on the first phase of the Free Choice

Profiling method (WEMELSFELDER et al., 2001), at the end of each clip, participants had up to 2 minutes to write down, individually, as many terms as they wanted to describe the expressive qualities of bird behaviour. They could repeat terms used in previous clips and add new terms in new clips. Since some video clips showed birds in groups, participants were instructed to write down terms to describe different expressions they observed within the group as a whole. (S2) Individual term list refinement: after a brief explanation about the four quadrants in a two-dimensional model of arousal and valence (RUSSELL; BULLOCK, 1985), each participant had 20 minutes to select, for each quadrant, a minimum of three terms of their own list of terms generated in S1. (S3) Term list refinement in groups: three groups were formed with participants equally distributed according to their level of academic knowledge and professional competence in animal welfare, broiler chicken production and disease. They had 30 minutes to discuss about their own list refined in S2 and to build a single list per group, divided in positive and negative valence, including terms representative of low and high arousal. The three lists, one per group, were written in a white board for the next step. (S4) Final term list definition: this step consisted of an opened session where all participants discussed about the three lists built in S3 and proposed the terms to be part of a single list, which would be the fixed list of terms in Brazilian Portuguese for the assessment of emotionally expressive qualities of broiler chicken behaviour. At the end of this session, participants checked again if there were terms representative of the four quadrants of valence and arousal.

After this session, all the terms of each step were typed into an Excel® file and evaluated according to the purpose of this study. Considering that in Brazilian Portuguese some adjectives should agree in number and gender with the noun, and that the QBA for broiler chickens is commonly used to assess group of birds, terms that require agreement with the noun were standardized to be in plural and masculine because this is the classification of number and gender for 'the animals' in Portuguese (*os animais*). As example, the term 'calm' may be written '*calmo*' (singular, masculine), '*calmos*' (plural, masculine), '*calma*' (singular, feminine) and '*calmas*' (plural, feminine), depending on the noun. In this case, all the terms were considered as plural and masculine (in our example '*calmos*') to be analyzed. In addition, any term that was not representative of emotionally expressive quality of animal behaviour was marked and removed from the list afterwards, like terms

expressing what the bird was doing (drinking, panting, foraging, preening, etc.). Terms were counted using the Insite Website (http://linguistica.insite.com.br/corpus.php). At the end, the fixed list of descriptive terms created by the participants was analyzed by the researchers and, considering the representativeness of the four quadrants and the meaning of each term (MEAGHER, 2009), seven new terms were added to the final list. At the end of this process, the fixed list had 25 terms. Terms were ordered in the scoring form by the researchers so that terms that were similar were not placed closed to each other to avoid any influence during assessment.

6.2.2 Testing of the fixed list of descriptive terms

In October 2018, 45 undergraduates of animal sciences, enrolled in the ethology course, were invited to participate of a 2 h classroom instruction about broiler chicken behaviour and the QBA, with the goal of testing the fixed list. After the classroom instruction, the participants discussed the meaning of the terms developed in 6.2.1.2 (APPENDIX VIII) for 30 minutes, so that there was a common understanding of the terms within the group (MEAGHER, 2009). They also practiced the application of the fixed list of terms with three video clips. After a 20 minutes break, the participants watched 18 video clips of 1 minute each, followed by 2 minutes to score each video using a scoring form with a 125 mm visual analogue scale (VAS) per term, anchored with ‘minimum’ and ‘maximum’ at each end. The video clips selected were those developed in 6.2.1.1, and they were ordered as described in 6.2.1.2. A total of 10 out of 12 video clips presented birds in the last week of life in regular situations inside the commercial poultry barns, and six of them were horizontally mirrored and repeated to test intra-rater reliability. Two video clips of younger birds interacting with environmental enrichment, a wooden platform and straw, were included. Participants were instructed to score video clips of animals in groups considering the group as a unit, assessing the total intensity of different animal expressions. At the end of this session, participants discussed about applicability of the terms. VAS values for each term were determined measuring the distance in mm with a ruler, from the minimum point of the scale to the point where the participant marked the VAS. These values were entered into a Microsoft Excel® worksheet to be analyzed.

6.2.3 Statistical analysis

6.2.3.1 Testing of the fixed list of descriptive terms

Principal Component Analysis (PCA), no rotation, was conducted (JOHNSON; WICHERN, 2004). Parallel analysis (FRANKLIN et al., 1995), based on simulated datasets under independence structure, was used to choose how many components to retain. The PC scores attributed to the 18 video clips on the first four principal components were evaluated for inter- and intra-rater reliability using intraclass correlation coefficient (ICC) (BARTKO, 1966). Intra and inter-rater agreement for separate terms were assessed through the Variance Components method, by fitting linear mixed models (MCCULLOCH; SEARLE, 2004). Agreement was also assessed by means of ICC, computed from the variances associated to videos, subjects, and error. For intra-rater analysis, only videos that were shown twice were considered. On the other hand, when analyzing inter-rater agreement, for these videos the ratings provided in the first exhibition were considered. The order in which videos were presented (first or second exhibition) was adjusted when analyzing intra-rater agreement. Because some features presented some skewness, and it is known that agreement is underestimated in such situations (CARRASCO et al., 2007), bootstrap bias corrected point estimates and confidence intervals were obtained (EFRON; TIBSHIRANI, 1994; KARLSSON, 2009). For this purpose, a total of 5,000 simulations were performed for each analyzed feature. As a general guide, ICC reliability coefficient was considered poor when bellow 0.40, fair when between 0.40 and 0.59, good when between 0.60 and 0.74, and excellent when higher than 0.75 (CICCHETTI, 1994).

Analysis were conducted in R statistical environment, version 3.5.1 (R CORE TEAM, 2018). The following packages made feasible this study: lme4 (BATES et al., 2015) for linear mixed models, boot (CANTY; RIPLEY, 2017) for bootstrap resampling, and psych (REVELLE, 2017) for PCA.

6.2.4 Ethical approval

This project was approved by the Human Research Ethics Committee of the Health Science Sector n. 1,958,250, March 10th, 2017 (ANNEX V) and by the Animal Use Ethics Committee of the Agricultural Campus n. 122/2016, December 7th, 2016 (ANNEX VI), both of the Federal University of Paraná.

6.3 RESULTS

6.3.1 Development of the fixed list of descriptive terms

A total of 14 participants accepted the invitation (5 male and 9 female). Four participants were animal scientists and ten veterinarians; one participant was from the meat industry (master's degree), three from the government (two master's degree) and ten from postgraduation programs in animal and veterinary sciences, in public and private institutions at doctorate and post doc levels. All participants were experienced in broiler chicken production, except one PhD student in swine welfare. Experience ranged from 1 to 17 years. Three participants had previous knowledge with the QBA.

In S1, participants wrote down 970 terms, including repeated terms and terms not representative of expressive qualities of animal behaviour. A total of 136 distinctive terms were generated, of which 88 were considered as expressive qualities of behaviour (QBA terms). Median number of QBA terms generated per participant was 21 (10 – 30). In S2, participants choose a total of 91 distinctive terms from their lists generated in S1, of which 73 were considered QBA terms. When participants worked in groups in S3, group 1, 2 and 3 provided a list with 13, 17 and 23 QBA terms, respectively, divided in positive and negative valence (TABLE 8). Total QBA distinctive terms was 36, being 17 positive and 19 negative descriptors. In S4, eight positive and ten negative QBA terms were selected by participants. Due to different interpretations, participants did not agree that painful and desperate were the best terms to express broiler chicken affective state. Even there, both terms were included by the participants in the final list because they were considered representative of poor animal welfare, associated to highly negative affective states of an animal.

TABLE 8 - DESCRIPTIVE TERMS OBTAINED IN A WORKSHOP FOR THE DEVELOPMENT OF A FIXED LIST IN BRAZILIAN PORTUGUESE TO ASSESS THE EXPRESSIVE QUALITITES OF BROILER CHICKEN BEHAVIOUR; RESULTS OF DISCUSSION IN GROUPS (STEP 3) AND CONSENSUS IN OPENED SESSION (STEP 4)

Step 3						**Step 4**	
Group 1		**Group 2**		**Group 3**		**All participants**	
Positive terms		**Positive terms**		**Positive terms**		**Positive terms**	
Portuguese	**English**	**Portuguese**	**English**	**Portuguese**	**English**	**Portuguese**	**English**
ativos	active	atentos	attentive	ágeis	agile	atentos	attentive

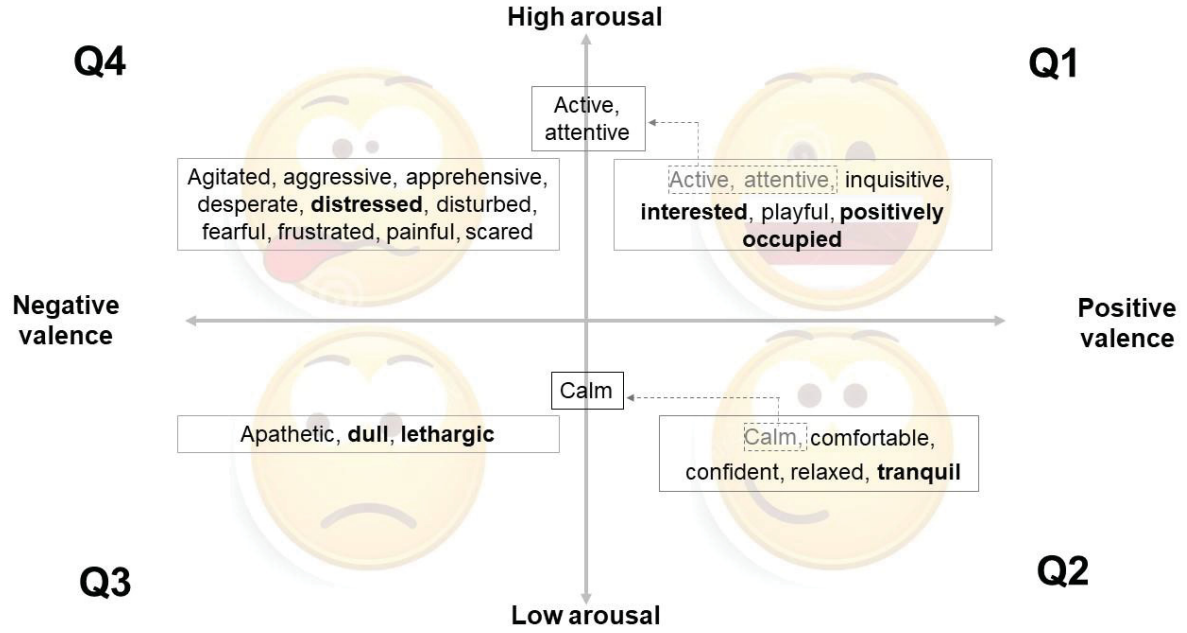
Step 3						Step 4	
Group 1		Group 2		Group 3		All participants	
Positive terms		Positive terms		Positive terms		Positive terms	
Portuguese	English	Portuguese	English	Portuguese	English	Portuguese	English
calmos	calm	brincalhões	playful	altivos	proud	ativos	active
confortáveis	comfortable	calmos	calm	atentos	attentive	brincalhões	playful
curiosos	inquisitive	confiantes	confident	ativos	active	calmos	calm
indiferentes	indifferent	confortáveis	comfortable	calmos	calm	confiantes	confident
ocupados positivamente	positively occupied	curiosos	inquisitive	com vitalidade	lively	confortáveis	comforta-ble
relaxados		relaxados	relaxed	confortáveis	comfortable	curiosos	inquisitive
		sociáveis	sociable	corajosos	brave	relaxados	relaxed
		tranquilos	tranquil	curiosos	inquisitive		
				exploradores	explorer		
				relaxados	relaxed		
				tranquilos	tranquil		
Negative terms		Negative terms		Negative terms		Negative terms	
agitados	agitated	agitados	agitated	agitados	agitated	agitados	agitated
amedrontados	fearful	alertas	vigilant	agressivos	aggressive	agressivos	aggressive
apáticos	apathetic	apáticos	apathetic	amedrontados	fearful	apáticos	apathetic
apreensivos	apprehensive	assustados	scared	angustiados	distressed	apreensivos	apprehen-sive
desconfortáveis	uncomfortable	com medo	fearful	assustados	scared	assustados	scared
incomodados	disturbed	frustrados	frustrated	desconfortáveis	uncomfortable	com medo	fearful
		inquietos	restless	desesperados	desperate	desespera-dos	desperate
		preocupados	concerned	estressados	stressed	com dor	painful
				inquietos	restless	frustrados	frustrated
				prostrados	prostrate	incomoda-dos	disturbed
				tensos	tense		

SOURCE: The author (2019). NOTE: English translation for reference.

The fixed list of descriptive terms was analyzed by the researchers, considering the representativeness of the four quadrants (FIGURE 17) and the meaning of each term. Some terms were added to balance the quadrants and to further study the application of other terms. The terms positively occupied and lively were mentioned by the participants during steps 1, 2 and 3. Thus, these terms were included by the researchers in the final list of terms to study their application in addition to active, since active may be positive (e.g. birds performing grooming behaviour) or negative (e.g. birds pecking another bird). The same rationale was used by including the term tranquil to study the term calm. Some new terms were added to the final list, as the case of lethargic and dull to balance low negative terms, in addition to apathetic. The term interested was also included in addition to attentive, since attentive may be both positive and negative. Finally, the term distressed was

added to the study as an attempt to replace ‘desperate’. The final list of terms, ordered to be applied by the raters, is presented in TABLE 9.

FIGURE 17 - DESCRIPTIVE TERMS OF QUALITATIVE BEHAVIOUR ASSESSMENT FOR BROILER CHICKENS DEVELOPED IN BRAZILIAN PORTUGUESE BY 14 EXPERTS, CLASSIFIED ACCORDING THEIR POSSIBLE LOCATION REGARDING QUADRANTS (Q1, Q2, Q3, Q4) IN A TWO-DIMENSIONAL MODEL OF AROUSAL AND VALENCE PROPOSED BY RUSSELL AND BULLOCK (1985). TERMS ARE LISTED IN ALPHABETICAL ORDER, TERMS IN BOLD WERE ADDED BY THE RESEARCHERS, DASHED LINE INDICATES THE VALENCE INITIALLY CONSIDERED BY THE EXPERTS



SOURCE: The author (2019), adapted from SOROUSH et al. (2018).

TABLE 9 - DESCRIPTIVE TERMS OF A FIXED LIST IN BRAZILIAN PORTUGUESE TO ASSESS THE EXPRESSIVE QUALITITES OF BROILER CHICKEN BEHAVIOUR ORDERED TO BE APPLIED USING A VISUAL ANALOGUE SCALE

Language	Terms
Portuguese	Assustados, Curiosos, Com dor, Relaxados, Agressivos, Ocupados positivamente, Letárgicos, Confortáveis, Com medo, Ativos, Entediados, Confiantes, Agitados, Interessados, Apáticos, Brincalhões, Desesperados, Apreensivos, Atentos, Perturbados, Calmos, Frustrados, Com vitalidade, Incomodados, Tranquilos
English translation for reference	Scared, Inquisitive, Painful, Relaxed, Aggressive, Positively occupied, Lethargic, Comfortable, Fearful, Active, Dull, Confident, Agitated, Interested, Apathetic, Playful, Desperate, Apprehensive, Attentive, Distressed, Calm, Frustrated, Lively, Disturbed, Tranquil

SOURCE: The author (2019).

6.3.2 Testing of the fixed list of descriptive terms

A total of 40 participants joined in this session, and 36 (7 male and 29 female) were considered because they attended the full session and filled correctly the scoring forms with the terms described in TABLE 9. They felt some terms like ‘dull’ and ‘confident’ were difficult to assess. ‘Lethargic’ seemed redundant to them because there was the term ‘apathetic’, or it would be more useful to veterinarians as there was a perception it was a clinical term. Participants did not feel the term ‘distressed’ in Portuguese was adequate to express poor welfare. ‘Tranquil’ was considered unnecessary because there were the terms ‘relaxed’ and ‘calm’. Participants felt that ‘positively occupied’ was clear and useful to assess the birds. Even though aggressiveness was not a characteristic observed in the video clips, participants agreed it is important to keep the term ‘aggressive’.

The PCA identified four main components with Eigenvalues greater than 1, together explaining 69.4% of the variance (TABLE 10). Principal component (PC) 1 ranged from negative terms disturbed and frustrated to positive terms comfortable and lively, suggesting a valence dimension, which is important to assess animal mood. Principal component 2 ranged from calm and dull to agitated and active, suggesting an arousal dimension. Principal component 3 presented no positive loadings; however, differences between higher and lower loadings ranged from apathetic and relaxed to active and painful, also suggesting an arousal orientation for this component. Principal component 4 ranged from desperate and comfortable to dull and apathetic, without an obvious pattern.

TABLE 10 - OUTCOMES FOR THE FIRST FOUR PRINCIPAL COMPONENTS (PC) IN A PRINCIPAL COMPONENT ANALYSIS OF A FIXED LIST OF TERMS DEVELOPED IN BRAZILIAN PORTUGUESE TO ASSESS THE EXPRESSIVE QUALITIES OF BROILER CHICKEN BEHAVIOUR

Terms	**PC1**	**PC2**	**PC3**	**PC4**
Scared	-0.251	0.157	-0.078	-0.275
Inquisitive	0.163	0.307	-0.133	0.164
Painful	-0.257	0.055	-0.061	-0.171
Relaxed	0.183	-0.190	-0.323	-0.246
Aggressive	-0.071	0.177	-0.090	0.250
Positively occupied	0.213	0.216	-0.083	-0.009
Lethargic	-0.136	-0.189	-0.293	0.193
Comfortable	0.242	-0.072	-0.249	-0.284
Fearful	-0.259	0.144	-0.119	-0.277
Active	0.163	0.330	-0.051	0.066

Terms	PC1	PC2	PC3	PC4
Dull	-0.115	-0.202	-0.316	0.435
Confident	0.216	0.122	-0.173	-0.131
Agitated	-0.034	0.349	-0.085	0.037
Interested	0.189	0.304	-0.099	0.133
Apathetic	-0.167	-0.150	-0.361	0.323
Playful	0.144	0.268	-0.109	0.112
Desperate	-0.256	0.161	-0.096	-0.329
Apprehensive	-0.231	0.114	-0.220	-0.033
Attentive	0.050	0.198	-0.230	0.064
Distressed	-0.246	0.135	-0.157	-0.142
Calm	0.170	-0.251	-0.307	-0.152
Frustrated	-0.265	0.043	-0.196	0.031
Lively	0.223	0.149	-0.177	-0.034
Disturbed	-0.269	0.107	-0.096	0.061
Tranquil	0.205	-0.188	-0.303	-0.205
Eigenvalue	8.5	4.4	2.6	1.3
% of variance explained	36.8	18.2	9.4	5.0
% cumulative variance explained	36.8	55.0	64.4	69.4

SOURCE: The author (2019). NOTE: English translation for reference.

When the terms were tested together in each principal component, PC1 and PC2 presented good inter- and intra-rater reliability, and PC3 presented excellent intra-rater reliability (TABLE 11). When the terms were tested separate, 5 achieved good/excellent inter-rater reliability, 8 had fair and 12 had poor agreement. Considering intra-rater reliability, 9 terms were classified as good, 15 as fair and 1 as poor (TABLE 12).

TABLE 11 - INTER- AND INTRA-RATER RELIABILITY OF QUALITATIVE BEHAVIOUR ASSESSMENT TERMS DEVELOPED IN BRAZILIAN PORTUGUESE FOR BROILER CHICKENS, ANALYZED USING INTRACLASS CORRELATION COEFFICIENT (ICC) FOR THE FIRST FOUR PRINCIPAL COMPONENTS (PC), GOOD AGREEMENT ARE IN BOLD

PC	Inter-rater reliability		Intra-rater reliability	
	ICC	Confidence interval (95%)	ICC	Confidence interval (95%)
1	**0.70**	0.43 - 0.82	**0.73**	0.63 - 0.80
2	**0.65**	0.39 - 0.79	**0.63**	0.48 - 0.77
3	0.05	0.01 - 0.11	**0.76**	0.65 - 0.84
4	0.28	0.12 - 0.46	0.54	0.40 - 0.65

SOURCE: The author (2019).

TABLE 12 - MEAN VALUES AND STANDARD DEVIATION (SD) OF QUALITATIVE BEHAVIOUR ASSESSMENT TERMS FOR BROILER CHICKENS DEVELOPED IN BRAZILIAN PORTUGUESE, MEASURED BY 36 UNDERGRADUATES USING A 125 MM VISUAL ANALOGUE SCALE (VAS); INTER- AND INTRA-RATER RELIABILITY OF TERMS USING INTRACLASS CORRELATION COEFFICIENT (ICC), GOOD AGREEMENT ARE IN BOLD AND FAIR ARE IN ITALICS

QBA term	VAS Mean ± SD (mm)	Inter-rater		Intra-rater	
		ICC	Confidence interval (95%)	ICC	Confidence interval (95%)
Desperate	13.99 ± 28.82	**0.81**	0.59 - 0.89	*0.54*	0.42 - 0.64
Fearful	15.12 ± 26.74	**0.70**	0.44 - 0.82	*0.52*	0.40 - 0.62
Painful	15.82 ± 29.13	**0.68**	0.44 - 0.81	**0.62**	0.49 - 0.71
Playful	11.47 ± 22.74	**0.66**	0.41 - 0.79	0.39	0.25 - 0.51
Scared	14.51 ± 26.09	**0.65**	0.39 - 0.78	*0.53*	0.41 - 0.64
Inquisitive	29.45 ± 32.85	*0.59*	0.34 - 0.75	*0.58*	0.46 - 0.67
Interested	36.46 ± 35.52	*0.57*	0.32 - 0.73	0.45	0.32 - 0.58
Active	44.19 ± 35.75	*0.56*	0.32 - 0.72	*0.54*	0.36 - 0.70
Distressed	20.23 ± 33.89	*0.46*	0.23 - 0.64	**0.70**	0.60 - 0.78
Positively occupied	39.32 ± 37.65	*0.45*	0.23 - 0.63	*0.58*	0.44 - 0.69
Frustrated	27.42 ± 36.95	*0.44*	0.21 - 0.63	**0.71**	0.59 - 0.79
Disturbed	34.39 ± 40.24	*0.43*	0.22 - 0.62	**0.72**	0.62 - 0.79
Agitated	38.42 ± 35.14	*0.40*	0.19 - 0.59	*0.51*	0.31 - 0.69
Comfortable	48.23 ± 37.39	0.35	0.16 - 0.54	*0.57*	0.44 - 0.68
Lively	50.51 ± 36.60	0.35	0.16 - 0.55	**0.64**	0.50 - 0.73
Apprehensive	24.47 ± 32.44	0.33	0.15 - 0.52	*0.59*	0.45 - 0.68
Calm	53.29 ± 37.27	0.32	0.14 - 0.51	*0.53*	0.38 - 0.66
Tranquil	58.14 ± 38.32	0.32	0.15 - 0.51	*0.50*	0.35 - 0.62
Relaxed	47.52 ± 36.67	0.28	0.11 - 0.46	*0.48*	0.34 - 0.61
Confident	33.17 ± 31.05	0.25	0.11 - 0.45	**0.65**	0.53 - 0.73
Dull	37.29 ± 36.84	0.19	0.07 - 0.34	**0.70**	0.59 - 0.78
Lethargic	32.16 ± 36.74	0.17	0.06 - 0.32	**0.63**	0.50 - 0.73
Apathetic	30.37 ± 37.02	0.16	0.06 - 0.32	*0.58*	0.44 - 0.69
Aggressive	7.46 ± 15.10	0.08	0.02 - 0.18	**0.61**	0.48 - 0.71
Attentive	44.14 ± 30.66	0.06	0.01 - 0.14	*0.50*	0.35 - 0.61

SOURCE: The author (2019). NOTE: English translation for reference.

6.4 DISCUSSION

6.4.1 Development of the fixed list of descriptive terms

This study aimed to develop and test a fixed list of terms in Brazilian Portuguese for the qualitative behaviour assessment of broiler chickens. Other fixed lists like for cattle, sheep and horses were developed and tested based on expert opinion (FORKMAN; KEELING, 2009; MINERO et al., 2016, 2018; PHYTHIAN et al., 2013). The present study succeeded in bringing together people with important skills and competencies regarding broiler chicken production to create the fixed list of

terms. To develop the fixed list for other species, experts discussed about published papers using free choice profiling, and refined the terms created in those studies. However, since this is the first study about QBA terms in Brazilian Portuguese, experts had to create and refine their own terms until they got a final list. This process was interesting because participants were engaged to explain their point of view and hear those from their colleagues. As a result, few adjustments were done on the final list to balance the four quadrants, specially the quadrant Q3, in which the only term mentioned by experts was apathetic (FIGURE 17). This quadrant is recognized as an experience of low reward-opportunity environments and low activity states (MENDL; OLIVER; PAUL, 2010). Perhaps the reduced behavioural repertoire of broiler chickens in the last week of life, caused by several factors such as barren environment, low light intensity, lameness and high stocking density (EFSA, 2010), has been considered as natural by the people who works with fast growing breeds. In this case, different stages of boredom that would fit on quadrant Q3, like monotony and lethargy, may not be easily perceived. Boredom and related affective states have largely been neglected despite being prevalent and harmful to the animals (BURN, 2017). In addition, human beings may not recognize some cues of affective states in broiler chickens as well as in other species that present clearer behaviours (e.g. tail movements) and facial expression, which makes harder to observe details on animal assessed at group level (JONG; GUNNINK; HINDLE, 2014). Terms in quadrant Q4 were predominant (FIGURE 17) and were probably considered by the experts as more significant to be included in broiler chicken welfare assessment, since situations such as disturbance, fear and pain, are clear expressions of a hostile or unbalanced environment. In these cases, there are direct undesirable consequences on bird health and fitness that companies want to avoid, such as birds piling on top of each other (JONES, 1996), reduced feed intake and resting behaviour (EFSA, 2012). In the case of quadrant Q1, unbalance occurred because participants considered active and attentive as positive, which in reality are two ambiguous terms (FIGURE 17).

Besides their development in two different languages, the lists of terms in English (WELFARE QUALITY®, 2009) and in Brazilian Portuguese presented nine common terms: active, agitated, calm, comfortable, confident, fearful, frustrated, relaxed and scared. Terms related to comfort, agitation and fear are reportedly common expressions of professionals who work in broiler chicken production in

Brazil, to refer to bird's behaviour (SOUZA; MOLENTO, 2015). Participants experienced with QBA might also have influenced during the S3 phase, by including terms like frustrated; however, other terms like confident were suggested by less experienced participants. In addition, ten different terms in Portuguese were included into the fixed list in S4, suggesting this study contributed to the development of a list which took into consideration terms used locally as well as worldwide in broiler chicken production. Particularly the results regarding the percentage of 40% of local terms tend to demonstrate the importance of producing lists bottom-up as opposed to translating pre-existing lists in the scientific literature. This method may be a valuable contribution to increase the use of the QBA in countries where English is not the native language.

6.4.2 Testing of the fixed list of descriptive terms

The pattern observed in this study, in which PC1 and PC2 had a valence and arousal component, respectively, is similar to QBA studies with other animal species such as dairy goats, donkeys and sheep (GROSSO et al., 2016; MINERO et al., 2016; PHYTHIAN et al., 2013). For broiler chickens, Muri et al. (2019) observed opposite results for PC1 and PC2, and Bassler et al. (2013) observed only PC2 presenting a valence orientation while PC1 remained unclear. Video sampling in the present study did not aim for a representative sample to describe AW conditions of the Brazilian broiler chicken farms. However, 10 out of 12 video clips originated from regular commercial broiler chicken farms. Thus, through PCA analysis, our results suggest that QBA was robust to differentiate between situations in which the birds were and were not coping with the environment, as presented by higher and lower loadings of the PC1, respectively, in field-relevant contexts.

Inter- and intra-rater concordance achieved in this study for the first two and three principal components, respectively, suggest the QBA is a reliable assessment tool. Inter-rater reliability of PC1 and PC2 have presented similar good agreement in studies with beef cattle, broiler chickens, donkeys, pigs, sheep and veal calves (FORKMAN; KEELING, 2009; MINERO et al., 2016, 2018; MURI; STUBSJØEN, 2017; PHYTHIAN et al., 2013; WEMELSFELDER et al., 2009). Intra-rater agreement levels observed up to PC3 in this study also demonstrated rater's ability to score consistently through the different situations even when they lack experience with the species. When individually analyzed, few terms presented good agreement level.

Higher levels of inter- and intra-rater reliability for each term are desirable; however, considering that the QBA is a holistic approach which takes into consideration the whole animal and integrates information of animals' expressions, interpretation should not be based only on individual descriptors but mostly on their integration (WEMELSFELDER et al., 2000, 2001). Studying individual terms is useful to optimize them and further improve the reliability of the fixed list. As observed by Grosso et al. (2016) and Muri and Stubsjøen (2017), improving reliability on individual terms will optimize the robustness of the dimensions. In addition, individual terms are also useful for correlation studies with other indicators (MURI; STUBSJØEN, 2017).

All terms of low animal expressivity (Q2 and Q3, FIGURE 17) had poor concordance among raters. In contrast, terms like desperate, fearful, painful, playful and scared had excellent and good inter-rater reliability. These terms are consistent with the basic emotions described by Panksepp and Watt (2011). Our results show that recognition of broiler chicken body expressions related to such terms was easier than the recognition of expressions related to terms describing low arousal states, following a similar pattern observed during the creation of the fixed list.

Some factors may have affected inter-rater reliability of the terms in this study. Raters discussed the terms before video clip assessment, but they did not have their definitions with them during the assessment. Thus, they may have changed the way they interpreted the terms over time (MURI; STUBSJØEN, 2017). The fixed list presented 25 terms, which is higher than the observed in recent papers using 9 to 13 fixed terms for other species, and where high inter-rater reliability of terms was achieved (MINERO et al., 2018; MURI; STUBSJØEN, 2017; PHYTHIAN et al., 2013). This may be improved by more training time so as the list is better understood by the raters. The need of extra material to help raters was also observed by the fact that some raters marked a sign in the first page of the fixed list of terms to identify each term as positive or negative. As observed in this study, intra-rater reliability presented good concordance in 9/25 terms, including some terms of quadrants Q2 and Q3 like confident, dull and lethargic. Even if these terms were interpreted differently by the raters when observing birds' behaviour, once each rater identified a pattern on birds for the terms, they scored them consistently along the video session. In this case, the raters may benefit from the definitions during assessment, and better inter-rater reliability results for the terms may in turn be achieved. To date, no previous definition for the QBA terms were published for broiler chickens. Definitions in this

study were prepared by one experienced researcher on broiler chicken welfare and behaviour to be applied during the testing phase of the fixed list. Thus, there may be some gain in further scrutinizing these definitions, by a group of experts as done by Minero et al. (2016) in order to refine and improve them.

Training and the level of knowledge of raters on the species to be assessed is an important item to be discussed. According to Fleming et al. (2016), raters with little experience with the animal species in question can contribute to qualitative behaviour assessment because they are encouraged to observe how an animal is behaving, and lack of experience does not seem to be a constraint to their ability to perceive animals' expression. Previous studies comparing groups with different levels of knowledge during the assessment of pig, dairy buffalo and dairy cattle support this rationale (BOKKERS et al., 2012; NAPOLITANO et al., 2012; WEMELSFELDER; HUNTER; LAWRENCE, 2012). For broiler chickens it has been argued that scoring birds using terms of QBA is more difficult for non-experienced people (JONG; GUNNINK; HINDLE, 2014) and raters need to have sufficient knowledge about broiler chicken production and behaviour to obtain reliable results (MURI et al., 2019). Our PCA results suggest lack of experience did not prevent participants from assessing the birds using the QBA; however, there is a need to improve reliability on individual terms by training the raters. More specifically, there seems to be a benefit from investing more time to train the raters to recognize emotions within each of the four quadrants, specially the quadrants Q2 and Q3, to increase general inter-rater reliability.

In this study, most of video clips presented birds in groups. The use of QBA at group level for broiler chickens is common practice, as specified at the Welfare Quality® protocol (2009). Difficulty of scoring broiler chickens at group level has already been discussed by Jong, Gunnink and Hindle (2014). Birds are normally performing different types of behaviour at the same time in a poultry house, like resting, feeding and walking. Since the group is assessed as a unit (FLEMING et al., 2016), raters are expected to observe the atmosphere in the group and score it accordingly. Depending on the situation, it is difficult to control exactly what the raters are observing, and they may look to different animals and different situations when observing large groups or at farm level (MURI; STUBSJØEN, 2017; PHYTHIAN et al., 2013). As observed in this study, the terms calm, tranquil and relaxed had poor inter-rater concordance, perhaps as a difficulty to balance these states while animals

are moving around, panting and resting at the same time. In this case, the intensity of each term may be perceived differently by the raters, with consequences to the inter-rater reliability. This possibility may be tested in the future by comparing reliability between individual and group assessments, which may present the proportion of the lack of reliability which is due to assessing groups of animals.

The term desperate was not a consensus during the development of the fixed list, and in this case the researchers added the term distressed. Both terms had contradictory inter- and intra-rater results, being desperate excellent inter and fair intra-rater concordance, and distressed fair inter- and good intra-rater concordance. Since these terms may have more than one meaning, they both remained unclear to the raters, and susceptible to different interpretations. Desperate, in Brazilian Portuguese, may be used when there is no hope or when there is a really dangerous situation, and in the latter we tend to think of birds jumping desperately, trying to escape from something. Distressed in Portuguese was used as '*perturbados*', and may be understood as being afflicted, but also as being disturbed (FERREIRA, 2017). Since it is important to consider the appropriateness of the descriptive terms (FLEMING et al., 2016; MEAGHER, 2009), there is a need to further study a term in Portuguese for poor welfare situations when the bird is vulnerable or helpless. In contrast, painful, which was also not a consensus among experts, seems a reliable term for broiler chickens. Further confirming Muri and Stubsjøen (2017), our findings suggest that the process of inclusion or exclusion of a QBA term is complex and depends on a combination of discussions and testing.

6.5 CONCLUSION

This study is a first step for the application of the QBA in broiler chicken farms in Brazil using terms created in Brazilian Portuguese. It also demonstrates the importance of producing lists bottom-up as opposed to translating pre-existing lists in the scientific literature. Due to its construction based on the dimensional model of valence and arousal, the fixed list allows a comprehensive assessment of the broilers' affective states. Results suggest the fixed list is reliable to assess the expressive qualities of broiler chicken behaviour; therefore, it is fully encouraged to test it on farm and by experienced raters, as well to further study it concerning poor welfare related terms. Expanding the studies to different regions in Brazil is also

advisable. There seems to be a challenge in recognizing emotions of low expressivity in broiler chickens; thus, training in these specific terms seems important to improve general inter-rater reliability. Given the power to differentiate between positive and negative as well between high and low emotionally expressive qualities of animal behaviour, the use of the Brazilian Portuguese fixed list developed in this study is a tool to add valuable information in welfare assessment of Brazilian broiler chickens.

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7 FINAL CONSIDERATIONS

This thesis contributed to identify meat inspection indicators to be used in a broiler chicken welfare monitoring system at Federal level in Brazil. It also identified gaps on data collection and proposed measures to further include an animal welfare view on meat inspection service. Data collection and analysis needs to be part of daily activities in the whole production chain. In this regard, a strategy based on the Hazard Analysis and Critical Control Point was proposed to encourage organizations to manage their activities aiming to prevent, reduce or eliminate animal welfare hazards from the farm to the slaughterhouse. Information provided by monitoring procedures may feed organizations with animal welfare data to perform risk analysis, supporting decisions on the production chain.

Additionally, there is a demand to develop scientific-validated animal-based indicators for animal welfare assessment. Representatives of the industry, government and academia were included in the development of the indicators in chapters 4 and 6, to promote a broader animal welfare discussion. These indicators may improve the ability to assess animal welfare within the Brazilian context and may also allow a more comprehensive welfare assessment by including prevalent welfare problems and a behavioural component. Based on this, the proposed indicators are adequate to be applied for different purposes, such as monitoring procedures or certification and assessment protocol activities. The qualitative behaviour assessment may be a valuable tool to add information regarding the validation of environmental enrichment strategies and new poultry house designs. It also gives the opportunity to look at the whole animal and observe the chicken as an animal capable of feeling different emotions and expressing them accordingly.

It is crucial for Brazil to expand animal welfare on private sector and government agenda. In this case, the animal welfare concept which includes mental, behavioural and health states is expected to be used, to give the birds a harmless environment, which supplies their needs. Organizational decisions need to consider animal welfare together with other regular issues, like animal health, environment and economics, to evaluate the impact of any change on birds. Future steps may include the development of a regulation for broiler chickens to deal with critical points such as contact dermatitis and lameness, including definitions of trigger levels for specific welfare indicators to the national industry, aiming at on-farm improvements

over time. In parallel, there is a demand for investment in scientific research to develop more animal-based indicators for animal welfare assessment, as well as for partnership with private companies to develop research in real farming conditions. Another critical point is the investment to expand knowledge regarding the inadequacy of religious slaughter without previous stunning. Players of broiler chicken chain need also to look at other animal production chains and understand the ethics behind the demands of society to ban battery cages for laying hens and gestation crates for sows, for example; and thus, better understand the need to improve poultry house environment.

Private and public policies are expected to be built based on scientific knowledge. Decisions have to be based on technical advice rather than on political influence. This thesis contributes by providing information to empower decision makers to plan actions and move forward a positive agenda for the welfare of broiler chickens. Considerations given here may put Brazil in the forefront of issues related to broiler chicken welfare. Desirable output expected from the chapters studied in the present thesis include reliable data to inform society about broiler chicken welfare conditions and to allow for real improvements to the animals. There is a structure in place already organized to collect data at national level for food safety purposes, and that is compatible with animal welfare interests. In addition, Brazilian broiler chicken chain is well developed. Most companies are ready to implement a robust animal welfare management system due to the vertical integration, which implies in companies controlling each operation and counting with specialized professionals in each area (e.g. nutrition, animal health, poultry house management).

This is an important moment for the animal food industry to show transparency on production processes and commitment to improve the quality of life of farm animals. Inclusion of animal welfare on organization's social responsibility standards has to produce visible improvements on animal welfare. Organizations that have not yet clearly stated an animal welfare commitment may be considered outdated and not in harmony with society's demands. Production methods have changed along the years and they will keep changing as a result of process innovation. Being proactive and moving towards a more animal-friendly production is a way of keeping closer to consumers. New technologies on food production are coming up to give the consumers new choices and they are developing rapidly. These technologies include plant-based products and cell-based meat. If animal food

companies want to keep competitive, especially considering the increasing ethical motivation of consumers, it is crucial to change the way to communicate to public, the way they collect and analyse data for animal welfare purposes, and the way to revert data information for the benefit of the animals.

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APPENDIX I – ABSTRACT: BROILER CHICKEN WELFARE OUTCOMES BASED ON SLAUGHTER CONDEMNATION DATA IN BRAZIL

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BROILER CHICKEN WELFARE OUTCOMES BASED ON SLAUGHTER CONDEMNATION DATA IN BRAZIL

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Brazil is the third largest broiler chicken producer in the world. In 2015, about 5.2 billion broiler chickens were slaughtered in establishments under Federal Inspection Service (SIF) of the Ministry of Agriculture, Livestock and Food Supply (MAPA), and there is a projection of a 46.4% increase in chicken meat production by 2023. In face of higher demand for information about farm animal welfare (AW), governmental monitoring actions are increasing worldwide. Condemnation data is already in use by competent authorities in European Union to monitor AW at the slaughterhouse. In Brazil, the MAPA undertakes meat inspection at slaughterhouses, but such outcomes have not yet been used for AW assessment. This study aimed to assess condemnation data from broiler chicken slaughterhouses in Brazil to evaluate their potential use as indicators in an AW governmental monitoring program. We collected condemnation data from the official database available at the MAPA website, from January 2010 to December 2015, considering all 18 States that slaughtered broiler chickens under SIF. Following the literature, assessment considered total and partial rejections for AW target indicators contusion, bruises, fracture, emaciation, dehydration, ascites, septicaemia, abscess, hepatitis, pericarditis, inadequate bleeding, contact dermatitis and dead on arrival (DOA). All indicators, except dehydration, were reported on inspection data. We identified significant variability among States, mainly on type of condemnation and terms used to describe indicators, thus reported values seem underestimated. For example, contusion, that was the main cause of partial condemnation (88.5%), was recorded in only 16 States and presented high variability on results, with median condemnation of 1,638.5 (0.013 – 46,167.1) per 100,000 birds. Carcass parts condemned for contusion were not identified. Pericarditis and hepatitis data were available in six States. Footpad dermatitis was reported only in data from the State of Goiás. In six States there was **condemnation for birds 'found dead', which may be related to DOA. Federal** Inspection has played an important role on meat inspection, complying with rigorous international standards. The inclusion of an AW view on condemnation information is a new concept to be included to SIF in order to obtain reliable data. Results suggest the need to establish a working group to set specific AW outcomes to be monitored, to standardize recording procedures among States and to integrate condemnation, DOA and flock data.

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APPENDIX II – ABSTRACT: BROILER CHICKEN MEAT INSPECTION DATA IN SOUTHERN BRAZIL: AN ANIMAL WELFARE APPROACH

Broiler chicken meat inspection data in Southern Brazil: an animal welfare approach

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The Federal Inspection Service (SIF) of the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) undertakes meat inspection at slaughterhouses, but outcomes have not been used for animal welfare surveillance. We assessed condemnation data from broiler chicken slaughterhouses in Southern Brazil to evaluate their potential use as animal welfare indicators (AWI). Data from January 2010 to December 2015 in the states of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS) were used. Correlation of AWI was tested using Spearman rank correlation test. Principal Component Analysis (PCA) was used to explore variance and covariance structures of AWI. Fractures and bruising were recorded together, and they represent the most prevalent welfare problem (PR, 22.1%; SC, 16.6%; RS, 23.7%), followed by skin lesion or inflammation (PR, 14.8%; SC, 9.1%; RS, 9.1%). Footpad dermatitis is not officially controlled since affected feet might be accepted as lower grade product. In PR, progressive increase on injury, arthritis, ineffective bleeding, and airsacculitis may reveal important welfare aspects. High correlation between AWI within PR was more commonly observed than in RS and SC, perhaps because of earlier implementation of local SIF standardization. PCA showed changes on condemnation data pattern in PR after standardization, pointing injury and *Escherichia coli* problems as main causes for condemnation related to animal welfare. They were strongly related to component 1, representing 39.4% of data variability. It seems crucial to update and standardize data collection to set a routine that allows risk analysis regarding both food safety and animal welfare. There is considerable potential to improve animal welfare assessment using SIF structure that is already in place for food safety purposes. In this regard, cooperative work between SIF and companies seems an interesting approach to promote transparency of production process, which would benefit society and animals.

APPENDIX III – PAPER: BROILER CHICKEN MEAT INSPECTION DATA IN BRAZIL: A FIRST GLIMPSE INTO AN ANIMAL WELFARE APPROACH

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Broiler Chicken Meat Inspection Data in Brazil: A First Glimpse into an Animal Welfare Approach

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Keywords

Animal-based indicators, carcass downgrading, risk analysis, welfare assessment, welfare surveillance.

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ABSTRACT

We aimed to study the potential use of carcass condemnation data of broiler chicken slaughterhouses in Brazil as indicators in an animal welfare monitoring program, and to identify points to be addressed to increase data reliability. Data from 2010 to 2015 in the states of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS) were used. Fractures and bruising were recorded together, representing the most prevalent welfare problem, followed by skin lesion or inflammation. In PR, progressive increases on injury, arthritis, ineffective bleeding, and air sacculitis condemnation may reveal important welfare aspects. High correlation between AWI within PR was more commonly observed than in RS and SC, perhaps as a result of earlier implementation of local meat inspection standardization. Principal component analysis showed changes on condemnation data pattern in PR after standardization, pointing injury and Escherichia coli problems as the main causes for condemnation related to animal welfare. There is considerable potential to improve animal health and welfare surveillance using meat inspection structure that is already in place for food safety purposes, provided that the competent authority harmonizes the procedure of meat inspection among the States, sets specific animal welfare outcomes to be monitored, and integrates condemnation, transport and flock data. It seems crucial to update data collection to establish a routine that allows risk analysis regarding both food safety and animal welfare. In this regard, cooperative work between Federal Inspection and companies seems an interesting approach to promote transparency of the production processes, which would benefit society and animals.

INTRODUCTION

Brazil is the second largest broiler chicken producer in the world. In 2015, about 5.2 billion broiler chickens were slaughtered in establishments under the Federal Inspection Service (SIF) of the Ministry of Agriculture, Livestock and Food Supply (MAPA), and there is a projection of a 46.4% increase in chicken meat production by 2023. Simultaneously, there is an increasing demand for information on ethical aspects of animal production. Based on this, governmental actions are increasing worldwide. In the European Union (EU), Directive 2007/43/CE (European Commission, 2007), on the protection of chickens kept for meat production, sets out compliance inputs for poultry farms, such as maximum stocking density, minimum lighting intensity, and air quality parameters. Additionally, outputs such as mortality and meat inspection data are considered with the purpose of establishing maximum stocking density values. Dermatitis, parasitic infections and systemic illness are also measured by the official veterinarian at the slaughterhouse to identify signs of poor welfare.

APPENDIX IV - PAPER: PROPOSAL OF A MANAGEMENT SYSTEM TO DEVELOP AN ANIMAL WELFARE STRATEGY FOR THE ANIMAL FOOD CHAIN

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Proposal of a management system to develop an animal welfare strategy for the animal food chain

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Abstract

This study aimed to propose general guidelines for an animal welfare (AW) management system based on the hazard analysis and critical control point (HACCP) to develop an AW strategy appropriate for individual organizations of the animal food chain. Main adaptations for steps within pre-hazard analysis included a description of the animal species and its intended use, the development of a flow diagram detailing operations where live animals are handled and focusing on animal handling procedures for each stage of animal production or process step. The hazard analysis step included considerations of all kinds of welfare problems that may occur in each step or production stage listed in the flow diagram. Hazard duration, including duration of its consequences, were added to the hazard characterization step. Main changes on establishing critical limits for critical control points included a proposal to set initial thresholds for animal-based measures while scientific-validated data are obtained. Corrective actions considered the concept of implementing real-time procedures to avoid animal suffering, as well as the possibility of reducing identified hazards for future animals. By implementing the HACCP-based system, companies will be prompted to reduce levels of identified AW problems, with potential for mid to long-term reduction of AW problems through planned corrective and preventive actions. Application of the management system may take broader AW discussions to higher corporate levels in companies, needed for the development of an AW strategy, and may promote transparency of processes in animal production, which will benefit both animals and society.

Keywords: HACCP, Animal welfare assessment, Outcome-based indicator, Quality management

Review Methodology: We reviewed academic papers using the terms animal health, animal welfare, HACCP and risk assessment. We followed the reference guide about HACCP for food safety from the Codex Alimentarius Commission of the World Health Organization and the Food and Agriculture Organization of the United Nations to propose adaptations towards an animal welfare HACCP system. In addition, we used references from scientific reports on animal welfare from the European Food Safety Authority.

Introduction

There seems to be an interesting trend in promoting animal welfare (AW) strategies as mechanisms for the implementation of concrete actions, optimizing the incorporation of the many factors and complexities involved in AW management. Good examples are The World Zoo and Aquarium Animal Welfare Strategy [1] and The Global Strategy on Animal Welfare [2]. The hazard analysis and critical control point (HACCP) is a science-based food safety management system widely implemented in the food industry. The aim of the HACCP is to stimulate improvement in food safety practices through the establishment of targets or standards to be implemented by the industry [3]. Following the well-established HACCP rationale as part of an animal welfare management system (AWMS), a strategy for the animal food chain may be designed with the goal of stimulating and supporting organizations in the development of AW-oriented plans to improve AW on the farm, during transport and at slaughterhouses. The relevance of an AW strategy for the animal food chain relates to the growing public concern regarding farm animals [4, 5].

APPENDIX V – ABSTRACT: REFINEMENT OF BROILER CHICKEN WELFARE OUTCOMES USING DELPHI METHODOLOGY

Session 05 Poster 22

Refinement of broiler chicken welfare outcomes using Delphi methodology

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Recent studies about broiler chicken welfare assessment suggest the need for refinement in some animal welfare indicators. This study aimed to refine three broiler chicken welfare indicators: bird cleanliness (BC), carcass scratches (CS), breast and abdomen contact dermatitis (CD). We built a questionnaire with pictures of birds with different levels of the target indicators to be classified as absent, low, moderate or severe. Following Delphi methodology, the questionnaire was sent to 146 experts invited for the first round (R1). In the second round (R2), 88 participants who answered R1 were asked about the relationship between feathering and BC; to quantify maximum accepted levels of CS according to age, depth and length of lesion; and, based on justification given in R1 for each level of CD, to select between two scales including erythema. Interquartile deviation was calculated to verify consensus among respondents. In R1, there was 56.8% (83/146) complete and relevant responses for BC, 56.1% (82/146) for CS and 55.5% (81/146) for CD. In R2, 73.5% (61/88) of specialists participated, 68.7% (57/88) completed the questionnaire. In R1, consensus was achieved for 8/10 pictures of BC, and in R2 results suggested the need to include feathering condition assessment during BC analysis. Considering CS, consensus was achieved for 5/8 pictures in R1. In R2, 98.2% (56/57) of respondents considered that old scratches must be assessed as animal welfare indicator. For CD, consensus was achieved in 2/10 pictures in R1, being them the extreme cases, absence and severe CD. Additionally, erythema was recognized as an unhealthy condition of the skin by 96.4% (80/83) of respondents in R1. In R2, 64.9% (37/57) of respondents chose a more detailed scale to assess CD. After R2, we built a visual and descriptive scale for the assessment of BC and CD on farm, and CS at the slaughterhouse.

APPENDIX VI – PAPER: DEVELOPMENT AND REFINEMENT OF THREE ANIMAL-BASED BROILER CHICKEN WELFARE INDICATORS

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Development and refinement of three animal-based broiler chicken welfare indicators

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Abstract

This study aimed to refine bird-soiling as a broiler chicken (Gallus gallus domesticus) welfare indicator, and to develop and test two additional indicators, namely contact dermatitis on the breast and abdominal areas and carcase scratches. We constructed a questionnaire with pictures of birds presenting different indicator levels for classification as absent, low, moderate or severe. The questionnaire was sent to 146 invited experts for the first round and 88 for the second, in a Delphi process. Visual scales were built for the target indicators, which were tested by three assessors in ten flocks on-farm (n = 1,303 birds) and at the slaughterhouse (n = 1,631 birds). High concordance was observed among groups of Delphi respondents and among assessors. A total of 90.7% of the birds were either moderately or severely soiled, 99.9% were poorly feathered, 73.4 and 90.0% presented erythaema and carcase scratches, respectively. The correlations between litter quality and all outcomes assessed on-farm, and between bird-soiling and contact dermatitis on the breast and abdominal areas, were moderate. Results suggest that adoption of the proposed scales may improve our ability to assess broiler chicken welfare, since relevant problems were prevalent and measurement consistency acceptable. Substantial concordance observed among assessors encourages application of these animal-based indicators to assess broiler chicken welfare in a wide range of poultry houses, in a variety of different countries, thereby allowing the scales to be tested in a host of animal welfare conditions.

Keywords: animal welfare, outcomes, plumage cleanliness, skin irritation, welfare assessment, welfare measures

Introduction

Animal welfare assessment may include animal- and resource-based indicators. The use of animal-based indicators to assess animal welfare has been encouraged (Veissier *et al* 2008; Rushen *et al* 2011; European Food Safety Authority [EFSA] 2012; World Organisation for Animal Health [OIE] 2013) and applied for regulatory purposes (European Commission 2017). The Welfare Quality® project proposed to standardise animal welfare assessment through the application of predominantly animal-based, scientifically validated measures (Blokhuis *et al* 2010) and it has been considered a robust tool to assess animal welfare (Webster 2009). The protocol for poultry includes measures of welfare related to four principles, ie good feeding, good housing, good health and appropriate behaviour (Welfare Quality® 2009).

Recent studies applying the Welfare Quality protocol® (2009) to assess broiler chicken (*Gallus gallus domesticus*) welfare suggested a need for refinement of some animal welfare measures. For example, Federici *et al* (2016) reported difficulties in assessing plumage cleanliness using the Welfare Quality protocol® scoring system, since birds assessed on-farm were poorly feathered on the breast. The visual eight-point scale developed by Wilkins *et al* (2003) to assess plumage cleanliness at the slaughterhouse was transformed in a four-point scale in the Welfare Quality protocol® to be assessed on-farm. However, type of soiling and bird feathering presented in the protocol pictures are not representative of the conditions observed in commercial farms for fast-growing broiler chickens. Previous studies have assessed bird cleanliness (Weeks *et al* 1994; Elwinger 1995; Dawkins *et al* 2004); however, details on the method used were often missing (Arnould *et al* 2009), suggesting the need for an updated scoring system.

A possible shortcoming in current broiler welfare assessment protocols is the absence of an effective measurement for contact dermatitis in the ventral body area for broiler chicken flocks, especially considering the high prevalence of contact dermatitis reported for other body parts, such as the foot-pads and hocks (Souza *et al* 2015; Tuytens *et al* 2015; Federici *et al* 2016). The Welfare Quality protocol® (2009) provides a scoring system to assess the presence or absence of breast blisters. According to Greene *et al* (1985), flocks showing a high prevalence of foot-pad dermatitis are expected to also present other forms of contact dermatitis.

APPENDIX VII – SCALES PRESENTED TO DELPHI RESPONDENTS DURING THE SECOND ROUND AND RELATION BETWEEN POOR FEATHERING AND BIRD SOILING

1. Contact dermatitis on the breast and abdominal areas: scales presented to Delphi respondents during the second round.

Escala 1 – Parte 1 / Scale 1 – Part 1

Escore/Score	Descrição	Description
Ausência / absence	- Pele sem lesão, inflamação ou eritema	- Skin without lesion, inflammation or erythema
Intermediário / Intermediate	- Eritema focal ou generalizado em tom rosa claro, ou - Pele pode apresentar diferentes graus de eritema, variando entre rosa claro e vermelho (até 50% da região ventral).	- Light pink local- or generalized erythema, or - Skin may present different degrees of erythema, from light pink to red (up to 50% of ventral body).
Severo / severe	- Grande área inflamada (mais de 50%), apresentando-se muito avermelhada	- Large area inflamed (more than 50%), dark red color

Escala 1 – Parte 2
Há crosta marrom ou bolha de peito? ( )Sim ( )Não

Scale 1 – Part 2
Is there brown spot or breast blister? ( )Yes ( )No

Escala 2 / Scale 2

Escore/Score	Descrição	Description
Ausência / absence	- Pele sem lesão, inflamação ou eritema perceptível	- Skin without lesion, inflammation or erythema
Leve / light	- Eritema focal ou generalizado em tom rosa claro, ou - Pele pode apresentar diferentes graus de eritema, variando entre rosa claro e vermelho (até 25% da região ventral).	- Light pink local- or generalized erythema, or - Skin may present different degrees of erythema, from light pink to red (up to 25% of ventral body area).
Moderado / Moderate	- Pele pode apresentar diferentes graus de eritema, variando entre rosa claro e vermelho (de 25% a 50% da região ventral), ou - Presença de crostas pequenas na cor marrom	- Skin may present different degrees of erythema, from light pink to red (from 25% to 50% of ventral body area), or - Presence of small brown spots
Severo / Severe	- Grande área inflamada (mais de 50%), apresentando-se muito avermelhada, ou - Grande crosta marrom ou bolha de peito	- Large area inflamed (more than 50%), dark red color, or - Large brown spots or breast blister

Adaptado de / adapted from de Jong et al., 2014

2. Relation between poor feathering and bird soiling: answers from Delphi respondents in two rounds.

Option to integrate bird soiling and poor feathering scores	First round	Second round
To propose a mathematical model for BS that considers general feathering	27.0% (13/48)	39.2% (20/51)
To propose a model that considers the proportion of body area presenting poor feathering)	52.1% (25/48)	31.4% (16/51)
To consider the worst BS score when poor feathering is observed)	4.2% (2/48)	3.9% (2/51)
When poor feathering is observed, cleanliness assessment should not be done	--	13.7% (7/51)
Other	16.7% (8/48)	11.7% (6/51)

APPENDIX VIII – DESCRIPTION OF TERMS IN BRAZILIAN PORTUGUESE USED DURING TRAINING CLASSROOM OF QUALITATIVE BEHAVIOUR ASSESSMENT FOR BROILER CHICKENS

Assustados	Animais mais agitados, amedrontados. Podem ser observadas vocalizações e tentativas de escape, com aves passando umas por cima das outras.
Curiosos	Animais com desejo de explorar ou explorando algo, que pode ser objeto, pessoa ou ambiente. Podem ser observados animais esticando o pescoço em direção ao item a ser explorado, olhando fixamente para ele.
Com dor	Animais com dificuldade de andar, apresentando claudicação; animais relutantes ou incapazes de se locomoverem devido a deformidades do sistema locomotor.
Relaxados	Animais com aspecto sereno, tranquilo, demonstrando estar em bom nível de conforto. Sem tensão e agitação.
Agressivos	Animais apresentando comportamento de dominância, enfrentamentos, brigas.
Ocupados positivamente	Animais ocupados com atividades positivas, como limpeza de penas, banho de cama, exploração de ambiente, interação com enriquecimento ambiental, alimentação, etc.
Letárgicos	Animais sonolentos, com pouca movimentação, com aspecto desanimado, sem vitalidade.
Confortáveis	Animais relaxados, tranquilos, sem incômodo aparente.
Com medo	Animais visivelmente agitados, amedrontados, vocalizando. São observadas tentativas de escape, com aves passando umas por cima das outras.
Ativos	Animais movimentando-se de forma positiva, sem estresse ou medo. Pode-se observar animais andando, comendo, bebendo, realizando comportamento de conforto (banho de cama, limpeza de penas), ciscando, explorando o ambiente, etc.
Entediados	Animais não demonstram vontade de se movimentar.
Confiantes	Animais com aspecto altivo, sem reações de medo ou outros sentimentos negativos.
Agitados	Animais inquietos, tensos, demonstrando certo nível de incômodo ou medo.
Interessados	Animais atentos ao ambiente onde estão, demonstrando vontade ou curiosidade de interagir com outros animais, objetos ou de explorar o ambiente.
Apáticos	Animais com pouca movimentação, com aspecto desanimado e demonstrando indiferença pelo ambiente onde estão.
Brincalhões	Animais interagindo com outros objetos ou estruturas de forma lúdica.
Desesperados	Animais visivelmente desanimados, desesperançados, angustiados.
Apreensivos	Animais demonstram-se preocupados com alguma coisa, com um certo nível de tensão.
Atentos	Animais alertas, vigilantes ao ambiente onde estão.
Perturbados	Animais com alto grau de sofrimento, desequilíbrio.
Calmos	Animais com aspecto sereno, tranquilo. Sem agitação.
Frustrados	Animais impedidos de atingirem a satisfação, ou de realizarem uma atividade. O impedimento pode ser por condições físicas do próprio indivíduo ou por condições do ambiente.
Com vitalidade	Animais demonstrando energia, força, vigor.
Incomodados	Animais importunados. Pode-se observar animais em desconforto térmico, que não conseguem descansar, completar atividades de conforto como tomar banho de cama ou limpar penas, etc.
Tranquilos	Animais com aspecto sereno. Sem agitação.

SOURCE: The author (2019). Adaptaded from AWIN (2015), Ferreira (2017) and Minero et al. (2016) by including practical examples for broiler chickens.

AWIN. **AWIN welfare assessment protocol for horses**. Disponível em: <https://air.unimi.it/retrieve/handle/2434/269097/384836/AWINProtocolHorses.pdf>. 2015.

FERREIRA, A. B. DE H. **Aurélio Dicionário da Língua Portuguesa**. 8. ed. Curitiba: Editora Positivo, 2017.

MINERO, M. et al. **Use of Qualitative Behaviour Assessment as an indicator of welfare in donkeys**. Applied Animal Behaviour Science, v. 174, p. 147–153, 2016.

ANNEX I – GRANT: UNIVERSITIES FEDERATION FOR ANIMAL WELFARE

UFAW
Established 1926

UNIVERSITIES FEDERATION FOR ANIMAL WELFARE

The Old School, Brewhouse Hill, Wheathampstead, Hertfordshire AL4 8AN, UK
Tel: +44 (0)1582 831818 Fax: +44 (0)1582 831414
Website: www.ufaw.org.uk
Email: ufaw@ufaw.org.uk

Mrs Ana Paula de Oliveira Souza
Laboratório de Bem-estar Animal
Setor de Ciências Agrárias
Universidade Federal do Paraná
Rua dos Funcionários
n. 1540, Bairro Juvevê
Curitiba-PR, CEP: 80035-050. Brazil

08 April 2016

Dear Mrs de Oliveira Souza

Re: UFAW Grant Application 56-15/16
To fund travel to the UFAW Animal Welfare Conference. 23rd June 2016

Thank you for your application requesting support from UFAW for the above project. I am pleased to confirm that your application has been approved. Please find enclosed a cheque for the sum of £637 made payable to 'Ana Paula de Oliveria Souza'. I would be grateful if you could acknowledge receipt by return of post

UFAW, The International Animal Welfare Science Society, has always been an organisation especially for those in the animal welfare research community and for others who believe in the importance of science in tackling animal welfare problems. UFAW holds meetings on animal welfare science, publishes the journal *Animal Welfare*, and, as you know, funds research and other animal welfare initiatives. However, it receives no funds from universities or government; UFAW relies on donations, member subscriptions and legacies.

To enable UFAW to continue its vital work it is fundamental that we recruit new members. If you are not already a member, then I hope that you will consider becoming one and so enclose a membership application form. If you are already a member of UFAW, then I would be most grateful if you could pass on the enclosed membership form to an interested friend or colleague. All members of UFAW receive information about our activities, meetings, and future awards and, for example, are eligible for a 35% discount on selected Wiley publications, including the UFAW/Wiley-Blackwell Animal Welfare Series: www.wiley.com/go/ufaw.

We are delighted to be able to provide assistance with your project and look forward to receiving a report on the meeting in due course.

With best wishes
Yours sincerely

Ms Jane Moorman
UFAW Secretary
Enc.

ANNEX II – PAPER SUBMISSION: ORDINAL OR VISUAL ANALOGUE SCALES FOR ASSESSING ASPECTS OF BROILER CHICKEN WELFARE?

qualitebr@gmail.com

De: eesserver@eesmail.elsevier.com em nome de Applied Animal Behaviour Science <eesserver@eesmail.elsevier.com>
Enviado em: segunda-feira, 4 de março de 2019 10:31
Para: qualitebr@gmail.com
Assunto: Submission Confirmation for Applied Animal Behaviour Science

*** Automated email sent by the system ***

Title: Ordinal or visual analogue scales for assessing aspects of broiler chicken welfare?
Research Paper

Dear Mrs. Souza,

Your submission has been received by the journal
Applied Animal Behaviour Science.

You will be able to check on the progress of your paper by logging onto the Elsevier Editorial Systems as an Author using the following information:

https://ees.elsevier.com/applan/
Your username is: qualitebr@gmail.com
Your password is: *******

Your manuscript will be given a reference number once an Editor has been assigned.

Thank you for submitting your work to this journal.

Kind regards,

Editorial Office Staff
Applied Animal Behaviour Science

ANNEX III – HUMAN RESEARCH ETHICS COMMITTEE OF THE HEALTH SCIENCE (N° 1,377,497)

UNIVERSIDADE FEDERAL DO PARANÁ - SETOR DE CIÊNCIAS DA SAÚDE/ SCS -

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: PERCEPÇÃO E ATITUDES HUMANAS SOBRE A SENCIÊNCIA ANIMAL E QUESTÕES RELACIONADAS AO BEM-ESTAR ANIMAL

Pesquisador: Carla Forte Maiolino Molento

Área Temática:

Versão: 9

CAAE: 34820114.0.0000.0102

Instituição Proponente: Programa de Pós-graduação em Ciências Veterinárias

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.377.497

Apresentação do Projeto:

Título: Percepção e atitudes humanas sobre a senciência animal e questões relacionadas ao bem-estar animal.

Pesquisadora Responsável: Profa. Dra. Carla Forte Maiolino Molento e orientada Doutoranda Ana Paula de Oliveira e Souza

Para pesquisa utilizando metodologia Delphi, os contatos dos especialistas serão obtidos por meio de busca em artigos científicos publicados na área específica, em empresas de avicultura de corte e de certificação de granjas de frango de corte, e em órgãos governamentais.O estudo envolverá a aplicação de questionários a de especialistas em bem-estar de frangos de corte no Brasil e outros países (América Latina, Estados Unidos, Canadá e países membros da União Europeia), o TCLE encontra-se traduzido para o inglês.

O questionário será disponibilizado online. Trata-se de estudo que constitui a linha de pesquisa da Dra. Carla Molento, de bem estar animais; as hipóteses de trabalho são: avaliar se os indicadores de dermatite de contato da região do pelo e de limpeza de penas que considerem falhas de empenamento proporcionam resultados mais acurados em granjas de frangos de corte.

Arranhaduras em carcaça de frangos de corte podem ser indicadores de bem-estar animal em abatedouros.

Endereço: Rua Padre Carrango, 285 - Térreo
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** comitica.saude@ufpr.br

UNIVERSIDADE FEDERAL DO PARANÁ - SETOR DE CIÊNCIAS DA SAÚDE/ SCS -

Justificativa de Ausência	Documento 9 - Termo de Consentimento Daniel Santiago.docx	14/08/2014 17:13:01		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	Documento 9 - Termo de Consentimento Fabiana Stamm.docx	14/08/2014 17:12:51		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	Documento 9 - Termo de Consentimento Priscilla Tamioso.docx	14/08/2014 17:12:39		Aceito
Outros	Documento 8 - Declaração de uso específico do material.docx	14/08/2014 17:12:02		Aceito
Outros	Documento 7 - Declaração de tornar públicos os resultados.docx	14/08/2014 17:11:25		Aceito
Outros	Documento 6 - Termo de confidencialidade.docx	14/08/2014 17:10:50		Aceito
Outros	Documento 5a - Concordância dos serviços envolvidos.docx	14/08/2014 17:10:25		Aceito
Outros	Documento 4 - Análise de mérito do projeto.docx	14/08/2014 17:10:02		Aceito
Outros	Documento 3 - Declaração de concordância do orientador.docx	14/08/2014 17:09:37		Aceito
Outros	Documento 2 - Ofício encaminhando ata de aprovação.docx	14/08/2014 17:09:02		Aceito
Outros	Documento 1 - Ofício do pesquisador encaminhando o projeto ao CEP.docx	14/08/2014 17:08:17		Aceito
Folha de Rosto	FOLHA R.jpg	13/08/2014 19:16:25		Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CURITIBA, 21 de Dezembro de 2015

Assinado por:
IDA CRISTINA GUBERT
(Coordenador)

Endereço: Rua Padre Carrango, 285 - Térreo
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** comitica.saude@ufpr.br

ANNEX IV – ANIMAL USE ETHICS COMMITTEE (N°79)

CERTIFICATE

We certify that the protocol number 079/2015, regarding the project **"Animal-based welfare indicators: refinement and applicability in Brazilian broiler chicken production – Subproject 2"** under **Ana Paula de Oliveira Souza** supervision – which includes the production, maintenance and/or utilization of animals from Chordata phylum, Vertebrata subphylum (except Humans), for scientific or teaching purposes – is in accordance with the precepts of Law nº 11.794, of 8 October, 2008, of Decree nº 6.899, of 15 July, 2009, and with the edited rules from Conselho Nacional de Controle da Experimentação Animal (CONCEA), and it was approved by the ANIMAL USE ETHICS COMMITTEE OF THE AGRICULTURAL SCIENCES CAMPUS OF THE UNIVERSIDADE FEDERAL DO PARANÁ (Federal University of the State of Paraná, Brazil), with degree B of invasiveness, in session of 11/12/2015.

Duration of the project	February/2016 until March/2017
Specie/Line	Broilers (Cobb, Ross and Hubbard)
Number of animals	35.340
Wheight/Age	2,8 – 3,0 kg / 35 to 45 days
Sex	Both
Origin	Broilers slaughtered in industrial slaughterhouse under Federal Inspection

Curitiba, 12 de Novembro de 2015.

Ananda Portella Félix
Presidente CEUA-SCA

Simone Tostes de Oliveira Stedile
Vice-Presidente CEUA-SCA

Comissão de Ética no Uso de Animais do Setor de Ciências Agrárias - UFPR

ANNEX V – HUMAN RESEARCH ETHICS COMMITTEE OF THE HEALTH SCIENCE (N° 1,958,250)

UFPR - SETOR DE CIÊNCIAS DA SAÚDE DA UNIVERSIDADE FEDERAL DO PARANÁ -

PARECER CONSUBSTANCIADO DO CEP

DADOS DA EMENDA

Título da Pesquisa: PERCEPÇÃO E ATITUDES HUMANAS SOBRE A SENCIÊNCIA ANIMAL E QUESTÕES RELACIONADAS AO BEM-ESTAR ANIMAL
Pesquisador: Carla Forte Maiolino Molento
Área Temática:
Versão: 14
CAAE: 34820114.0.0000.0102
Instituição Proponente: Programa de Pós-graduação em Ciências Veterinárias
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.958.250

Apresentação do Projeto:
Projeto oriundo do programa de pós-graduação em Ciências Veterinárias, intitulado "Percepção e atitudes humanas sobre a senciência animal e questões relacionadas ao bem-estar animal". Trata-se da apresentação de subprojeto "Indicadores de bem-estar baseados nos animais: refinamento e aplicabilidade na avicultura de corte no Brasil"
O estudo tem como pesquisador principal a Profa. Dra. Carla Forte Maiolino Molento e como colaboradora a doutoranda Ana Paula de Oliveira Souza.
O estudo tem como hipótese: "Os descritores de emoções na língua portuguesa diferem dos em língua inglesa, e os resultados obtidos com o uso dos descritores em português apresentarão alta correlação intra e interobservadores".
Os participantes da pesquisa - estudantes, cientistas e pesquisadores em zootecnia e medicina veterinária - serão recrutados através da divulgação da pesquisa em murais na universidade, em sala de aula, por meio e-mail a partir da coordenação dos cursos ou em redes sociais.
Na primeira fase do estudo serão selecionados doze avaliadores - estudantes, cientistas e pesquisadores das áreas de zootecnia e medicina veterinária de universidades de Curitiba. No primeiro dia os avaliadores receberão treinamento de duas horas sobre comportamento de frangos e sobre o método de avaliação qualitativa do comportamento (QBA). Em seguida, os avaliadores

Endereço: Rua Padre Camargo, 285 - Térreo
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** comitica.saude@ufpr.br

UFPR - SETOR DE CIÊNCIAS DA SAÚDE DA UNIVERSIDADE FEDERAL DO PARANÁ -

Outros	confidencialidade.docx	17:10:50		Aceito
Outros	Documento 5a - Concordância dos serviços envolvidos.docx	14/08/2014 17:10:25		Aceito
Outros	Documento 4 - Análise de mérito do projeto.docx	14/08/2014 17:10:02		Aceito
Outros	Documento 3 - Declaração de concordância do orientador.docx	14/08/2014 17:09:37		Aceito
Outros	Documento 2 - Ofício encaminhando ata de aprovação.docx	14/08/2014 17:09:02		Aceito
Outros	Documento 1 - Ofício do pesquisador encaminhando o projeto ao CEP.docx	14/08/2014 17:08:17		Aceito
Folha de Rosto	fOLHA R.jpg	13/08/2014 19:16:25		Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CURITIBA, 10 de Março de 2017

Assinado por:
IDA CRISTINA GUBERT
(Coordenador)

Endereço: Rua Padre Camargo, 285 - Térreo
Bairro: Alto da Glória **CEP:** 80.060-240
UF: PR **Município:** CURITIBA
Telefone: (41)3360-7259 **E-mail:** comitica.saude@ufpr.br

ANNEX VI – ANIMAL USE ETHICS COMMITTEE (N°122)

CERTIFICATE

We certify that the protocol number 122/2016, regarding the project **"Development and validation intra- and inter-observer of qualitative behaviour assessment descriptors"** under **Carla Forte Maiolino Molento** supervision – which includes the production, maintenance and/or utilization of animals from Chordata phylum, Vertebrata subphylum (except Humans), for scientific or teaching purposes – is in accordance with the precepts of Law nº 11.794, of 8 October, 2008, of Decree nº 6.899, of 15 July, 2009, and with the edited rules from Conselho Nacional de Controle da Experimentação Animal (CONCEA), and it was approved by the ANIMAL USE ETHICS COMMITTEE OF THE AGRICULTURAL SCIENCES CAMPUS OF THE UNIVERSIDADE FEDERAL DO PARANÁ (Federal University of the State of Paraná, Brazil), with degree 1 of invasiveness, in session of 07/12/2016.

Duration of the project	January/2017 until June/2017
Specie/Line	*Gallus gallus domesticus* (fowl) / Cobb, Ross and Label Rouge
Number of animals	20026 (Cobb and Ross: 15013; Label Rouge: 5013)
Wheight/Age	Cobb and Ross: 2,3 to 3 kg / 38 to 45 days; Label Rouge: 2,3 to 3 kg / 70 to 90 days
Sex	Both
Origin	Commercial aviaries in Medianeira and Ivaiporã – PR

Curitiba, 7 de dezembro de 2016.

Simone Tostes de Oliveira Stedile

Coordenadora CEUA-SCA

Comissão de Ética no Uso de Animais do Setor de Ciências Agrárias - UFPR