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CAUSES OF BROILER MORTALITY IN AN INTENSIVE PRODUCTION SYSTEM IN THE NORTHEAST REGION OF PARÁ, BRAZIL

CAUSAS DE MORTALIDADES EM FRANGOS DE CORTE EM UM SISTEMA DE PRODUÇÃO INTENSIVO NA REGIÃO NORDESTE DO PARÁ, BRASIL

CAUSAS DE MORTALIDAD EN POLLOS DE ENGORDE EN UN SISTEMA DE PRODUCCIÓN INTENSIVO EN LA REGIÓN NORDESTE DE PARÁ, BRASIL

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ABSTRACT

The objective of this study was to identify the causes of mortality in broiler chickens raised at an intensive commercial farm located in the northeastern region of the Brazilian state of Pará. This study focused on a flock of 34,000 birds, which was monitored during a 42-day production cycle. Necropsies and histological analyses were performed on a portion of the birds that died spontaneously. During the study period, a mortality rate of 1,508 birds was recorded, representing 4.4% of the total. Of this total, 237 birds underwent necropsy, resulting in 344 diagnoses. Of these, 55.8% were classified as non-infectious conditions and 44.2% as infectious conditions. The most prevalent non-infectious lesions diagnosed were ascites syndrome (40/11.6%), femoral head degeneration (37/10.8%), tracheitis (34/9.9%), cachexia/starvation (23/6.7%), and pododermatitis (20/5.8%). The most prevalent infectious conditions observed were airsacculitis (28/8.1%), polyserositis (23/6.7%), pneumonia (22/6.4%), omphalitis/yolk sac infection (21/5.8%), necrotic hepatitis (17/4.9%), vegetative endocarditis (14/4.1%), and fibrinous pericarditis (10/2.9%). Although the mortality rate was not considered high, infectious lesions were recorded as significant causes of mortality, contrary to expectations in modern poultry farming. This evidence highlights the importance of identifying the epidemiological and etiological factors underlying such conditions in order to implement appropriate control and prophylaxis measures.

KEYWORDS: *Mortality. Intensive Production. Broiler Chickens.*

RESUMO

O objetivo deste estudo foi identificar as causas de mortalidade em frangos de corte criados em uma granja comercial intensiva localizada na região nordeste do estado do Pará, no Brasil. O estudo concentrou-se em um lote de 34.000 aves, que foi monitorado durante um ciclo de produção de 42 dias. Foram realizadas necropsias e análises histológicas em uma parte das aves que morreram espontaneamente. Durante o período do estudo, foi registrada uma taxa de mortalidade de 1.508 aves, representando 4,4% do total. Desse total, 237 aves foram submetidas a necropsia, resultando em 344 diagnósticos. Destes, 55,8% foram classificados como condições não infecciosas e 44,2% como condições infecciosas. As lesões não infecciosas mais prevalentes diagnosticadas foram síndrome de ascite (40/11,6%), degeneração da cabeça do fêmur (37/10,8%), traqueíte (34/9,9%), caquexia/inanição (23/6,7%) e pododermatite (20/5,8%). As condições infecciosas mais prevalentes observadas foram airssaculite (28/8,1%), poliserosite (23/6,7%), pneumonia (22/6,4%), onfalite/infecção do saco vitelino (21/5,8%), hepatite necrótica (17/4,9%), endocardite vegetativa (14/4,1%) e pericardite fibrinosa (10/2,9%). Embora a taxa de mortalidade não tenha sido considerada

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alta, as lesões infecciosas foram registradas como causas significativas de mortalidade, contrariando as expectativas na avicultura moderna. Esses dados destacam a importância de identificar os fatores epidemiológicos e etiológicos subjacentes a tais condições, a fim de implementar medidas adequadas de controle e profilaxia.

PALAVRAS-CHAVE: Mortalidade. Produção Intensiva. Frangos De Corte.

RESUMEN
El objetivo de este estudio fue identificar las causas de mortalidad en pollos de engorde criados en una granja comercial intensiva ubicada en la región nordeste del estado brasileño de Pará. El estudio se centró en un lote de 34.000 aves, monitoreado durante un ciclo de producción de 42 días. Se realizaron necropsias y análisis histológicos en una parte de las aves que murieron espontáneamente. Durante el período de estudio, se registró una mortalidad de 1.508 aves, lo que representa el 4,4% del total. De este total, 237 aves fueron sometidas a necropsia, resultando en 344 diagnósticos. De estos, el 55,8% se clasificó como afecciones no infecciosas y el 44,2% como afecciones infecciosas.
Las lesiones no infecciosas más prevalentes diagnosticadas fueron síndrome de ascitis (40/11,6%), degeneración de la cabeza femoral (37/10,8%), traqueítis (34/9,9%), caquexia/inanición (23/6,7%) y pododermatitis (20/5,8%). Las afecciones infecciosas más prevalentes observadas fueron aerosaculitis (28/8,1%), poliserositis (23/6,7%), neumonía (22/6,4%), onfalitis/infección del saco vitelino (21/5,8%), hepatitis necrótica (17/4,9%), endocarditis vegetativa (14/4,1%) y pericarditis fibrinosa (10/2,9%).
Aunque la tasa de mortalidad no se consideró alta, las lesiones infecciosas se registraron como causas significativas de mortalidad, en contraste con lo esperado en la avicultura moderna. Esta evidencia resalta la importancia de identificar los factores epidemiológicos y etiológicos subyacentes para implementar medidas adecuadas de control y profilaxis.

***PALABRAS CLAVE**: Mortalidad. Producción Intensiva. Pollos De Engorde.*

INTRODUCTION

The study of mortality on poultry farms enables the evaluation of production processes and the identification of diseases in their early stages. In-depth knowledge of the most prevalent diseases on production sites provides substantial information for producers, veterinarians, and local animal health authorities, facilitating the implementation of biosecurity and control measures for these diseases [1]. In commercial poultry farming, necropsies are performed frequently. The objective is to determine the cause of the disease and/or animal mortality. Based on the necropsy results, clinical history, anamnesis, and records, it is possible to establish a presumptive diagnosis. Although the Northeast Micro-region of Pará is located within a major poultry production hub in the state, according to IBGE data, no studies have been identified that document mortality rates in broiler chickens raised in intensive systems in the region under consideration, particularly regarding the most significant causes. The present study aims to identify the most prevalent causes of mortality in broiler chickens raised in an intensive production system in the northeastern region of Pará.

MATERIAL AND METHODS

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The study was conducted on a commercial farm equipped with an intensive production system, located in the municipality of Terra Alta, in the northeastern subregion of the state of Pará. The farm in question consisted of a building with a total area of 2,400 m² (15 m × 160 m). The house had a concrete floor, side walls with curtains, and a negative-pressure ventilation system, evaporative cooling, misters, four rows of automatic feeders, and automatic pendulum-type drinkers. The litter used was 5 to 7 cm thick and consisted of fine sawdust. This study followed a complete production cycle lasting 42 days. The flock consisted of 34,000-day-old birds of both sexes. Dead birds were collected daily at 8:00 AM and 4:00 PM. Birds that died suddenly during the day were randomly selected for necropsy. The high number of deaths and limited resources, particularly the number of pathologists available for necropsies, resulted in an incomplete necropsy rate for the entire bird population. Consequently, birds that could not undergo necropsy on the day of collection were discarded, given the high daily mortality rate. Birds culled by the poultry farmer were considered sacrificed and were not subjected to necropsy. Necropsies were performed according to the Avian Necropsy Atlas [2]. Samples from various organs were collected in 10% buffered formalin. In cases of suspected bacterial or fungal diseases, swabs were aseptically collected from the affected organs and placed in transport medium to be sent to the Animal Microbiology Laboratory of the Institute of Veterinary Medicine (IMV) at the Federal University of Pará (UFPA), where isolation and microbiological identification were performed.

Histological evaluation was performed only on bird samples in which macroscopic changes were insufficient to establish a diagnosis (116/237). Organ fragments from the birds were fixed in 10% buffered formalin, processed according to standard procedure, embedded in paraffin, sectioned with a microtome into 5-µm-thick sections, stained with hematoxylin and eosin, and examined under an optical microscope. In cases where fungal diseases were suspected, Grocott's silver impregnation or periodic acid-Schiff (PAS) staining was performed. The observed lesions were subsequently classified into three groups: infectious lesions, when the lesion was suggestive of bacterial, viral, fungal, or parasitic infection; non-infectious lesions, when the lesions suggested metabolic, traumatic, or multifactorial changes; and indeterminate lesions, when there were no significant changes or the animals were in an advanced state of decomposition. The total number of changes observed in each bird was recorded, resulting in a number of diagnoses greater than the number of birds subjected to necropsy. Weekly mortality figures include birds that died in the house as well as culled birds. For microbiological analysis, swab and tissue samples were sent to the microbiology laboratory at the Federal University of Pará. At the laboratory, bacterial cultures were performed and biochemical profiles were established to classify the bacteria at the genus level.

In cases of suspected bacterial or fungal diseases, swab samples were collected from the affected organs under aseptic conditions and placed in transport media for subsequent shipment to the Animal Microbiology Laboratory of the Institute of Veterinary Medicine (IMV) at the Federal University of Pará (UFPA). In the laboratory, the samples underwent a treatment process following standard

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microbiological procedures. Cultures were performed on appropriate selective and non-selective media and incubated under aerobic conditions at 37 °C for 24–48 hours. Bacterial identification was performed based on colony morphology, Gram staining, and biochemical tests, following standard microbiological criteria appropriate for each isolated microorganism, allowing identification at the genus level. No additional studies were conducted, including identification at the species level and antimicrobial susceptibility testing.

RESULTS

A total mortality of 1508 (4.4%) birds were recorded. Table 1 shows the mortality recorded for each week of the production cycle and the number of birds necropsied. A total of 237 birds were necropsied, of which 86 had one or more non-infectious alterations (36%), 60 (25%) had one or more infectious alterations, 59 (25%) had both infectious and non-infectious alterations. A total of 344 alterations, of which 192 (55.8%) were non-infectious and 152 (44.2%) infectious (Table 1). The macroscopic characteristics of the main infectious and non-infectious alterations diagnosed are described in Tables 1.

Table 1. Number of deaths per week, autopsies performed per week and number of infectious and non-infectious conditions diagnosed

Information	**Production week**						
	1	2	3	4	5	6	**Total**
Mortality	661 (43,8%)	185 (12,3%)	251 (16,6%)	161 (10,7%)	160 (10,6%)	90 (6%)	**1508 (100%)**
Necropsies performed	81	33	42	31	27	23	**237**
	Non-infectious causes						**Nº of birds affected**
Ascitic syndrome	5	2	8	4	10	11	**40**
Degeneration of the femoral head	4	3	5	4	8	13	**37**
Tracheitis	0	0	8	15	8	3	**34**
Cachexia, starvation	20	1	2	0	0	0	**23**

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Pododermatitis	0	2	4	1	5	8	**20**
Visceral gout	8	0	0	0	0	0	**8**
Pulmonary congestion	0	1	3	3	0	1	**8**
Hepatic rupture	0	1	2	1	1	1	**6**
Polytrauma	4	0	0	0	0	0	**4**
Hemopericardium	0	0	1	1	0	1	**3**
Dilation of the proventriculus and gizzard	0	0	0	0	1	1	**2**
Incarceration intestinal	0	1	0	0	1	0	**2**
Laryngeal obstruction	1	1	0	0	0	0	**2**
Septal defect atrial and ventricular	0	0	0	2	0	0	**2**
Teratoma	0	0	0	0	0	1	**1**
Total non-infectious	42	12	33	31	34	40	**192 (55,8%)**
	Infectious causes						**N. of birds affected**
Airsacculitis	0	2	4	10	5	7	**28**
Polyserositis	0	14	6	2	1	0	**23**
Pneumonia	0	1	4	7	6	4	**22**
Omphalitis infection of the yolk sac	13	7	0	0	0	0	**20**
Necrotic hepatitis	2	2	5	2	5	1	**17**
Endocarditis	0	0	1	6	2	5	**14**

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vegetative							
Fibrinous pericarditis	1	0	3	1	2	3	**10**
Granulomatous typhlitis	0	0	0	1	4	0	**5**
Enteritis	0	0	2	2	0	0	**4**
Arthritis	0	1	1	0	0	1	**3**
Cellulitis	0	0	0	0	1	2	**3**
Others	0	0	2	0	0	1	**3**
Total changes infectious	16	27	26	33	26	24	**152 (44,2%)**
Total changes diagnosed							**344**

The main non-infectious changes diagnosed were ascitic syndrome (11.6%), degeneration of the femoral head (10.8%), tracheitis (9.9%), cachexia/starvation (6.7%), pododermatitis (5.8%), visceral gout (2.3%) and pulmonar congestion (2.3%). Of the 37 birds that had degeneration of the femoral head, in 27 this alteration was associated with an infectious alteration, such as polyserositis, pneumonia and airsacculitis, and in 5 birds with a non-infectious alteration, such as ascitic syndrome. Of the 34 birds that had tracheitis, this alteration was considered the main lesion in only two. In 27 of these birds, the main lesion was an infectious alteration, mainly pneumonia (14/34), airsacculitis (9/34) and enteritis (4/34), and five had a non-infectious alteration (ascitic syndrome).

The main infectious changes were airsacculitis (8.1%), polyserositis (6.7%), pneumonia (6.4%), omphalitis/yolk sac infection (5.8%), necrotic hepatitis (4.9%), vegetative endocarditis (4.1%) and fibrinous pericarditis (2.9%). Microbiological analysis was carried out on 16 samples. *E. coli* was isolated in cases of airsacculitis (1), necrotic hepatitis (1), cellulitis (1) and coelomitis (1). *Proteus sp.* was isolated in cases of airsacculitis (1), vegetative endocarditis (1), polyserositis (1) and fibrinous pericarditis (1). In the latter, *Staphylococcus* sp. was also isolated. *Citrobacter* sp. was isolated in cases of arthritis (1) and cellulitis (1). *Klebsiella* sp. was isolated in a case of fibrinous pericarditis (1) and *Salmonella* sp. in cases of polyserositis (4).

DISCUSSION

The results obtained show that mortality in the study group (4.4%) was the result of a complex interaction between infectious and non-infectious factors, with a slight predominance of the latter

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(55.8%). In contrast, the infectious diseases identified—mostly bacterial in nature and predominantly respiratory and systemic in nature—do not constitute isolated primary events, but rather secondary manifestations of an unbalanced production system. The diversity of isolated agents, with no clear predominance of a specific pathogen, reinforces this interpretation, indicating low etiological specificity and a strong influence of predisposing factors. Mortality rates of 1.64% [3], 3.96% [4] and 4.63% [5] have been reported in Brazilian poultry houses with a dark house production system.

The mortality rate recorded in the poultry house under study was considered normal for the property, which in previous cycles had rates of between 3 and 5%, according to the producer. Most of the mortality was concentrated in the first week (1.94%), which is higher than that recommended by the companies that supply the main strains in the broiler industry, which recommend a mortality rate in the first week of less than 1% [6].

During the first week, the main changes observed were cachexia/starvation and omphalitis/yolk sac infection. Bonfanti (2016), observed starvation mortality in 5.6% and 6.1% of total mortality in 2 flocks raised in dark house aviaries, lower than in the present study. Some of the chicks had a large amount of beetle remains compatible with *Alphitobius diaperinus* inside their digestive tracts, which may have contributed to the flock's unevenness and higher cull rate. This insect is of great importance in commercial poultry farming because it has great potential for transmitting pathogenic microorganisms to birds and humans, such as *E. coli* [7,8], and other enterobacteria [7].

Omphalitis/yolk sac infection was observed in 8.43% of the birds necropsied, and was the main cause of death in the first week. This alteration is mainly associated with *E. coli* infection and can occur up to the third week of production [9]. Infection can occur through the contamination of eggs with feces, in which the bacteria can penetrate the eggshell and cause high embryonic mortality. In these cases, the chicks that hatch are underdeveloped and weak, so they could form part of the culled birds [9]. In the poultry house, infection occurs when the bacteria penetrate the poorly healed navel, producing edema and inflammation in the surrounding tissues, with frequent translocation of the bacteria to the yolk sac, due to their anatomical proximity [8]. [3] recorded omphalitis as the only cause of infectious mortality in 2 flocks of birds, accounting for 25.8% and 26.8% of mortality. In the present study, it is likely that most of the cases of omphalitis were due to contamination by feces in the hatchery, since 65% of these cases (13/20) occurred during the first week, a period in which the litter retained appropriate characteristics, without excess moisture and feces that facilitate bacterial proliferation.

In addition to the high mortality rate in the first week, the high cull rate (29.6%) is also a factor that draws attention in this study. [3] recorded a cull rate of 8.4 and 12% in two aviaries with a dark house production system. In 11 conventional commercial poultry houses in Rio Grande do Sul, the average cull rate was 11% [10]. Underdeveloped (emaciated), weak, injured and locomotor- disordered chickens are generally included as culls [11]. Some of these conditions result in birds with poor weight gain and poor body condition, giving rise to unevenness of the flock. Several of the alterations

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diagnosed in the analyzed birds that died spontaneously could explain the high rate of culled birds, since both underdeveloped animals and animals with weakness or locomotor alterations were euthanized.

Non-infectious alterations were the most frequent, the main one being ascitic syndrome, like what has been observed in other studies [3]. The syndrome occurs due to the high speed of growth and oxygen demands and is exacerbated when the birds are subjected to conditions that lead to hypoxia, such as poor ventilation, cold and stress [3,12]. It mainly affects birds in the final third of the production cycle, but it has also been documented in younger birds, as early as 3 days old [12], as observed in the present study.

Tracheitis, characterized primarily by ciliary loss, hyperplasia, mucosal disorganization, and metaplasia, was observed in 14.3% of the birds subjected to necropsy. These changes are similar to those described in birds kept in environments with high ammonia concentrations [13] and favor the establishment of infection by microorganisms from the birds normal microbiota or those normally found in the environment, such as *Aspergillus* sp. Twenty-seven birds with tracheitis also presented, concomitantly and as the primary lesion, an infectious change, mainly pneumonia and alveolar sacculitis, demonstrating the importance of these lesions as a predisposing factor for the entry of microorganisms into the respiratory system. Ammonia levels were not measured during the study. It is suggested, however, that the presence of respiratory tract lesions, high litter density, and constant litter moisture indicate that ammonia levels likely increased during the production cycle. Furthermore, in a study conducted on the same farm, where ammonia levels were monitored, concentrations above 100 ppm were recorded [14], while recommended ammonia levels are below 25 ppm [1].

Degeneration of the femoral head was recorded in 15.6% of the birds from the first to the last week. This condition has been associated with metabolic disorders at bone level, a product of the accelerated growth rate [15], and can be observed from the first week, increasing in intensity the closer it gets to slaughter age or in the presence of microorganisms [15]. Birds with more advanced lesions, with loss of epiphyseal cartilage and femoral necrosis, show apathy, reduced consumption of food and water, which leads to dehydration and weight loss, and end up dying or being discarded [15]. In only 3 birds were these alterations the only necropsy finding. In 27 birds this alteration was observed concomitantly with some infectious alteration, and in 4 with non-infectious alterations, so it was not considered the main cause of death. It is worth noting that these alterations may also have contributed to the increase in the culling rate.

Pododermatitis was diagnosed from the second week until the end of the cycle, coinciding with the period when excessive humidity was observed in the litter. Excessive humidity is considered one of the main factors predisposing to the occurrence of pododermatitis [16]. These lesions can have negative effects on food consumption, as they cause pain when walking, as well as serving as a gateway for microorganisms, which can result in systemic infection [16]. These alterations may also

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have contributed to the high culling rate observed in this study, since animals with foot lesions tend not to move, which makes feeding and weight gain difficult, and are therefore discarded.

Alterations to the respiratory tract were among the main infectious lesions, including airsacculitis and pneumonia, which were recorded from the second week until the end of the cycle. These infections are often caused by opportunistic agents that are found in the environment, such as *Aspergillus* sp. [17], or agents that belong to the bird's normal microbiota, such as *E. coli* [9]. In this study, granulomatous airsacculitis was observed in 57.1% of the birds with airsacculitis, in which structures compatible with fungal hyphae and conidia were found in the histopathological evaluation in most cases. The main fungi involved in this type of lesion are *Aspergillus fumigatus* and *Aspergillus flavus*, with the main sources being excess moisture in the litter and moldy feed [17]. Fungal airsacculitis was diagnosed from the 13th day of the cycle. The excess moisture in the litter, observed from day 7 onwards due to water leaking from the drinkers, may have contributed to the occurrence of the disease.

Airsacculitis is an important cause of partial or total condemnation in slaughterhouses in Brazil [18]. At a slaughterhouse in the state of Pará, Dufossé (2018) recorded aerosaculitis in 11.88% of condemnations in 2014 and 24.74% of condemnations in 2015, suggesting a problem in the sanitary management of poultry houses. Although the slaughter of the birds under study was not monitored, it is to be expected that in addition to losses due to mortality during the production cycle, there will be losses due to condemnations at the slaughterhouse, since the lesion occurred with high frequency in the flock under study.

The second most common infectious alteration recorded in the poultry house was polyserositis, with 60.9% of the cases recorded occurring in the second week of production. This alteration is observed in cases of systemic bacterial infection, including poultry pathogenic *E. coli* (APEC) with the importance linked to economic losses due to mortality in the poultry house and the condemnation of carcasses at the slaughterhouse [8,9]. *Salmonella* sp also has great potential to produce cases of polyserositis [20], such as those observed in this study. Infection by *Salmonella* sp. is important both because of the high mortality that the serovars *S. Gallinarum* and *S. Pullorum* can cause, and because of the risk to public health due to food poisoning [20].

Although the mortality rate was not considered high, infectious causes of mortality accounted for a significant proportion of the study flock, even with partial necropsy of birds that died on the farm and incomplete etiological confirmation of the samples, which differs from what is expected in current poultry farms. This evidence highlights the importance of identifying the epidemiological and etiological factors underlying such changes in order to implement appropriate control and preventive measures.

CONCLUSION

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The observed mortality was attributed to a multifactorial pattern, in which non-infectious changes predominate in the pathogenesis of the diagnosed conditions. At the same time, infectious agents may act as aggravating factors and contribute to mortality. The implementation of appropriate management and biosecurity measures to control infectious diseases on the farm under evaluation could contribute to reducing the mortality rate, resulting in improved production indices. Correcting certain factors identified as predisposing to the occurrence of infectious and non-infectious changes, such as excess moisture in the bedding and likely high ammonia levels, is essential for reducing the incidence of disease and, consequently, the mortality rate.

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BIOETHICS AND BIOSECURITY COMMITTEE APPROVAL

The study submitted by protocol number CEUA 3062210820 (ID 001525) was approved by Ethics Committee on Research with Experimental Animals of Federal University of Pará.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

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