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Impact of deep pectoral myopathy in broiler chickens and correlation with zootechnical variables

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Abstract

Deep pectoral myopathy (DPM) is a silent anomaly that affects broiler chickens, causing condemnation of chicken breast meat, thereby leading to financial losses for the food industry. In this context, this work aimed to evaluate DPM incidence in commercial birds and quantify its correlation with zootechnical variables of broiler chicken batches produced by a poultry processing industry. Data were subjected to exploratory analysis considering the effect of each factor, followed by analysis of variance, and when significant, Tukey's multiple comparison test was performed. Data were also subjected to Pearson's linear correlation and principal component analysis. It was found that the DPM incidence was 1.63%, representing a daily average loss of 2,523 kg of chicken breast meat. The distribution by classes allowed the identification of categories with higher incidence in the DPM, namely: season (autumn; 1.83%); average age (> 44 days; 2.06%); daily weight gain (> 64 g; 1.58–1.64%); and mortality (> 8.52%; 1.84%); for the variables average weight and slaughter density, no differences were observed ($p < .05$). Measuring the DPM impact in commercial birds and its correlation with zootechnical variables has practical relevance for the food industry as it allows for the directing of efforts towards establishing productivity goals aimed at reducing its incidence.

Keywords: chicken breast; productivity goals; seasons; zootechnical results.

Practical Application: Deep pectoral myopathy reduces meat quality and zootechnical performance. The study may assist in prevention and management in poultry farming.

1 INTRODUCTION

The consumption of chicken meat has been increasing steadily compared to other sources of animal protein. This trend is driven by several factors, including consumer preference for affordable and nutritionally rich food. Global chicken meat production in 2023 grew by 1.8%, reaching nearly 103 million tons. It is projected that this production will continue to rise in the coming years, especially in the United States of America and Brazil, the largest producers (USDA, 2023).

Conversely, amid this expansion, one of the issues causing losses to the poultry industry is the occurrence of deep pectoral myopathy (DPM), also known as green muscle disease or degenerative muscle disease of the supracoracoideus, affecting the major and minor pectoral muscles of birds. This abnormality was initially described in turkeys and heavy breeders in 1968 but has become increasingly common in broiler chickens over the years, especially those genetically selected for breast muscle development (Bianchi et al., 2006).

The increased demand for chicken meat has intensified broiler production, leading to the emergence of muscle abnormalities associated with poultry meat. Consequently, the poultry industry has shown growing interest in understanding the impacts of these abnormalities on various meat quality characteristics (Giampietro-Ganeco et al., 2021).

The occurrence of pectoral anomalies in broiler chickens directly translates into economic losses for the meat and derivatives production sector (Petracci et al., 2014). These affected muscles are typically discarded during deboning, resulting in yield losses. However, a major concern is the consumption of whole carcasses silently affected by these conditions, which can lead to consumer complaints. Importantly, this condition is not associated with any infectious agent and, therefore, has little relevance to public health, except for its impact on meat appearance (Bilgili & Hess, 2008).

The relationship between DPM incidence and zootechnical variables has not been fully elucidated. Nevertheless, evidence suggests a genetic selection focus on increased weight gain and

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breast size as primary objectives. This muscular hypertrophy affects the smaller pectoral muscle, which becomes compressed between the inelastic muscle fascia and the sternum, leading to ischemia and subsequent necrosis (Kijowski & Kupinska, 2016).

The main impact for the food industry lies in the alteration of the appearance of the breast muscles, directly influencing consumer meat choice due to its unappealing appearance and product rejection (Kuttappan et al., 2013).

Research into inducing DPM has been conducted in controlled environments, albeit with limited applicability to commercial production settings (Siller et al., 1979). However, scientific literature lacks studies that quantify the losses caused by DPM and measure its relationship with zootechnical variables under commercial farming conditions, including its economic impact.

Therefore, this study aimed to assess DPM incidence in commercial poultry and quantify its relationship with zootechnical variables of broiler flocks. This research expands our understanding of this abnormality, providing insights to optimize poultry farming practices and mitigate DPM incidence, thereby adding value to the food industry.

Relevance of the work

This study evaluates the effects of deep pectoral myopathy in broilers, correlating it with zootechnical variables. The condition compromises meat quality and causes significant economic losses. The results contribute to a better understanding of the disease, aiding in the adoption of preventive measures and in the improvement of poultry productivity.

2 MATERIAL AND METHODS

The study conducted descriptive research on condemnation data of broiler breast affected by DPM, sourced from a poultry processing plant located in the state of Goiás, Brazil. Condemnation data of broiler breast were provided by the quality control department of the slaughterhouse and were statistically analyzed to correlate with zootechnical indicators of the originating flocks.

The zootechnical information database included data from 2,368 batches of male broiler chickens of the commercial lineage Ross AP95, slaughtered between January 3, 2022 and September 29, 2023, totaling 158,554,451 birds. The dataset encompassed continuous slaughter and broiler breast production information for over 23 months.

Data on the volume of condemned broiler breast due to DPM incidence were provided by the quality control department of the poultry processing plant, documented in reports spanning 437 production days. These data were compiled into a database generated by the Brazilian Federal Inspection Service (SIF) and archived by the company.

Based on this foundation, the research compared the incidence of DPM associated with the following factors: age, average weight, stocking density, feed conversion ratio, average daily weight gain, and mortality. Additionally, the incidence of DPM across batches was evaluated according to seasonal variations.

To investigate the incidence of DPM, groups were created based on zootechnical variables (Table 1).

2.1 Statistical analysis

The data underwent exploratory analysis, considering the effect of each factor, followed by analysis of variance (ANOVA); when significant, Tukey's multiple comparison test was applied. Pearson's linear correlation analysis was also conducted on the data.

Statistical software R was utilized for data analysis, employing the ExpDes.pt and MVar.pt packages.

3 RESULTS AND DISCUSSION

In the industrial plant, the average daily production of slaughtered birds and total weight were 362,825 birds and 1,051,654 kg, respectively (Table 2). The average daily production of chicken breast was 155,109 kg. From this production, a loss of 2,523 kg per day due to condemnation caused by DPM occurred, equivalent to 1.63% of the total quantity produced.

Table 1. Stratification into groups based on zootechnical variables per batches of broiler chickens.

Zootechnical Variable	Unit of Measurement	Groups					
		I	II	III	IV	V	VI
Age	Days	< 38	38–40	40–42	42–44	> 44	-
Average weight	kg	2.46–2.66	2.66–2.86	2.86–3.06	3.06–3.26	3.26–3.46	3.46–3.66
Density	kg per m^2	< 33	33–36	36–39	39–42	> 42	-
CR	-	1.35–1.55	1.55–1.75	1.75–1.95	1.95–2.15	2.15–2.35	-
DWG	G per day	< 58	58–61	61–64	64–67	67–70	> 70
Mortality	%	2.50–4.50	4.50–6.50	6.50–8.50	> 8.52	-	-

CR: feed conversion ratio; DWG: average daily weight gain.

Table 2. Average daily values of slaughtered birds, total weight, chicken breast production, condemnation due to deep pectoral myopathy (DPM), and incidence of DPM in processed chicken breasts by the poultry processing plant from January 3, 2022 to September 29, 2023.

Birds slaughtered per day	Total weight (kg per day)	Chicken breast production (kg per day)	Condemnation due to DPM (kg per day)	Incidence of DPM (%)
362,825	1,051,654	155,109	2,523	1.63

The analysis of DPM incidence during seasons revealed that autumn had the highest incidence at 1.93%, followed by spring and summer with incidences of 1.62% and 1.47%, respectively. The lowest incidence was in winter at 1.45%. There was no significant difference ($p < .05$) in DPM incidences between spring, summer, and winter (Table 3).

Table 4 presents the results of DPM incidence on zootechnical indicators. Concerning the effect of average age, it was observed that at 44 days, there was a higher incidence compared to 38 days, without differing from other ranges.

It was found that average weights from 2.66–2.86 kg and from 2.86–3.06 kg showed higher incidences of DPM than weights from 3.26–3.46 kg and from 3.46–3.66 kg, without differing from other ranges. Regarding weights from 2.46–2.66 kg, 3.06–3.26 kg, and 3.26–3.46 kg, they did not differ from each other, with the first two having higher values than the

Table 3. Effect of seasons on the incidence of deep pectoral myopathy (DPM), considering chicken breast production and discarded breasts from birds processed by the poultry processing plant from January 3, 2022 to September 29, 2023.

Season	Incidence of DPM (%) *	Chicken breast production (kg)	Discarded breast (kg)
Winter	1.45[b]	20,259,369	293,893
Autumn	1.93[a]	19,355,553	374,421
Spring	1.62[b]	11,327,807	183,927
Summer	1.47[b]	16,817,698	246,731

*Distinct letters in the column differ significantly by Tukey's test at 5% probability.

Table 4. Influence of stratified zootechnical variables on the incidence of deep pectoral myopathy (DPM), average daily production of chicken breast, and average daily loss caused by DPM from January 3, 2022 to September 29, 2023.

Zootechnical Variable	Groups	Incidence of DPM (%) *	Chicken breast production (kg per day)	Loss due to DPM (kg per day)
Age (days)	< 38	0.66[b]	1,171	8
	38–40	1.09[ab]	11,696	127
	40–42	1.62[ab]	60,241	976
	42–44	1.97[ab]	56,151	1,106
	> 44	2.06[a]	25,849	532
Average Weight (kg)	2.46–2.66	1.46[ab]	8,437	123
	2.66–2.86	1.56[a]	53,913	841
	2.86–3.06	1.60[a]	74,204	1,187
	3.06–3.26	1.50[ab]	15,951	239
	3.26–3.46	0.54[bc]	2,020	11
	3.46–3.66	0.47[c]	584	3
Density (kg /m^2)	< 33	1.34	570	8
	33–36	1.69	11,156	189
	36–39	1.62	65,332	1,058
	39–42	1.64	28,361	465
	> 42	1.62	49,690	805
Feed Conversion Ratio	1.35–1.55	0.93[bc]	3,227	30
	1.55–1.75	1.61[ab]	140,226	2,258
	1.75–1.95	1.97[a]	4,103	81
	1.95–2.15	0.44[c]	5,080	22
	2.15–2.35	0.51[c]	2,474	13
Average Daily Weight Gain (g/day)	< 58	0.62[b]	1,652	10
	58–61	0.52[b]	2,997	16
	61–64	1.15[ab]	9,848	113
	64–67	1.58[a]	31,642	500
	67–70	1.64[a]	64,010	1,050
	> 70	1.61[a]	44,960	724
Mortality (%)	2.5–4.5	1.45[b]	38,382	557
	4.5–6.5	1.46[b]	76,978	1,124
	6.5–8.5	1.74[ab]	26,338	458
	> 8.52	1.84[a]	13,411	247

*Distinct letters in the column differ significantly by Tukey's test at 5% probability.

heavier weights from 3.46–3.66 kg, which did not differ from the previous class.

For bird density, it was found that there was no effect of the classes on the incidence of DPM. Regarding feed conversion, the highest incidence was identified in the range of 1.75–1.95, differing only from the conversion range of 1.5–1.75. The two highest feed conversion ranges had the lowest incidence of DPM, not differing from the lowest range.

The highest value of average daily weight gain occurrence was 1.58% for batches in the range of 64–67 g per day. Batches with an average below 61 g per day had the lowest incidence of DPM, which did not differ ($p < .05$) between the initial ranges < 58 and 58–61 g per day. It was found that the incidence of DPM was the same for batches with an average daily weight gain of 61 g per day or more. For mortality, the highest class > 8.52% had the highest incidence at 1.84%, while the lower classes of 2.5 and 6.5% had the lowest incidences, at 1.45 and 1.46%, respectively.

The analysis of the zootechnical information generated in the breeding of commercial poultry batches is of great importance for modern poultry farming. This information constitutes reference parameters for decision-making that allows for the incorporation of preventive and corrective actions to improve the breeding of field batches.

The data base for this study was represented by 0.68 million tons of chicken meat produced from January 3, 2022 to September 29, 2023. According to data from the Brazilian Association of Animal Protein (ABPA, 2023), 14.524 million tons of chicken meat were produced in Brazil in 2022. A fraction of 8.19% of this production originated from the state of Goiás. Therefore, this data base corresponded to 5.72% of the total production of the state of Goiás during the evaluated period.

In this context, investigating the relationship between zootechnical variables under field conditions and the incidence of DPM in the food industry allows for the direction of information for the development of production protocols aimed at mitigating the incidence of this abnormality.

The total incidence of DPM identified in this study was 1.63% (Table 2), pointing to a discard of 2,523 kg of breast meat per day. The loss is significant for the food industry, mainly affecting the sustainability of the production chain.

To quantify the size of this loss, considering the chicken meat consumption of 45.56 kg per inhabitant (ABPA, 2023), the amount discarded during the evaluated period of this study would meet the consumption of 13.8 thousand consumers per year.

The autumn season showed a higher incidence of DPM than other seasons (Table 3). It occurs between March and June, which has the greatest daily temperature range in the region, with variations reaching 30°C every 24 hours. Under these conditions, the effective operation of the poultry house climate control equipment is fundamental to maintaining the thermal comfort zone of the birds, ensuring assertive control of the environment to mitigate the negative effects of temperature variations on bird welfare. This control is associated with continuous monitoring of the environmental parameters of the facilities to establish the ideal conditions of temperature, humidity, and air renewal throughout the birds' breeding cycle.

Any temperature fluctuations outside the ideal range cause discomfort, leading to behavioral changes in the birds, especially those related to wing agitation. The relationship between this behavior and the incidence of DPM is associated, as proposed by Siller et al. (1979). The authors indicate that the incidence of DPM in broilers due to forced exercise, when the birds are induced to flap their wings, highlights the ischemic origin of the pectoral muscle, resulting from pressure exerted on the musculature, preventing adequate blood perfusion.

The behavior of the DPM incidence on the variables average age, average weight, feed conversion, and daily weight gain showed a relationship with the breeding age of the batches, aiming for slaughter at a weight of 2.8 kg at 41 days of age, concentrating the highest volume of birds in these classes.

The increasing behavior of DPM incidence by total mortality can be explained by the general conditions causing mortality during the breeding phase of batches. The variation in incidence between the lowest and highest ranges reached 0.69%, representing an average increase of 17 kg of discarded breast meat per day due to DPM. Thus, it was inferred that the conditions related to the viability of the birds also influenced the occurrence of muscular abnormalities related to DPM after slaughter. This information may be relevant for planning the production of chicken breast meat by the processing industry.

The incidence of DPM by density showed similar behavior in all classes. The availability of feeders, drinkers, and control of environmental conditions are relevant factors for maintaining animal welfare conditions, directly affecting this zootechnical index. The index found showed no relationship with these conditions, hypothetically more favorable at lower densities. This information may be relevant to the processing industry, as removing the link between DPM and bird density broadens the horizon for cost reduction strategies by promoting better batch densification.

Garcia et al. (2002), evaluating the effect of increasing density in poultry breeding on the quality of chicken breast meat, measured the negative impact related to increased carcass lesions and reduced breast size of slaughtered birds. In this sense, the absence of density effect on DPM incidence should also be weighed against increased condemnations due to field causes, establishing the best cost-benefit relationship for flock composition. In field conditions, the strategy for controlling DPM incidence should weigh the cost-benefit relationship by establishing zootechnical indices aimed at lower incidence levels. Knowing the behavior of DPM incidence on the zootechnical variables of age, daily weight gain, feed conversion, mortality, occupancy density, and the seasons allows the food industry to create strategies aimed at its control.

4 CONCLUSIONS

The impact of DPM in broilers is directly related to the condemnation of chicken breasts at the processing plant. This research highlighted that this condition constitutes a significant challenge for the broiler industry, with an incidence rate of

1.63%, resulting in considerable daily losses of 2,523 kg of chicken breast.

The detailed analysis revealed that specific factors such as the season of the year, bird age, daily weight gain, and mortality rate have a pronounced correlation with the incidence of DPM. The highest incidences were observed in autumn, in birds over 44 days old, those with a daily weight gain exceeding 64 g, and in batches with a mortality rate above 8.52%. On the other hand, variables such as average weight and slaughter density showed no significant differences in DPM incidence.

Understanding the correlation between DPM and these zootechnical variables provides a strategic advantage for the poultry industry, allowing for the implementation of more effective management practices and targeted interventions to reduce the occurrence of the condition, thereby minimizing economic losses and improving the quality of poultry products.

Similarly, the historical analysis of these zootechnical indices becomes predictive, meaning that their measurement throughout the breeding cycle allows for the inference of the expected behavior of DPM incidence. This is relevant for industrial production planning, signaling the quantity and quality of the raw material to be produced and directing actions aimed at its proper utilization.

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