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ARTICLE

Comparison of Locomotion Problems and Its Economic Impact on Cobb and Ross Broiler Strains

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ABSTRACT

The rapid weight gain and fast muscle growth due to intense genetic selection and improved nutrition for additional breast muscle in broiler commercial strains affect chickens health. In order to compare the main locomotive problems in broilers of Cobb and Ross strains, two pens from a commercial farm in Veracruz, Mexico were used. The first pen housed 16,500 males and 16,500 females of Cobb strain and the second one 16,500 males and 16,500 females of Ross strain. Chicks were checked for locomotion problems from day one until their sale. Animals with problems were recorded and necropsies were performed to identify the pathology. Out of 1406 animals with locomotive problems (2.13% of the total), 58.9% were Cobb and 41.1% Ross (P <0.05). The frequency of locomotive problems was 2.51% for Cobb and 1.75% for Ross. Most common individual lesions were osteochondrosis (38.61%), inflamed joints with purulent contents (37.13%), and valgus (19.65%). Locomotive problems appeared since the first week, but its number increased as birds gained weight, particularly from the fourth week on. Problems occurred more in males than in females and in Cobb birds than in the Ross strain. Economic loss due to locomotion problems was higher for the Cobb strain.

1. Introduction

Poultry meat production has been a very dynamic industry over the last decades. Genetic enhancements and breeding have resulted in the current broiler chicken strains characterized by faster weight gain and better feed conversion. In fact, the potential for growth and body conformation of poultry are related to improved genetics, better understanding of nutrition and feeding, and overall improved management techniques that increased the efficiency and profitability of the poultry sector [1-3]. Genetic broiler lines have a high growth rate and the formation of notable muscle masses, mainly in the

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breast and thighs. A short period of growth and fattening, around 6-7 weeks, has made chicken the main base of the production of chicken meat for consumption [4]. However, the incidence of leg abnormalities in rapidly growing broilers is higher than in other broilers chickens [5]. Bone deformation is a very frequent and serious problem that affects the well-being of chickens of this type [6]. Bone abnormalities compromise the welfare of the birds and cause harm to the poultry industry due to culling, late mortality, poor performance and carcass condemnation [7]. Even though associated pathologies to this condition are known, they have s not been widely reported, and there is not much information on its presentation in commercial farms with high population densities in tropical conditions, so the objective of this study was to compare the main locomotive problems in Cobb and Ross strains broilers in Mexico and their economic impact.

2. Material and Methods

2.1 Location and Facilities

Birds used in this study were reared under similar conditions in two conventional poultry houses from the Santa Ana farm located in the town of San Antonio, Municipality of Paso del Macho, in the State of Veracruz, Mexico, were used. This is in a tropical climate and at an altitude of 250 meters. The pens are 15 m wide by 138 m long for a total of 2070 m^2. The ventilation is tunnel type, with 11 extractors, wet walls, sensors, Gasolec brooders, Cumberland feeders, lubing drinking nipples. Also, 1 kg/m^2 of rice husk was used as litter. All management was identical for the birds, regardless of their lodging or strain.

2.2 Poultry Management

The chicks received 200 g of pre-starter from 0 to 7 days of age, 1 kg of starter feed from 8 to 21 days, 2 kg of grower feed from 22 to 34 days, and 1,800 kg of 35-day finisher feed until sale. The feed used for feeding all birds of similar age was the same. Four to five days before the arrival of the chickens, the pens are cleaned and disinfected. When in the hatchery, the chicks receive a Marek + Newcastle vectorized vaccine by subcutaneous application and the Bronchitis MA5 and 491 vaccine by micro-spray. By the eighth day on the farm, Gumboro vaccine (univax plus) is given by mouth. At the 12th day, the emulsified Newcastle vaccine (subcutaneous route) + live virus Newcastle vaccine (ocular route) is applied. On the eighteenth day, the Gumboro vaccine (univax BD) is given. The stocking density was 16.03 birds/m^2.

2.3 Experimental Design

For this study, 66,000 chickens were followed throughout their fattening period. In house 1, 16,500 males and 16,500 females of the Cobb strain were included, while in house 3, 16,500 males and 16,500 females of the Ross strain were housed. From the day of arrival to departure, animals with locomotion problems were recorded and necropsies were performed. The type of problem was determined in each case and to which group (strain and sex) they corresponded to. From week 3 on, birds weight was recorded separately on weekly basis for each of the categories, i.e. strain and sex. The average body weight gain was obtained at the end of each week for each strain and sex by dividing the total broiler weight of the animal category by the number of animals. Economic impact of locomotive problems was calculated base on production by pen (kg), gross income by pen ($USD), losses due to locomotion problems (kg), economic losses due to locomotion problems ($USD), and proportion of economic losses due to locomotion problems (%). Sale price of broilers was $USD 0.81 per kilogram.

2.4 Data Analysis

The results of daily observations on the different variables were captured in Microsoft Excel and later statistical analysis was performed using Minitab v 17 to determine differences between broiler strains (Cobb and Ross) and animals sex (female and male). To compare weekly weight lost between broiler strains, t test was performed from week 2 on.

3. Results

Out of 1406 animals with locomotive problems (2.13% of the total), 58.9% were from the Cobb line and 41.1% from the Ross line ($P < 0.05$). The frequency of locomotive problems during the fattening period was 2.51% (828/33,000) for the Cobb strain and 1.75% (578/33,000) for the Ross strain. The most common individual lesions were osteochondrosis (38.61%) and inflamed joints with purulent contents (37.13%), followed by valgus (19.65%), chondrodystrophy (4.30%) and rotation of the tibia (0.30%). However, injuries more often occurred jointly, as shown in Table 1.

Locomotive problems appeared in the first week of fattening and augmented progressively as the birds gained weight, especially from the fourth week, in which the appearance of lesions increased notably, which coincides with chickens take off in weight gaining. In the fifth week, the number of cases due to swollen joints with purulent content and osteochondrosis in the Cobb strain exceeded by far the number of cases occurring in the Ross strain. Only in the sixth week did the Cobb strain surpass the Ross in a number of cases. However, when considering the overall period, the Cobb strain had more locomotive problems than the Ross strain. Seventy-three percent of the problems occurred in the last three weeks.

In general, in the Cobb strain, locomotive problems more often occurred in males than in females (65.58% vs 34.42%, $p < 0.05$), except in the cases of chondrodystrophy, osteochondrosis, and chondrodystrophy and osteochondrosis, in which the frequency in females was greater. In the case of the Ross strain, males had more locomotive problems than females (64.71% vs. 35.29%, $p < 0.05$). Only for osteochondrosis, the frequency in females exceeded that of males.

Table 2 shows that most cases of locomotive problems occurred in males of the Cobb strain (543, 38.62%), followed by males of the Ross strain (374, 26.6%). In turn, females of the Cobb strain (285, 20.27%) were more affected than females of the Ross strain (204, 14.51%). Although weight and economic losses occurred during the first two weeks, they were negligible, but mounted gradually as the time passed by, but always being greater for Cobb strain birds.

Table 1. Locomotive problems identified by broiler strain per week of fattening in a commercial farm in San Antonio, Mexico.

Week	1		2		3		4		5		6		7		Tot	%
Locomotive problem/ line*	C	R	C	R	C	R	C	R	C	R	C	R	C	R		
Inflamed joints with purulent content, osteochondrosis	1	1			6	5	17	14	82	38	123	54	63	62	466	34.40
Inflamed joints with purulent contents	10		8	7	15	4	15	13	29	32	28	25	14	11	211	14.90
Osteochondrosis	1	1	6	3	3	3	1	3	18	17	27	16	22	50	171	12.53
Osteochondrosis and valgus		1	1	1	6	1	7	4	13	10	12	7	33	42	138	10.16
Valgus	5	3	4	6	7	7	8	7	15	6	19	13	22	15	137	9.56
Inflamed joints with purulent content, valgus, osteochondrosis				1	1	1	13	12	9	6	10	4	23	19	99	7.34
Inflamed joints with purulent contents and valgus		1	3	1	6	5	20	8	7	13	5	1	3	5	78	5.71
Chondrodystrophy	28	4	32	6	6		3	2	2	1	1				85	3.93
Chondrodystrophy and osteochondrosis			6	1	3	2			2						14	1.04
Rotation of the tibia		1		1			1		2		1			1	7	0.44
Total	45	12	60	27	53	28	85	63	179	123	226	120	180	205	1406	100

*C=Cobb, R= Ross

Table 2. Weekly cases of locomotive problems identified by broiler strain and sex, and associated weight lost in a commercial farm in San Antonio, Mexico.

		Cobb			Ross		Cobb	Ross
Week	Male	Female	Total	Male	Female	Total	Weight Lost, kg	
1	22	23	45	8	4	12	-	-
2	23	37	60	16	1	17	-	-
3	23	30	53	14	14	28	24.21 a	14.8 a
4	57	28	85	42	21	63	84.17 a	60.13 b
5	132	47	179	89	34	123	250.5a	163.34 b
6	167	59	226	73	47	120	383.66a	211.07 b
7	119	61	180	132	73	205	381.05a	449.11 a
Total	543	285	828	374	194	568	1,123.59a	898.45 b

Different literal per row indicates statistically significant difference ($P < 0.05$).

Given that chickens of the Ross strain achieved a higher production per house of 33,000 birds, as well as lower losses caused by locomotion problems, this condition had a greater economic impact on the Cobb strain (Table 3).

Table 3. Economic impact of locomotive problems identified by broiler strain in a commercial farm in San Antonio, Mexico (in USD).

Variable	Cobb	Ross
Production by pen, kg	91677.28	92344
Gross income by pen, $USD	75784.69	75328.59
Losses due to locomotion problems, kg	1,123.59	898.45
Economic losses due to locomotion problems, $USD	916.55	315.11
Proportion of economic losses due to locomotion problems, %	1.23	0.42

4. Discussion

According to Almeida Paz (2008), locomotive disturbances affect around 6% of the animals in commercial lots [8]. In a study encompassing broiler flocks of the five major UK producers, Knowles et al. (2008) found that at a mean age of 40 days, over 27.6% of birds showed poor locomotion and 3.3% were almost unable to walk [5]. Webster et al. (2013), in a nation-wide study in new Zealand, used the 6 point (0-5) gait scoring method and determined a percentage of birds with gait score 3-5 of 30.3 ± 6.77% [9]. In a review, Hartcher and Lum (2020) declared that the prevalence of birds with moderate to severe gait impairment is between 5.5 and 48.8% [10]. The current study found that the average frequency of locomotive problems was 2.13%, ranging from 1.75% in the Ross strain to 2.51% in the Cobb strain, all well below international previous reports.

Fernandes et al. (2012) pointed out that together, femoral degeneration, tibial dyschondroplasia, and angulation deviations are the main diseases associated with lameness in broiler chickens; in addition, they may or may not occur in association [11]. A study in 28 broiler flocks of chicks reared in conventional production systems in Denmark, reported as the main problems tibial dyschondroplasia, varus/valgus deformations, crooked toes, foot pad burns, and asymmetrical development of the tarsometatarsus [12]. Vitamins D, A, C, K and B, as well as calcium and phosphorus and the relationship between them are essential to bone development [13]. The deficiency or imbalance of vitamins and minerals are associated with rickets and tibial dyschondroplasia [14]. Also, insufficient intake of vitamin D leads to increased incidence of rickets and tibial dyschondroplasia [15]. The tibial dyschondroplasia is one of the most common problems of the legs, being clinically detectable in animals older than 35 days old [16]

The risks of the occurrence of leg problems are significantly influenced by body weight and sex of the chicks [12]. According to Sorensen et al. (2000), locomotion disorders are relatively less important at 28 days than later [17] also, light broilers had significantly better footpad dermatitis and gait score than heavier broilers [18]. Hence, one of the main factors responsible of leg problems in broilers is their fast growth rate which results in a high prevalence in conventional production systems and compromises the welfare of the birds [12]. In the current study, males of the Cobb strain showed more locomotion disorders than males of the Ross strain. Sterling et al. demonstrated that Cobb broilers have better growth rate with a better feed conversion ratio than the Ross strain [19]. The Cobb strain chickens acquire a great weight quickly, allowing sacrifice at a very early age; they are voracious, have a good muscular conformation especially in breast, show a nervous temperament, and are very susceptible to high temperatures. Ross broilers also have very fast growth, exceptional feed conversion and high meat yield; these chickens have been selected for their vigor, strong legs, and powerful cardiovascular system. Stringhini et al. (2003) evaluated the performance and carcass characteristics of different broiler strains in São Salvador, Goiás, Brazil. Male broilers had better productive parameters and heavier body and carcass weight than females, but there were no differences in commercial parts yield and carcass characteristics among Ross, Lohmann y Arbor Acres strains [20]. In a study that evaluated the performance of broiler strains (Cobb 500, Ross 308, and Hubbard Flex) in hot weather, the Cobb and Ross strains showed at 49 days old the best breast yield, with the Hubbard strain having the greatest drumstick yield. Regardless of strain, the males showed superior performance to that of females [21]. Total body weight of Cobb-500 and Ross-308 on the first week was 207.40±14 gram and 196.00±16 gram respectively, a significant difference of weight gain ($P<0.05$) [22]. From the previous exposure, it is evident that the appearance of locomotion injuries is exacerbated with higher growth rates. Since Cobb chickens have a higher growth rate than Ross and their body weight is higher by the end of the fattening, then the risk of locomotion problems is increased.

Arguably, reduced growth and culling of lame birds affects farm profitability impacting production costs [23]. Poor performance is a consequence since these animals cannot feed and drink correctly [24]. Also, injured carcasses condemnation in slaughterhouses is increased [25]. In fact, condemnation at *postmortem* inspection has been associated with increasing gait [26]. The current study found low economic losses due to locomotion problems in poultry probably as a consequence of the relatively small proportion of affected animals.

Over the past 60 years, the genetic selection of broilers has focused on production traits such as growth rate and feed efficiency. Advances in nutrition and genetics led to an increase in body growth and meat deposition rate of broiler chickens causing metabolic disturbances that damaged the production system [27]. This has led to significant problems in birds such as leg disorders and cardiovascular diseases [28]. Locomotion disorders, commonly known as deformities or locomotion problems, may occur because of changes in bone and cartilaginous growth plate [29]. The prevalence of locomotion disorders and the weakness of the bones in broiler chickens have become a big concern, as they have an important impact in the audits of animal welfare, as well as on the physical and microbiological quality of the carcasses [23,28].

Nowadays, broiler rearing system is a crucial factor affecting birds comfort, welfare, health, and production efficiency [30]. Locomotion disorders are due to multiple contributing factors such as age [31], breed and strain[32], stocking density and growth rate[33], bedding material and quality [34], air quality[35], housing type [36,37], poor temperature control in incubation room or very smooth hatch trays [38], problems in transporting the chicks to the farms and stress due to climatic variations (especially heat stress) [39], poor nutrition of the breeders (minerals, vitamins and calcium) and severe feed restriction in certain phases of life [40]. Not many therapies have been tried for this problem, but increasing levels of glucosamine sulfate supplementation in the diet increased the weight gain of age broilers [41].

5. Conclusions

In a commercial broiler farm in Veracruz, Mexico an overall prevalence of 2.13% for locomotive problems was found in a population of 66,000 birds. Cobb strain chickens were more affected than Ross strain birds, as were males more than the females. Osteochondrosis, inflamed joints with purulent contents, and valgus accounted for more of 95% of the cases. Locomotive problems occurred since the first week and increased as birds gained weight, particularly from the fourth week on. Economic loss due to locomotion problems was higher for the Cobb strain, but in average accounted for 0.83 % of the gross income. Even though locomotion problems do not seem to be a big issue, it is convenient to explore venues for prevention and treatment of this condition.

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Conflict of Interest

No potential conflict of interest was reported by the authors.

Authors' Contributions

This work was carried out in collaboration among all authors. B.L. Guevara-Torres carried out the research on the field, collected the samples, and wrote the first draft of the paper. L.A. Landin-Grandvallet and A. Tirado-Madrid designed and supervised the study. J.A. Villagómez-Cortés managed the literature search, performed the statistical analysis, and wrote the manuscript´s English version. All authors reviewed and approved the final version of the paper.

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