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Coccidiosis Prevalence and Correlation with Intestinal Health of Broilers in Brazilian Agricultural Industries Between the Years 2012 and 2014

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Abstract: The aim of this study was to assess the correlation between lesions caused by *Eimeria* and the prevalence of clinical and subclinical coccidiosis and other gastrointestinal disorders among broilers reared in Brazil from 2012 to 2014. Intestinal health was evaluated in 5,528 broilers from 82 poultry houses in Brazil in two phases: 1 (12 to 21 days) and 2 (22 to 40 days). Intestinal aspects, lesion scoring and oocyst count of *E. maxima* in the intestinal mucosa were analyzed. *E. acervulina* was the most prevalent (mean of 13.5%) species in both rearing phases followed by *E. maxima* (6.75%) and *E. tenella* (4.35%). There was a positive correlation of *E. acervulina* ($p = 0.05$) with thin intestinal walls and abnormal intestinal tonus in phases 1 and 2, as well as with ingestion of contaminated litter in phase 2. *E. maxima* showed a positive correlation ($p = 0.05$) with excess mucus, thickening or thinning of the intestinal walls in phase 1 and cell desquamation, excess fluid and Turkish towel appearance in phase 2. *E. tenella* showed a positive correlation ($p = 0.05$) with excess fluid in phases 1 and 2 and with thickening of the intestinal walls and lesions caused by *E. maxima* in phase 2. The microscopic detection of *E. maxima* (mean of 23.8%) was correlated ($p = 0.05$) with factors that negatively affect intestinal health. Subclinical coccidiosis affected 64.45% more broilers in phase 2 than in phase 1.

Key words: Broiler, coccidiosis, *Eimeria*, gastrointestinal tract, poultry farming

INTRODUCTION

The birds gut integrity is fundamental, since the mechanisms of digestion and absorption are inherent in the physiological metabolism of the gastrointestinal tract (TGI) of the bird and cannot be manipulated (Maiorka, 2005). Numerous infectious and non-infectious agents can damage intestinal mucosa, as well as compromising digestion and absorption processes (Ito *et al*., 2004).

Maintaining the integrity of the intestinal mucosa under normal physiological conditions has a high energy cost. In practice, this results in high feed conversion, given that part of ingested nutrients are intended to metabolic processes involved with the repair of the intestinal mucosa, thus providing a lower absorption efficiency (Maiorka, 2005).

Coccidiosis is one of the diseases with great economic impact on the poultry sector. Its manifestation forms are clinical or sub-clinical infection, causing decrease in productive performance with less weight gain, increased feed conversion, as well as an increase in flock mortality (Meireles, 2009).

Laboratory diagnosis of coccidiosis requires the identification of the species involved and quantification of intensity of their infection by assessing the morphology, oocysts count in feces, location of the parasites in the gut of poultry, intensity of macroscopic lesions, prepatent period and oocysts sporulation time (Long and Reid, 1982).

Coccidiosis is routinely diagnosed by assessing macroscopic lesions in the intestine of broilers. *Eimeria acerulina*, *Eimeria maxima* and *Eimeria tenella*, are the species with occurrences monitored on a regular basis. The macroscopic diagnosis has probably been effective in helping the coccidiosis control programs conducted by the poultry industry (Costa and Paiva, 2009).

The prevalence of coccidiosis in an integration of broilers, located in the northwest of the state of Parana in 2012, was higher for *E. maxima*, followed by *E. acervulina*, having *E. tenella* with the lower prevalence (Amaral and Otutumi, 2013).

This study aimed to analyze the correlation of lesions caused by *Eimeria* with the other changes found in the gastrointestinal tract of broilers and the prevalence of coccidiosis in two production phases (1st 12-21 days old and 2nd 22-40 days old) in Brazil between the years 2012 and 2014.

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MATERIALS AND METHODS

In this study, the intestinal health monitoring was held in 82 broiler integration businesses in Brazil, in the states of: Rio Grande do Sul, Santa Catarina, Parana, Mato Grosso do Sul, Sao Paulo, Minas Gerais, Rio de Janeiro, Goias, Alagoas, Para, Paraiba, Pernambuco and Distrito Federal during the period 2012-2014.

The data were posted in the Intestinal Health Program (PSI) of Vetanco of Brazil, in order to obtain the percentage of affected birds and their ratings according to lesion scores. The analyzed data were divided into two stages of production, the 1st phase from 12 to 21 days old and the 2nd phase from 22 to 40 days old birds.

Therefore, this study was observational. The evaluated broiler chickens were fed diets prepared by their respective integrated companies without any interference of the appraiser in the formulation and use of performance enhancers and anticoccidial drugs.

The most common anticoccidial program is the dual system, which uses a drug in the first phase (1 to 21st day of age) and another one in the second phase (22nd day until product withdrawal limit). This program reduces the possibility of parasite resistance, a fact that extends the time that the drug will be efficacious in the field (Revolledo and Ferreira, 2005) and ensures more effective anticoccidial programs. In order to monitor the intestinal health of broilers, at least three birds per flock were evaluated. The birds were collected randomly inside the house at three different points (entry, middle and end).

In the intestinal analysis, the following lesions were observed: presence of cell desquamation, excess fluid, excess mucus, ingestion of contaminated litter, thickening or thinning of the intestinal walls, Turkish towel appearance and necrotic enteritis. Injuries caused by *Eimeria acervulina*, *Eimeria maxima* and *Eimeria tenella* were scored according to their degree of intensity, as specified by the Johnson and Reid's method (1970), where the zero score indicates the absence of lesions and four indicates severe injury.

For microscopic assessment *E. maxima*, the scraped intestinal mucosa technique for oocysts count was used, which were performed at the bowel portion next to Meckel's diverticulum. Costa and Paiva (2009) describe that the highest concentration of *E. maxima* is found in the jejunum and Meckel's diverticulum, but can occur in the duodenum and at the end of the ileum. The content of the regions was smeared on the microscope slide and after that the cover slip is placed over the content by pressing it gently. These slides were subjected to visual evaluation under the microscope at 100X magnification for oocyst count in five different points (the four corners and center). The microscopic scores were ranked from zero to four, where zero is the absence of oocysts, score 1: 1-10 oocysts, score 2: 11-20 oocysts, score 3: 21-40 oocysts and score 4: above 41 oocysts (Vetanco do Brasil, 2011).

Data were analyzed using the Pearson correlation coefficient (SAS, 2011), with a 95% confidence interval.

RESULTS

According to the macroscopic analysis of lesions shown in Fig. 1, *Eimeria acervulina* incidence was the highest among the species of *Eimeria* evaluated in both production phases. In phase 1, *E. acervulina* lesions were found in 10.8% of necropsied chickens, presenting positive correlation ($p = 0.05$) with thin intestinal walls and abnormal intestinal tonus. In phase 2, *E. acervulina*, occurred in 16.2% of the birds, with a positive correlation with ingestion of contaminated litter, thin intestinal walls and abnormal intestinal tonus findings (Table 1).

E. maxima had the second highest incidence in the birds evaluated. In phase 1, this coccidia was present in 4.7% of birds, showing a positive correlation with excess mucus, thickening intestine and thin intestinal walls (Fig. 1). There was an increase in the prevalence of injuries caused by this species in the 2nd phase, when it affected 8.8% of the birds and was positively correlated ($p = 0.05$) with cell desquamation, excess fluid and the Turkish towel appearance (Table 1).

E. tenella was the species that had the lowest prevalence in phase 1 and phase 2 (3.2 and 5.5%, respectively) (Fig. 1). A positive correlation ($p = 0.05$) was observed between the occurrence of injuries caused by *E. tenella* in 1st and 2nd phase with excess fluid and the 2nd phase with thickening of the intestinal walls and the occurrence of *E. maxima* macroscopic lesions (Table 1).

In the microscopic evaluation, *E. maxima* was present in 18% of mucosal scrapings evaluated in phase 1, which represented a subclinical coccidiosis of 282.98% with respect to clinical coccidiosis (gross lesions of *E. maxima*). There was a positive correlation between occurrence of *E. maxima* micro and thickening of the intestinal walls findings and with the occurrence of *E. maxima* macroscopic lesions. In phase 2, there was a significant increase in the occurrence, (29.6%) of the assessed mucosal scrapings showed oocysts of *E. maxima*. This prevalence represented a subclinical coccidiosis of 236.37% in relation to clinical coccidiosis. On the other hand, there was a positive correlation of the *occurrence* of *E. maxima* in the intestinal mucosa with excess fluid, necrotic enteritis, *E. acervulina*, *E. maxima* and *E. tenella*. The data showed an increase of occurrence of subclinical coccidiosis conditions along the birds' lifespan, when there was a 64.45% growth in number of affected birds in the second phase measured in relation to the first one.

Figure 2 demonstrates that macroscopic lesion score 1+ was the most founded in both 1st and 2nd phases of production for all birds evaluated. While the most severe lesion score (4+) was present in a very small number of birds in the macroscopic evaluation. However, to *E. maxima* in the intestinal mucosa the

Table 1: Positive statistical correlation (p = 0.05) of broilers affected by the factors that decrease intestinal health in relation to *Eimeria* in 1st and 2nd phase from 2012 to 2014 in Brazil[1]

	Cellular desquamation	Fluid excess	Mucus excess	Bedding intake	Thick intestine	Thin intestine	Altered intestinal tonus	Turkish towel appearance	Necrotic enteritis	*Eimeria acervulina*	*Eimeria maxima*	*Eimeria tenella*
E. acervulina				2nd phase		1st and 2nd phase	1st and 2nd phase					
E. maxima	2nd phase	2nd phase	1st phase		1st phase	1st phase		2nd phase				
E. tenella		1st and 2nd phase			2nd phase						2nd phase	
E. maxima micro[2]		2nd phase			1st phase				2nd phase	2nd phase	1st and 2nd phase	2nd phase

[1]1st phase (12 to 21 days of age) and 2nd phase (22 to 40 days of age). [2]Microscopic assessment of *E. maxima* in the intestinal mucosa

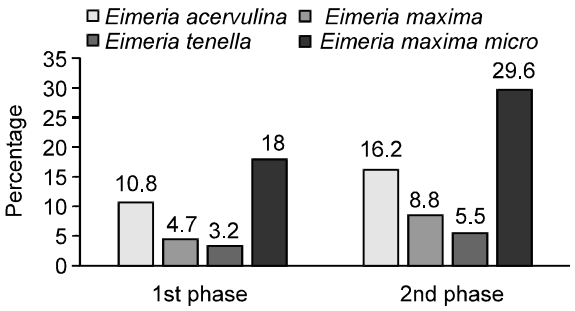

Fig. 1: Percentage of *Eimeria* in 1st and 2nd broiler production phases, in Brazil, in the 2012-2014 period

score 4+ was present in a considerable number of birds, 14.9 and 16.6% in the 1st and 2nd phases, respectively. This represents a significant number of oocysts present in the intestinal mucosa. Once eliminated in the bedding, these oocysts promote poultry recontamination and, therefore, a higher chance to spread to other birds in the flock. Having a large numbers of oocysts in bedding leads to a greater chance of coccidiosis occurrence in its clinical form.

DISCUSSION

The prevalence of *E. acervulina* (mean 13.5%) meets Gazoni's (2011) report, which described this species as the most prevalent among the *Eimeria*, present in 14.59% of birds aged 12-48 days in the period May 2010 to April 2011. However, Amaral and Otutumi (2013) evaluated 960 broilers coming from 80 batches throughout the year 2012 by means of lesion scores described by Johnson and Reid (1970) and found an average prevalence of only 8.21% for *E. acervulina*.

Gazoni (2011) reported an average prevalence of 5.12% for *E. maxima*. Nonetheless, Amaral and Otutumi (2013) reported 8.52%. The results of Amaral and Otutumi (2013) to *E. maxima* are above those reported in this paper (mean 6.75%) and the one described by Gazoni (2011).

The average occurrence of *E. tenella* obtained by Gazoni (2011) was 11.47%. Whereas Amaral and Otutumi (2013) claim that *E. tenella* presented lesion in 2.42% of the birds. The result described by Gazoni (2011) to *E. tenella* is well above the one found in this study (mean 4.35%) and the one found by Amaral and Otutumi (2013). This difference can be explained by the different general disturbances in the gut as disbacterioses, viruses and mycotoxicoses in each evaluation.

Due to a lack of maturity of their immune system, young animals are the most susceptible to clinical infections that often occurs in asymptomatic adult animals who spread the parasite. However, severe outbreaks can occur in adult birds, as demonstrated in this study, showing that in the second phase there was a higher percentage of birds affected by the described *Eimeria*. The route of infection is fecal-oral and sporulated oocyst

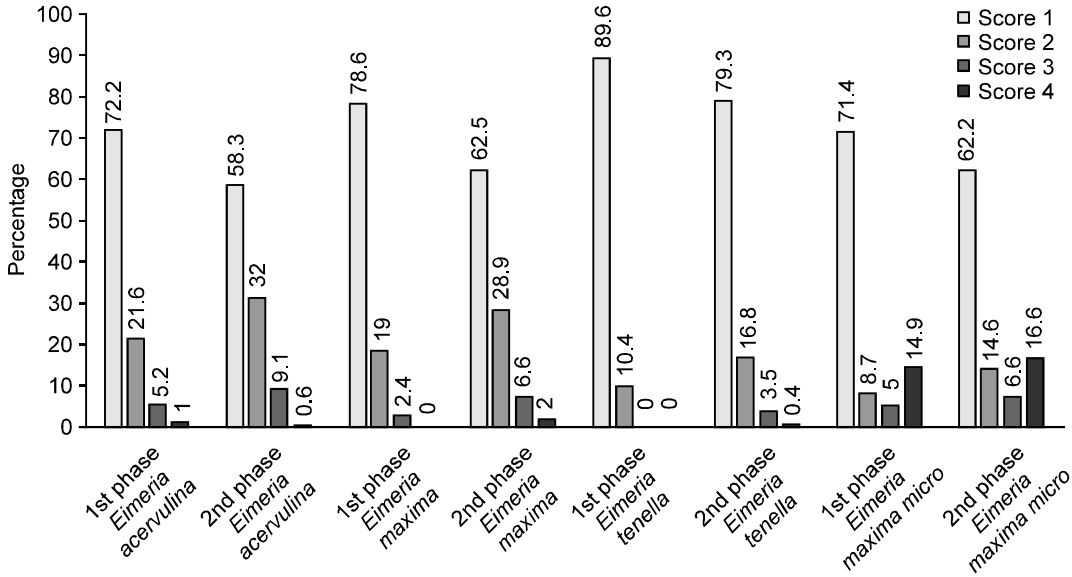

Fig. 2: Percentage of *Eimeria* scores in 1st and 2nd broiler production phases, in Brazil, in the 2012-2014 period

is the infective form. For the oocysts to sporulate, moderate temperature (between 18 to 30°C), relative humidity greater than 70% and well oxigenated ambient are required. The average time of sporulation is about 17 h for *E. acervulina*, 18 h for *E. tenella* and 30 h for *E. maxima* (Long and Reid, 1982).

By taking into account the *E. maxima* micro scores with an average prevalence of 23.8%, according to Ito *et al.* (2004) the intestinal scraping is the most suitable for subclinical coccidiosis detection (Fig. 2). The study done by Teeter (2008) evaluated the impact of coccidiosis challenge in poultry on its growth curve. In Teeter's study (2008), it was observed that for each point of increase in microscopic evaluation of coccidiosis lesions, daily body weight dropped 1.5% during the challenge period of 6 days. Therefore, it is important to know the degree of lesion to quantify the performance loss in the birds.

The economic importance of coccidiosis goes far beyond mortality, it is mainly related to subclinical losses of asymptomatic animals, which keep environmental contamination through oocysts elimination in their feces. Birds that did not exhibit clinical disease can also become uneconomical due to the malabsorption syndrome (Maiorka, 2005). Therefore, it is important to monitor the gut health of the birds performing the autopsy and mucosal scrapings to provide an early diagnosis of coccidiosis. This way, situations where anticoccidial programs are inefficient can be detected and preventive or therapeutic measures can be taken using coccidiocide drugs via drinking water (Kawazoe, 2009).

Conclusion: The subclinical coccidiosis was very common in the broilers evaluated in this study (mean 23.8%). It is one of the likely factors that cause a reduction in growth performance of broiler flocks in Brazil. It showed positive statistical correlation with the thick intestine, excess fluid, necrotic enteritis and *Eimeria acervulina*, *Eimeria maxima* and *Eimeria tenella*. *E. acervulina* was the most prevalent species in both phases of production analyzed (1st phase 12 to 21 days old and 2nd phase 22 to 40 days old), affecting on average 13.5% of broilers. This species had statistical correlation with ingestion of contaminated litter, thin intestine and abnormal intestinal tonus. *E. maxima* has statistical correlation with excess mucus, thin intestine, thick intestine, cell desquamation, excess fluid and Turkish towel. *E. tenella* demonstrates statistical correlation with excess fluid, thick intestine and *E. maxima*. The injury score grade 1+ was the most frequent in both the first and the second production phases for all *Eimeria*. An increase in the degree of lesion scores of phase 1 to phase 2 was found enhancing the importance of intestinal health monitoring, especially in the first evaluated production phase (12 to 21 days of age) for controlling the deleterious effects. Therefore, with the results it is clear and evident that professionals in the poultry area should routinely perform monitoring, which can increasingly contribute to more assertive decisions in preventive and/or therapeutic treatments focusing on maintaining the productive performance of broilers and aiming to optimize the poultry production system.

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