Epidemiological factors associated to bovine coccidiosis in calves (Bos indicus) in a subhumid tropical climate.

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SUMMARY.

Objectives. To identify some of the factors associated with bovine coccidiosis in calves (Bos indicus) in a subhumid tropical climate and to identify the species of Eimeria present in the animals.

Material and Method. The state of Yucatan, Mexico was divided into three zones according to annual rainfall records. In each zone two small herds (<100 animals) and two large herds (>200 animals) were selected. Faecal samples were taken from two hundred calves (Bos indicus) six times in one year (1200 faecal samples). Samples were tested by McMaster and flotation techniques. Samples positive to Eimeria oocysts were cultured in potassium dichromate.

Results. Eimeria oocysts were found in 87.8% of the samples (1054/1200). A high prevalence was associated with the high rainfall zone (OR= 1.93; 1.16 to 3.20 CI 95%), with large herd-size (OR= 1.83; 1.27 to 2.63 CI 95%) and with rainy season (OR= 3.34; 2.03 to 5.56 CI 95%). Oocyst excretion was positively affected by large herd-size and rainy season. Nine species of Eimeria were identified. The most frequent species were E. bovis (26.4%), E. auburnensis (16.2%), E. ellipsoidalis (14.7%), E. canadensis (12.1%) and E. zuernii (10.6%).

Conclusions. In the subhumid tropical climate, the environment and some farm management are important factors in the presentation of bovine coccidiosis in calves.

Key words: Calves, Eimeria, Bos indicus, tropical diseases.

RESUMEN.

Factores epidemiológicos asociados a la coccidiosis bovina en becerros (Bos indicus) de clima tropical subhúmedo.
Objetivos. Identificar algunos factores de riesgo asociados a la coccidiosis en becerros (Bos indicus) en clima tropical subhúmedo, e identificar las especies de Eimeria presente en los animales.

Material y métodos. El estado de Yucatán México fue dividido en tres zonas de acuerdo a la precipitación pluvial anual registrada en los últimos años. En cada zona se seleccionaron dos ranchos chicos (<100 animales) y dos ranchos grandes (>200 animales). Un total de 200 becerros (Bos indicus) fueron muestreados de heces fecales 6 veces durante un año (1200 muestras fecales). La muestras fueron procesadas mediante las técnicas de McMaster y flotación centrifugada. Las muestras positivas a ooquistes de Eimeria fueron transferidas a cultivo de dicromato de potasio.

Resultados. Ooquistes de Eimeria fueron encontradas en el 87.8% de las muestras (1054/1200). La zona de alta precipitación pluvial (OR= 1.93; 1.16 a 3.20 IC 95%), los ranchos grandes (OR= 1.83; 1.27 a 2.63 IC 95%) y el período de lluvias (OR= 3.34; 2.03 a 5.56 IC 95%) fueron asociados con altas prevalencias. La excreción de huevecillos por gramo de heces fue mayor en ranchos grandes y en el período de lluvias. Se encontraron 9 especies de Eimeria, siendo las más frecuentes E. bovis (26.4%), E. auburnensis (16.2%), E. ellipsoidalis (14.7%), E. canadensis (12.1%) y E. zuernii (10.6%).

Conclusiones. La condición ambiental y el manejo de los ranchos son factores importantes en la presentación de la coccidiosis bovina en becerros explotados en clima tropical subhúmedo.

Palabras clave: Bovino, coccidiosis, Eimeria, Enfermedades tropicales.

INTRODUCTION.

In the tropics, cattle are affected by several gastrointestinal parasites including nematodes, cestodes and protozoa (1). The genus Eimeria is one of the most important gastrointestinal protozoa affecting the productivity of cattle (2). These parasites produce a contagious enteritis with a high rate of subclinical infection or there may be diarrhea and dysentery. In some cases there is anemia and the chronic form of the disease is characterized by inferior growth rates (1,2). Some of the species of Eimeria which cause pathological damage in cattle are E. bovis, E. zuernii, E. ellipsoidalis and E. auburnensis (3,4,5,6,7).

Climatic factors, age of the host, as well as management determine the pattern of presentation of coccidiosis in different regions (1). The incidence increases where the calves are brought together for weaning, or moved into confinement fattening units, or fed in small areas for the winter months. Faecal contamination of feed and water are important for the transmission of the infection (8). Stress will precipitate clinical disease in previously infected animals (9).

In the state of Yucatan, Mexico, there are suitable environmental conditions for the sporulation and survival of coccidia oocysts. However, there is little information on the occurrence and risk factors associated with bovine coccidiosis. The objectives of this study were: 1) determine prevalence, 2) identify some of the factors associated, 3) the dynamic of coccidia oocyst excretion in calves in a subhumid tropical climate and 4) identify the species of Eimeria present in these animals.

MATERIAL AND METHODS.

This trial was carried out in the state of Yucatan (south-east), Mexico. The state has a subhumid tropical climate with a summer rainy season. The monthly maximum temperature varies from 35°C to 40°C and the mean temperature is 26.6°C. The relative humidity (RH) varies from 65 to 100% (mean RH is 80%). The annual rainfall varies from 415 mm to 1290 mm depending on the area. There are two different seasons: rainy and dry (10).

This study was carried out from June 1992 to May 1993. The state of Yucatan was classified in three zones according to the average rainfall
Bovine coccidiosis in calves.

during past five years: a) low rainfall (less than 500 mm), b) medium rainfall (from 501 to 1000 mm) and c) high rainfall (more than 1000 mm).

Four cattle ranches were selected in each of the three rainfall zones. Each ranch had similar features as follows: 1) breeders, 2) semi-intensive management system, 3) Bos indicus cattle, and 4) animal population from 50 to 300 cattle.

In each rainfall zone, two small herds (from 50 to 100 cattle) and two large herds (200 to 300 cattle) were selected.

Fifteen to twenty 7-months old male calves were selected in each ranch. Each identified by ear tattoo and ear tags in order to easily find the animals in future samplings. The selected calves were not separated from the rest of the herd. All animals were grazed in Guinea grass (Panicum maximum) and confined during the day in a handling pen where they were offered water and a mineral mix ad libitum. In all of the ranches, the calves grazed with their dams. None of the calves on the ranch received anthelmintic treatment or coccidiostat during the trial.

The selected calves in each ranch were sampled six times (every two months) for a period of 12 months (200 animals sampled in all ranches). Fifty g of faecal material was collected per rectum in a plastic bag. Samples were individually identified. Faecal samples were tested by egg count (McMaster technique) and flotation technique (11). Positive samples to Eimeria oocysts with more than 500 oocysts per gram (OPG) were mixed in 2% (w/v) aqueous potassium dichromate solution and incubated at room temperature for a week (11). A strict morphological criterion was used to identify the Eimeria oocyst present: size, shape, colour, wall thickness and presence or absence of the micropyle (9,11).

During the trial, rainfall, RH and ambient temperature information was obtained from the nearest meteorological centres in each of the three zones.

Prevalence was calculated by rainfall zone, season and herd-size strata (12). Xi² and Odds Ratio (95% confidence interval) were calculated in order to determine the association between the prevalence of Eimeria sp oocysts and rainfall zone, season and herd size (13). A P value ≤ 0.05 was required for significance. The effect of season was examined by dividing the year into the two seasons (June-January and February-May). For rainfall zone, the low rainfall zone was chosen as the referent. To examine the effect of herd-size, small herd-size was used as the referent and in the case of season, dry season was used.

A fixed effects linear model analysis was used in order to determine the variables that are significant to the excretion of Eimeria sp oocyst per gram of faeces (OPG). The model included the rainfall zones (low, medium and high), herd-size (small and large) and season of sampling (dry and rainy) as independent variables and also included first level interactions. The dependent variable was the excretion of Eimeria sp OPG of faeces (14).

A Spearman correlation coefficient was calculated in order to evaluate the relationship between excretion of Eimeria sp OPG of faeces and rainfall recorded during the study (15).

RESULTS.

RH of the three zones studied presented a variation from 65% to 85%. Levels lower than 75% were found in February and May (dry season). Mean monthly ambient temperature showed a variation from 21°C to 30°C. Higher ambient temperatures (28.6°C to 30°C) were observed in April and May. Annual rainfall registered in the studied areas was 1009 mm, 822 mm and 627 mm for the high, medium and low rainfall zones respectively.

In figure 1, average rainfall of the three zones is shown. Rainy season was observed from June until January and dry season was observed from February until May.

During the study period, 1200 samples were collected from the 200 calves. 1054 samples were positive to Eimeria sp oocyst and 146 were...
There was no significant difference between medium and low rainfall areas (84.4% vs. 85.3%). Prevalence was significantly higher in large herds than in small herds (90.63% vs. 84.13%; P<0.001). Prevalence was significantly higher in the rainy

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of Samples</th>
<th>No. of positive samples (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>P</th>
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<td><strong>Zone</strong></td>
<td></td>
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<tr>
<td>Low</td>
<td>289</td>
<td>85.3</td>
<td>1</td>
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<tr>
<td>Medium</td>
<td>456</td>
<td>84.4</td>
<td>0.87</td>
<td>0.56 to 1.35</td>
<td>N.S.</td>
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<tr>
<td>High</td>
<td>455</td>
<td>92.3</td>
<td>1.93</td>
<td>1.16 to 3.20</td>
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<td><strong>Herd-size</strong></td>
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<td>Small</td>
<td>516</td>
<td>84.13</td>
<td>1</td>
<td></td>
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<tr>
<td>Large</td>
<td>684</td>
<td>90.63</td>
<td>1.83</td>
<td>1.27 to 2.63</td>
<td>&lt;0.001</td>
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<tr>
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<tr>
<td>Dry</td>
<td>800</td>
<td>84.37</td>
<td>1</td>
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<tr>
<td>Rainy</td>
<td>400</td>
<td>94.75</td>
<td>3.34</td>
<td>2.03 to 5.56</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

OR=Odds Ratio; CI=Confidence Interval; P=Probability (by x² test)
N.S.= Non significant.

Revista Biomédica
season than in the dry season (84.37% vs. 94.75%; P<0.001). Odds ratio of the studied factors are shown in table 1.

Excretion of *Eimeria* sp OPG of faeces of all calves per sampling period is shown in figure 2. The linear model analysis (r²=0.537; P<0.001) showed no significant effect of the three rainfall zones in the excretion of *Eimeria* sp OPG of faeces (P>0.05). However, there was a significant effect of season (P<0.007) and herd-size (P<0.005) on the excretion of *Eimeria* sp OPG of faeces. No interaction was found to be significant. Excretion of *Eimeria* sp OPG of faeces (median) by season were 1179 vs. 428 for the rainy and dry seasons respectively. OPG median by herd-size were 832 vs. 656 in the large and small respectively. There was a positive correlation between the excretion of *Eimeria* sp OPG of faeces and rainfall recorded during the study (r²=0.45; P<0.05) (figure 3).

The species of *Eimeria* sp. identified by coproculture, showed that *E. bovis*, *E. auburnensis*, *E. ellipsoidalis*, *E. canadensis* and *E. zuernii* are the most frequent (table 2).

**DISCUSSION.**

The results show that there was a high prevalence (above 84%) in the three rainfall zones. High prevalences are a common feature of coccidiosis in calves (2). The direct life cycle of the parasite favours a constant infection of susceptible animals such as calves (9). However,
prevalence depends on other factors such as climatic conditions (temperature and moisture), age of animals as well as herd management (15,16). Although there were two zones where the rainfall was lower than 1000 mm per year and have four months of dry season, the prevalence of infected animals was above 84% in the three zones studied. This is opposite to the finding of Vassiliades (17) who reported that in places where rainfall was lower than 1000 mm per year and had a well defined dry season, there are no ecological conditions for a high prevalence of bovine coccidiosis. The excretion of *Eimeria* sp OPG of faeces of calves in the three selected rainfall zones were not significant different. This could be related with the fact that the rainfall registered were not the expected, and only there was a difference of 382 mm between the high and low zones during the year.

Rodríguez *et al*. (16) found in tropical climate that bovine coccidiosis is more frequently when the RH is around 75% and temperature between 20°C and 25°C. This could had been an important factor in reducing the excretion of *Eimeria* OPG of faeces (P<0.05) during the dry season when there was less than 50 mm of rainfall per month and RH less than 75%.

Fayer (15) as well as Larsen y Henriksen (18) found that ambient temperatures above 25°C inhibit the process of sporulation of *Eimeria* oocyst. However, Ernst and Benz (19) and Blandino (20) reported that the optimum ambient temperatures for oocyst sporulation are 30°C and 34°C respectively. There is a variety of findings about the ambient temperature that favours the infective phase of *Eimeria* sp. In the state of Yucatan, mean annual temperature varies from 21°C to 30°C, and this could favour the development of the infective phase (sporulated oocysts) in the environment.

The positive correlation between the excretion of *Eimeria* sp OPG and rainfall (independently of the zone) could be explained by the close relation between rain and the RH. In the rainy season RH is higher. High RH together with the ambient temperature found in this area provides the appropriate environment for sporulation in this season (1,2,9,21). As a result, the prevalence of calves positive to oocyst excretion in the rainy season was higher than in the dry season (OR=3.34; 2.03 to 5.56 CI 95%). These results are similar to the seasonal variation of oocyst excretion in cattle reported by Rodríguez *et al*. (16) in Cuba, and Munyua and Ngotho (8) in Kenya both in tropical climates. However, in some regions of Iraq it was determined that the seasonal variation in a year was almost non-existent (22).

In this study a significant effect of herd-size was found to be affecting both prevalence and excretion of *Eimeria* sp OPG of faeces. Calves in large herds were significantly more likely to have *Eimeria*-infection than were calves in small herds (OR=1.83; 1.27 to 2.63 CI 95%). These could be related with the fact that calves of the large herds are in overcrowded conditions during the day time when they are located in the management pen. These animals will be more likely to ingest large numbers of sporulated *Eimeria* oocysts over a short period of time (8). Fayer (15) and Rodríguez (23) reported that overcrowded conditions in the management pen produce an immunodepressive effect that will favour the infection. Also, animals in an overcrowded management pen will facilitate faecal contamination of water and feed troughs (1,9,24). Large herds may have a heavier pathogen burden because they may have allowed less time for pasture or buildings to be empty of animals, which could prevent natural depletion of organisms in the environment and may foster continual accumulation of oocysts in the environment.

Oocyst excretion levels found in this study were higher than those found in other countries (650 OPG vs. < 200 OPG of faeces) (6,7). Munyua and Ngotho (8) found that the incidence of *Eimeria* species appeared to follow an age pattern with young animals showing higher levels of infestation than older animals but this could not be confirmed in this study. Nine species of *Eimeria* were
recognized in the present study. However, the number of species of coccidia that occur in cattle throughout the world is still undecided, although most reviewers accept 19-22 (9,25). The most common species identified were *E. bovis*, *E. zuernii*, *E. ellipsoidalis* and *E. auburnensis*. Kennedy and Kralka (26) and Hasbullah et al. (6) found that these species are the most frequently found in cattle and are the most pathogenic (2,5,6,7,9). Paiz and Villagran (5) and Jubb (27) report that clinical manifestation of bovine coccidiosis are caused by *E. bovis* and *E. zuernii*. However, the mere presence of pathogenic *Eimeria* species does not necessarily indicate clinical disease. In this study the majority of the calves were found to be harboring pathogenic species of coccidia and yet no clinical symptoms were exhibited.

CONCLUSIONS.
Factors affecting the prevalence of *Eimeria* in calves were rainfall zone (high rainfall), herd-size (large herds) and season of the year (rainy). However, the factors affecting the excretion of *Eimeria* sp OPG of faeces were herd-size and season. Nine species of *Eimeria* were identified in faeces of *Bos indicus* growing calves in Yucatan, Mexico.

REFERENCES.
18.- Larsen AB, Henriksen SA. Coccidia and intestinal coccidiomorphs. En: Yvore P, ed. Proceedings of the 5th International Coccidiosis Conference, (Les Colloques de...
218

**RI Rodríguez-Vivas, JL Domínguez-Alpizar, JF Torres-Acosta.**

1. INRA, Versailles, France; INRA Service des Publications 49), 1989: 467-470.


20.- Blandino T. Estudio de las especies de coccidias en el ganado bovino en Cuba. Rev CENIC 1977; 8:115-120.


