

Coccidiosis of Goats in Florida, USA

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ABSTRACT

Fecal samples from 277 goats on eleven farms in Florida were examined to determine the prevalence and intensity of the multiple species of *Eimeria* that infect goats in this region. The number of oocysts per gram of feces (OPG) was determined by the modified McMaster technique. Species identification was done following sporulation. *Eimeria* oocysts were found in 97% of the fecal samples. Goats less than one year of age shed significantly more oocysts than goats greater than one year of age ($P < 0.01$). Goats of the Nubian breed had the highest OPG counts when compared to Boer, Boer-Spanish crosses, and Saanen breeds. Nine *Eimeria* spp. were identified. *Eimeria arloingi* (91%), *E. ninakohlyakimovae* (82%) and *E. alijeve* (79%) were the most prevalent species. Other species present were *E. caprina* (60%), *E. christenseni* (60%), *E. hirci* (46%), *E. caprovina* (29%), *E. aspheronica* (15%), and *E. jolchijevi* (9%).

Keywords: Coccidiosis; *Eimeria* Spp.; Goat; Florida

1. Introduction

Goat production has grown in Florida over the last several decades. The majority of the Florida goat industry is characterized by production systems called ranchettes. The popularity of ranchettes was thought to have developed in response to the growth in Florida's human population combined with some people's desire to live in rural areas while working in urban areas. The goat appeared to be ideal for these small-scale producers because it is easy to handle and can convert limited nutritional resources into meat and milk [1].

Coccidiosis, caused by protozoa of the genus *Eimeria*, is one of the major parasitic diseases influencing the goat industry in many parts of the world including Florida.

The widespread occurrence of coccidiosis in Florida can be attributed to two major factors: favorable climatic conditions and intensive production systems. The warm, moist environment that characterizes the subtropical climate of Florida provide optimal conditions for the sporulation of *Eimeria* oocysts. This results in year-round exposure of goats to infective oocysts [2]. Year-round intensive rearing on improved pastures, which characterizes the production systems of the majority of goat farms in Florida, leads to a greater risk of goats ingesting infective oocysts due to the concentrating effects of confine-

ment [3,4].

The production capabilities of the Florida goat industry is constrained by multiple factors including the effects of gastrointestinal parasite infections. Currently, producers are not able to meet the local demand for goat-derived products that is fueled primarily by large immigrant populations. Additionally, it is difficult for Florida goat producers to compete with the prices of goat-derived products imported from other areas like Texas and Australia because of the ability of producers in those regions to produce goats at a lower cost [2]. As coccidiosis is considered to be one of the most economically important diseases of intensively-reared goats worldwide, information to better manage coccidiosis may help Florida producers to increase animal productivity, lower their production costs and improve their ability to compete with other goat producing regions [5-7]. Therefore, the objective of this study was to determine the prevalence and intensity of infection of *Eimeria* species in goats in Florida.

2. Methods and Materials

Fecal samples were collected individually from the rectum of at least 40% of each herd from eleven farms in Florida between May and July of 2008. The fecal samples were stored no more than 24 hours at 4°C until examined. Two farms produced Boer-Spanish crossbreds

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goats for meat, six farms raised Boer goats for breeder stock and meat, two farms reared Nubians for meat and dairy purposes, and one farm managed a Saanen herd for dairy purposes. Goats examined were categorized into two groups based on age of animal: kids (younger than 1 year) and adults (older than 1 year). The ages of the animals were based on owner records.

The number of oocysts per gram of feces (OPG) was determined by the modified McMaster technique in sodium nitrate solution, with a detection level of 50. To carry out the identification of *Eimeria* species, samples with >1000 OPG were incubated in 3% potassium dichromate and aerated daily for at least one week to allow sporulation to occur. Samples were then concentrated by the Sheather's sugar flotation technique. Oocysts were differentiated on the basis of oocyst and sporocyst morphology according to the descriptions and illustrations given by [8,9]. Measurements were made using an ocular micrometer. The slide was scanned in parallel sweeps and the first 100 oocysts seen were identified. If there were fewer than 100 oocysts in the sample, all were identified.

Statistical analyses on all data were carried out using SigmaStat Statistical Software [10]. The analysis of OPG was done using the analysis of variance (ANOVA) to determine differences among breeds and the t-test to determine differences among age groups after the data was transformed using $\log_e(\text{FEC} + 100)$. The data was log transformed to normalize the data. The Chi-square was used to test the significance of differences among the prevalence found on these farms. Probability of <0.05 was regarded as significant.

3. Results

Oocysts of *Eimeria* spp. were found in 97% of 277 fecal samples of goats. All farms examined had at least one species of *Eimeria* spp. present. The OPG of kids was significantly higher than adult goats ($P < 0.01$) (Table 1).

The proportion of animals infected with at least one species of *Eimeria* spp. was similar among age groups. In adult animals, the Nubian breed had the highest average OPG when compared to the other three breeds (Table 2).

Nine *Eimeria* species were identified in this study (Table 3). *Eimeria arloingi*, *E. ninakohlyakimovae* and *E. alijeivi* were the most prevalent species. *Eimeria caprina*, *E. christenseni*, and *E. hirci* were relatively common species. *Eimeria caprovina*, *E. aspheronica*, and *E. jolchejevi* were the least prevalent species.

Eimeria alijeivi and *E. hirci* infection was significantly more prevalent in adult goats than kids ($P < 0.01$). Mixed infections were encountered in most of the samples, with up to eight *Eimeria* species recovered from individual samples.

Table 1. The number and percentage of goats infected and mean counts of *Eimeria* oocysts per gram (OPG) of goats from Florida.

	Kids (<1 year old) n = 126	Adult (>1 year old) n = 151	All goats n = 277
No. (%) of infected	123 (98)	147 (97)	270 (97)
Mean OPG	13229 ^a	2229	7232

^aSignificantly ($P < 0.05$) different than adult goats.

Table 2. Mean counts of *Eimeria* oocysts per gram (OPG) in adult goats (>1 year) from Florida by breed.

	Boer n = 77	Boer-Spanish n = 47	Nubian n = 20	Saanen n = 7
Mean OPG	2408	844	5420 ^a	443

^aMeans with differing superscripts differ significantly ($P < 0.05$) from each other.

Table 3. The prevalence (in percentages) of *Eimeria* species in goats from Florida.

<i>Eimeria</i> species	Kids (<1-year old) n = 77	Adults (>1-year old) n = 59	All goats n = 136
<i>E. arloingi</i>	92	89	91
<i>E. alijeivi</i>	71 ^a	88	79
<i>E. aspheronica</i>	14	17	15
<i>E. caprina</i>	58	61	60
<i>E. caprovina</i>	34	24	29
<i>E. christenseni</i>	65	54	60
<i>E. hirci</i>	38 ^a	56	46
<i>E. jolchejevi</i>	6	12	9
<i>E. ninakohlyakimovae</i>	82	81	82

^aSignificantly ($P < 0.05$) different than adult goats.

4. Discussion

The high prevalence of *Eimeria* spp. encountered in this study is similar to other studies performed in the United States [11-14]. Infections by multiple *Eimeria* spp. in single animals are also common and tend to characterize the majority of infections exemplified by the multiple infections that have been described in other studies [3, 6,15].

The higher intensity of infection of kids when compared to the adult goats in this study was similar to the findings of previous authors [8,12,16,17]. These findings further the notion that the number of oocysts shed declines as the animal matures. This decline is most likely due to the development of an immunological resistance that is related to host age and exposure to the parasites. The resistance observed in adult goats appears to be relative rather than absolute as adults continue to shed oo-

cysts in the feces, which allow them to act as the major source of infection for young, naive animals. Although clinical coccidiosis is usually observed in young animals that have not acquired resistance, the resistance observed in older animals can be overcome by a severe challenge or an immune system diminished sufficiently by stressful conditions to result in clinical disease [5].

The nine species identified in this study were generally similar to the type and number of species found in other parts of the United States. The same nine species found in this study of Florida were found in studies performed in the mid-western United States and in Montana [12,14]. These nine species in addition to *E. ahsata* were found in Maryland [13].

The dominance of *E. arloingi*, *E. ninakohlyakimovae* and *E. alijevi* in this study is similar to other reports from various geographic and climatic areas [7,14,15]. *Eimeria arloingi* and *E. ninakohlyakimovae* are the most ubiquitous species worldwide and are also considered to be the most pathogenic species of goats [5]. The relative differences in prevalence of *Eimeria* species and differences seen in prevalence by age between this study and other studies cannot be explained.

In this study, Nubians had the highest OPG counts when compared to Boers, Boer-Spanish crosses, and Saanens. Although the multiple factors that may affect the results in this study due to possible differences in management practices among the herds should also be considered, differences in intensity of infection among breeds have been reported in other studies. When goats of similar age were compared in a study conducted in Australia, Nubian goats had higher OPG counts than Saanen and Angora breeds [16]. In another study, Nubian goats shed higher OPG daily when compared to Saanens after experimental infection [18].

5. Conclusion

The high prevalence of *Eimeria* oocysts found in the fecal samples of goats in this project indicates that *Eimeria* infections are very common in goats in Florida. The high prevalence of *Eimeria* infections, the relatively common practice of intensive rearing and the favorable climatic conditions found in Florida all contribute to the large impact that coccidiosis has on Florida goat production, both clinically and economically. It has been hypothesized that the intensity of *Eimeria* infection and the incidence of clinical coccidiosis is not as correlated to the intensity of management as it is to strict hygienic practices, parasite management practices (*i.e.* chemical prophylaxis), and the nutritional status of the herd as it relates to their degree of immunological competence [3, 7,16]. As the Florida goat industry continues to progress, it is important that Florida producers adopt effective

management practices to decrease the development and impact of coccidiosis on their farms.

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