OOCYST EXCRETION PATTERN OF THREE INTESTINAL EIMERIA SPECIES IN FEMALE RABBITS

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Abstract: The dynamic change in faecal Eimeria oocyst excretion was evaluated in 10 naturally infected female rabbits, starting from their weaning at 33 d of age until about 1 mo after their second parturition. Faecal samples collected from examined animals were qualitatively and quantitatively analysed to evaluate presence and number of Eimeria oocysts. In addition, isolated Eimeria oocysts were identified at the species level following sporulation. Animals were found to be infected by Eimeria perforans, Eimeria exigua and Eimeria magna and shed Eimeria oocysts after weaning and after parturition. In particular, at 33 d of age all female rabbits examined were negative, while the discharge of Eimeria oocysts started at 39th day of age and peaked between 46th and 53rd day of age. From 81-109 d of age until the first parturition and from 25 d of age of the litters born at the first parturition to the second parturition, all animals resulted negative. After parturition, Eimeria oocyst output occurred from 6th to 12th day after the first parturition and from 7th to 13th day after the second parturition, while a second period of oocyst excretion was observed from 18th to 24th day after both parturitions. These findings may indicate the existence of a relationship between the periparturient phase and Eimeria oocyst output and suggest an important role of the mothers in transmission of the infection to their litters.

Key Words: Eimeria, oocyst excretion pattern, weaning, periparturient phase, female rabbits.

INTRODUCTION

Coccidiosis is a major parasitic disease of the rabbit caused by protozoa of the genus Eimeria (Apicomplexa: Eimeridae) that affects mainly young rabbits after weaning (Drouet-Viard et al., 1997; Pakandl and Hlásková, 2007) and can be responsible for important economic losses in rabbit farms (Bhat et al., 1996; Taylor et al., 2007; Li et al., 2010). Coccidial infection is initiated by oral ingestion of sporulated oocysts by the susceptible host and the infection can lead to clinical coccidiosis primarily in kits, whereas adults are mostly healthy carriers (Bhat et al., 1996; Coudert et al., 2000). According to their pathogenicity, species responsible for rabbit intestinal coccidiosis can be classified into 4 types: non pathogenic (Eimeria coecicola), slightly pathogenic (Eimeria exigua, Eimeria perforans, Eimeria vejlovskyi), mildly pathogenic or pathogenic (Eimeria irresidua, Eimeria magna, Eimeria media, Eimeria piriformis) and highly pathogenic (Eimeria intestinalis, Eimeria flavescens) (Coudert et al., 1995; Taylor et al., 2007; Pakandl, 2009). Clinical signs of the disease include failure to gain weight, poor feed conversion, growth retardation, diarrhoea, anaemia and possibly death (Coudert et al., 1995; Bhat et al., 1996; Taylor et al., 2007; Pakandl, 2009).

Previous studies have shown that rabbits younger than 19-21 d cannot be infected by coccidia (Pakandl and Hlásková, 2007; Pakandl, 2009) even when experimental animals are kept coccidia-free for several generations (Pakandl et al., 2008), while kits are more frequently infected from around 5-6 wk of age (Drouet-Viard et al., 1997; Grès et al., 2003) to around 3 mo of age (Gomez-Bautista et al., 1987). Concerning oocyst shedding pattern in female rabbits used for reproduction, it was previously shown (Poloowski, 1993) that 2 peaks occurred after parturition: the first one in the perinatal period and the second in the period preceding weaning of the litters. The present study was designed to evaluate the dynamic change of Eimeria oocyst excretion in naturally infected female rabbits from their weaning until the weaning of the litters born from their second parturition.

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MATERIALS AND METHODS

Animals

The study was conducted in 2003 on 10 “Leprino di Viterbo” breed (ANCI, 2012) weaned female rabbits (mean weight 0.803±0.062 kg at the beginning of the experiment) from the same farm. The experimental period was from females weaning, at 33 d of age, until the weaning of the litters born from their second parturition. Animals were reared in individual metallic cages (150×100×76 cm, length×width×high) with a wire mesh floor and fed a commercial laboratory pelleted feed free of anticoccidial drugs. Water was distributed ad libitum. On a daily basis, faeces and urine were removed, cages were cleaned and water and food containers were washed and refilled. Reproduction was natural and the 2 parturitions occurred in late spring (in May) and late autumn (in November). The nest (46×27×25 cm) was placed in the cage 3 d before the presumed day of parturition and removed at 20 d of age of the litter. Weaning of the litters occurred at 33 d of age.

Throughout the study period, animals were checked daily to observe clinical signs, such as diarrhoea, indicating a clinical form of coccidiosis and their weight was recorded weekly.

All experiments were carried out in accordance with the guidelines set by Italian law on the use of animals in research.

Sampling

Faecal samples were collected from each examined animal by means of plastic sheets placed under the wire mesh of the cage floor. From the beginning of the study at 33 d of age until the first parturition at about 165 d of age, and from the weaning of the litters born from the first parturition until the second parturition at about 343 d of age, samples were collected twice a week at 8.00 a.m. Faecal samples were instead collected daily at 8.00 a.m. during the period starting from the parturition of each female rabbit until weaning of the respective litter, i.e. for 33 consecutive days after each parturition. Individual faecal samples were also collected daily from all the males used for mating in the 2 wk before they were placed in the females’ cages.

Parasitological Analysis.

Samples were quali-quantitatively analysed by flotation test using a low density solution (specific gravity 1.2) (Coudert et al., 1995) and by a modified McMaster method with a sensitivity of 20 oocysts/gram of faeces (OPG) (Permin and Hansen, 1998), to assess the presence and number of Eimeria oocysts.

To identify isolated Eimeria species, oocysts from faecal samples were allowed to sporulate by suspending them in 2.5% potassium dichromate (K₂Cr₂O₇) in Petri dishes. Dishes were checked daily until the sporulation of the oocysts. Oocysts, sporocysts, sporozoites and other structures were microscopically observed by immersion oil (1000×) and measured by means of an eye-piece micrometer. For the identification of isolated Eimeria species, descriptions given by several authors (Levine and Ivens, 1972; Pellerdy, 1974; Eckert et al., 1995; Grès et al., 2002; Taylor et al., 2007) were used. The frequency of each species in each culture was determined in 50-100 mature oocysts.

Statistical Analysis.

Data obtained from the evaluation of the OPG number were statistically elaborated with the analysis of variance and with the Test of Student of Newman-Keuls for multiple comparisons with P<0.05 significance (Glantz, 2003a), using McGraw-Hill software (Glantz, 2003b).

RESULTS

From parasitological analysis at weaning (33 d of age), all female rabbits examined were negative for Eimeria oocysts. Oocysts shedding started at 39 d of age in 3/10 of examined rabbits, while at 42 d of age all animals (10/10) were shedding Eimeria oocysts (Figure 1). Statistically, significantly (P<0.05) higher oocyst counts (2406±41 OPG, mean ± standard deviation of the period) were observed between 49th and 53rd days of age of examined animals (Figure 2). Compared to previous days, oocysts number significantly decreased (P<0.05) from 56th to 60th (1010±191 OPG) and
from 63rd to 109th (122±216 OPG) day of age. In this latter period, a decrease in the number of positive rabbits was also observed (Figure 2). Afterwards, all animals were negative till mating (Figure 2), at the age of 135 d, and also from mating to the first parturition, at about 165 d of age, except for 2 animals that excreted 200 Eimeria OPG at 143 d and at 150 d of age, respectively.

After the first parturition, all the mothers were negative till the 5th day post-partum, while faecal Eimeria oocysts appeared between the 6th and the 12th (458±245 OPG) day. Oocyst excretion stopped between the 13th and the 17th day and started again from the 18th till the 24th (331±208 OPG) day after parturition (Figure 3). From 25 d of age of the litters born at the first parturition to the second parturition, all examined female rabbits were negative.

Figure 1: Number of rabbit females found to shed Eimeria perforans, Eimeria exigua and Eimeria magna oocysts from weaning at 33 d of age to mating at 135 d of age.

Figure 2: Mean output of Eimeria perforans, Eimeria exigua and Eimeria magna oocysts/gram of faeces (OPG) observed in 10 rabbit females from weaning at 33 d of age to mating at 135 d of age.
A similar trend, characterised by 2 periods of oocyst emission from the parturition to the weaning of the litters, was observed in all female rabbits also after the second parturition. More precisely, the examined female rabbits shed faecal oocysts from 7th to 13th day post-partum (Figure 4), with a significantly higher emission ($P<0.05$) between the 9th to the 11th day (533±50 OPG) and from the 18th till the 24th day (277±167 OPG) after the parturition. Oocyst output stopped from 25th day post-partum till the weaning of the litters (Figure 4).

Statistically, highly significant differences ($P<0.01$) resulted from the multiple comparison of the mean OPG counts observed after weaning and after the first and second parturitions. More in particular, the mean OPG count recorded in the juvenile period (673±143 OPG) was significantly higher ($P<0.05$) compared to the mean OPG count observed both after the first (459±273 OPG) and after the second (346±145 OPG) parturition, while no differences emerged from the comparison of these 2 latter values. All faecal samples from the males used for mating were negative for Eimeria oocysts.

Figure 3: Mean output of *Eimeria perforans*, *Eimeria exigua* and *Eimeria magna* oocysts/gram of faeces (OPG) observed in 10 rabbit females from the first parturition in May 2003 to the weaning of their litter.

Figure 4: Mean output of *Eimeria perforans*, *Eimeria exigua* and *Eimeria magna* oocysts/gram of faeces (OPG) observed in 10 rabbit females from the second parturition in November 2003 to the weaning of their litter.
From microscopic analysis of sporulated oocysts, *Eimeria perforans*, *Eimeria exigua* and *Eimeria magna* were the species identified throughout the study period and in all examined female rabbits. In mean, *E. perforans* (61%) oocysts dominated, while *E. magna* (32%) and *E. exigua* (7%) oocysts were less represented. Through all the study, animals did not show clinical signs of coccidiosis and their weight was in normal range (from 3.6 to 4.2 kg at the end of the study).

**DISCUSSION**

In the 10 rabbit females observed in this study from their weaning, at 33 d of age, till the weaning of the litters born from their second parturition, quasi-quantitative evaluation of faecal *Eimeria* oocyst shedding pattern showed the occurrence of *E. perforans*, *E. magna* and *E. exigua* oocyst emission after weaning and after each parturition. In particular, at 33 d of age all examined animals were found negative while oocyst shedding started from the 39th day of age, peaked between 46th and 53rd day of age and stopped at 81-109 d of age. These data confirm the outcomes of previous studies reporting that *Eimeria* infections occur mainly in kits just after weaning (Drouet-Viard et al., 1997; Pakandl and Hlásková, 2007).

In addition, the female rabbits examined showed 2 periods of oocyst excretion after parturition: the first in the perinatal period and the second in the period just preceding weaning of the litter. In particular, the first excretion of *Eimeria* oocysts appeared from 6th to 12th d after the first parturition, in late spring, and from 7th to 13th d after the second parturition, in late autumn, while the second emission period was observed from 18th to 24th d after both the first and the second parturitions. Indeed, in this study the trend of oocyst emission was very similar after both parturitions in terms of oocyst count, length of the oocyst shedding period (number of days) after parturition and the number of shedding animals. All these findings seem to confirm previously reported data (Polozowski, 1993) concerning a relationship between *Eimeria* oocyst output and the periparturient phase.

Although in previous studies (Gallazzi, 1977; Nosal et al., 2006) cyclical variations in the excretion of intestinal *Eimeria* oocysts in rabbits appeared to be mostly affected by the seasonal period, no differences emerged in the present study from the comparison of data observed in examined female rabbits in the 2 different periods of the year following the first (in May) and second (in November) parturitions. Therefore, other factors that occur during the periparturient period should be responsible for the faecal oocysts shedding observed in examined female rabbits.

A periparturient rise of *Eimeria* spp. oocyst faecal count was also observed previously in other mammalian species (Faber et al., 2002; Taylor et al., 2007; Bruhin et al., 2011; Turner et al., 2012). Moreover, the periparturient increase in the emission of (o)ocysts was also reported for other intestinal protozoa, such as *Cryptosporidium parvum* and *Giardia duodenalis* in infected sheep and goats (Xiao et al., 1994; Ortega-Mora et al., 1999; Castro-Hermida et al., 2005). In wild rabbits, the periparturient increase in the emission of *Trichostrongylus retortaeformis* eggs was evidenced (Hobbs et al., 1999). According to Marai et al. (2010), stress conditions and hormonal changes occurring in rabbits during pregnancy, parturition or suckling periods may lead to lowered resistance to parasitic infections and heightened susceptibility in the dam. The increase in nutrient requirements during pregnancy and lactation is another factor that may have a relevant role in lowered resistance to parasitic infections, as demonstrated in sheep (Ortega-Mora et al., 1999; Houdijk et al., 2000; Kidane et al., 2010). The possibility that the periparturient emission of *Eimeria* oocysts as observed in female rabbits herein examined may be the result of reinfections seems unlikely, mainly because no oocyst shedding was observed in any females examined in the periods from mating to first parturition and between the weaning of the litters born from the first parturition and the second parturition. In addition, female rabbits were reared in individual cages; cages were cleaned daily, food and water contamination with infective oocysts was prevented and the males used for mating were negative for *Eimeria* oocysts at coprological analysis. Consequently, the reactivation of a latent infection should represent the main factor responsible for the periparturient excretion of *Eimeria* oocysts observed in all female rabbits examined in this study.

Adult rabbits, which are usually symptomless carriers of coccidian infections, could serve as a potential source of infection for kits (Bhat et al., 1996; Coudert et al., 2000). Findings from this study suggest that mothers may play an important role in *Eimeria* transmission to the litters. In fact, from results obtained here, the 2 periods of oocyst emission observed in all examined female rabbits after parturition, i.e. from the 6th-7th to the 12th-13th and from the
Among Eimeria species responsible for natural coccidial infections in animals examined in this study, E. perforans and E. magna are included among the most frequent species reported in farm rabbits in Italy (Gallazzi, 1977; Vereecken et al., 2012), while the prevalence of E. exigua is lower (Vereecken et al., 2012). As for their pathogenicity, E. perforans and E. exigua are considered slightly pathogenic, while E. magna is considered mildly pathogenic to pathogenic (Coudert et al., 1995; Bhat et al. 1996; Pakandl 2009). Overall, during the whole observation period and in all examined animals, E. perforans, E. magna and E. exigua oocyst numbers were always lower than 4000-5000 OPG, which is the number of Eimeria OPG considered advisable to apply only medical prophylaxis in rabbits infected by coccidia (Coudert et al., 2000; Gutiérrez, 2003). Therefore, the low or mild pathogenicity and the low intensity of isolated Eimeria species could explain why clinical signs of coccidiosis were absent in all female rabbits examined in the present study and their weight was within normal range.

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**REFERENCES**


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