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A longitudinal study on the effect of lambing season on the periparturient egg rise in Ontario sheep flocks

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ABSTRACT

The epidemiology of the periparturient egg rise (PPER) of gastrointestinal nematodes (GINs) in sheep remains unclear, and may be influenced by the lambing season. This longitudinal study was performed to determine the effect of out-of-season lambing on the PPER in ewes in Ontario, and whether total plasma protein (TPP) and packed cell volume (PCV) were associated with the PPER. Six farms that practiced out-of-season lambing were enrolled, and sampled for three consecutive lambing seasons (winter, spring and autumn). For each lambing season, all farms were visited five times. On the first visit for each lambing season, 15–20 pregnant ewes and 15–20 non-pregnant/early gestation ewes were randomly selected. At each visit, fecal samples were collected from all selected animals and processed individually to measure GIN fecal egg counts (FECs). Blood samples were collected on three visits in each lambing period and processed to measure TPP and PCV. The ewes were classified into one of five production stages (maintenance [i.e. not pregnant], early or late gestation [<120 d and ≥120 d, respectively], and early or late lactation [<40 d and ≥40 d, respectively]) based on information collected during farm visits. Linear mixed models were developed for the TPP, PCV and logarithmic-transformed FEC (lnFEC). During the winter and spring lambing season, the FECs increased gradually over the gestation period and peaked during lactation, with these increases being larger in ewes with a low PCV (three-way interaction in the final model). In the autumn lambing season, the FECs started off higher in early gestation, and increased rapidly to peak in late gestation, particularly for animals with low PCV levels. In the TPP model, PCV and lnFEC were positively associated with TPP. During both autumn and winter lambing seasons, the TPP decreased from maintenance throughout gestation and early lactation, followed by an increase in late lactation, except for when there were high FECs. During the spring lambing season, TPP peaked at early gestation, and then decreased in late gestation, to increase more gradually over lactation. In the PCV model, PCV increased with TPP and decreased exponentially with increases in lnFEC. The PPER occurred during all three lambing seasons, and its magnitude and distribution varied with

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the lambing season, suggesting that the PPER in ewes depends on both environmental and animal physiological factors, an important consideration when implementing preventive parasite control strategies on sheep farms that practice out-of-season lambing.

1. Introduction

Gastrointestinal nematodes (GINs) are a leading cause of clinical disease and death in grazing sheep worldwide, hindering both sheep production and profitability (Sutherland and Scott, 2010). In Ontario, Canada, the most predominant GIN genera are *Teladorsagia* sp., *Haemonchus* sp. and *Trichostrongylus* spp. (Mederos et al., 2010).

The periparturient egg rise (PPER) observed in the spring in temperate climate countries is a major source of GIN pasture contamination for both lambs and ewes (Barger, 1999). Moreover, it may sometimes result in an acute Type II syndrome, whereby parasites that survive the winter in the host as arrested larvae resume development, resulting in a sudden onset of clinical signs in late winter and early spring (Taylor et al., 2007).

There are conflicting ideas on the cause, and occurrence, of increased fecal egg shedding in ewes. Some authors consider this egg rise to be a seasonal phenomenon, observed only during the spring months, and independent of the ewes' productivity stage (Zawadowsky and Zvjaguintzev, 1933; Brunsdon, 1964; Gibbs, 1967; Gibbs and Barger, 1986). This so-called "spring rise" (Cvetkovic et al., 1971) has been related to the increased availability of parasites on pasture in favorable ambient conditions (Zawadowsky and Zvjaguintzev, 1933), while others have suggested that this could be due to reactivation of hypobiotic parasites. The arrested development of nematodes has been described in several studies (Blitz and Gibbs, 1972; Michel, 1974), and the resumption of parasite development may occur spontaneously or be triggered by seasonal changes in photoperiod or ambient temperatures (Blitz and Gibbs, 1972).

Other authors believe the fluctuation in egg shedding observed during the periparturient period is linked to the ewes' productivity stage, and the endocrine, immunological, and metabolic changes that ensue (Taylor, 1935; Crofton, 1954; Brunsdon, 1970; Michel, 1976; Jeffcoate and Holmes, 1990; Coop and Holmes, 1996; Donaldson et al., 1998; Beasley et al., 2010b). Crofton (1954) suggested that prolactin may play a role in the PPER, since it also increased during parturition and lactation, but other studies have indicated that this is most likely an incidental finding (Jeffcoate and Holmes, 1990; Beasley et al., 2010a). Brunsdon (1970) suggested that the PPER may be caused by a relaxation in immunity during the periparturient period, and work conducted by Beasley et al. (2010b) showed that changes consistent with a reduction in immunity expression occurred in both pregnant and lactating ewes. These changes in immunity may facilitate the parasites' establishment within the host, enhance their prolificacy, and increase their longevity (Michel, 1976). Houdijk et al. (2001) suggested that a lack of metabolizable protein may also be a determinant factor in the PPER since both gestation and lactation are nutritionally demanding periods (Houdijk, 2008) and compete with the hosts' immune system for available protein. Total plasma protein (TPP) is a useful indicator of the protein available to the animal, while low packed cell volumes (PCV) are suggestive of blood and protein loss, which could be a consequence of a parasitic infection (Radostits et al., 2007). Both TPP and PCV could therefore be useful diagnostic indicators of the PPER.

Since its first description (Taylor, 1935), the PPER in ewes has been observed in both temperate (Brunsdon, 1970; Cvetkovic et al., 1971; Beasley et al., 2010b) and tropical climates (Tembely et al., 1998; Ng'ang'a et al., 2006). More recently, Mederos et al. (2010) reported an increase in fecal egg shedding in ewes that lambed during the spring, prior to pasture exposure, on conventional farms in Ontario, Canada. However, a recent survey conducted by the Ontario Sheep Marketing Agency (OSMA) showed that 32% (148/461) of all respondents, and 65% (34/52) of the respondents with flocks larger than 300 ewes, practiced out-of-season lambing (Ontario Sheep Industry Survey, 2009). Consequently, in many flocks in Ontario, ewes lamb throughout the year and not all ewes are pregnant during the spring time. Dunsmore (1965) suggested that both environmental and physiological factors might be important contributors to the PPER. It is therefore important to elucidate the epidemiology of fecal egg shedding patterns on Ontario sheep farms that practice out-of-season lambing, and to identify clinical parameters that might be associated with the PPER. Ultimately, this would enable us to devise improved preventive strategies for parasite control on these farms.

The objectives of this study were therefore to determine whether: (i) ewes that lamb out-of-season experience a PPER; (ii) ewes either not bred or in early gestation during the spring season experience an increase in fecal egg shedding at that time, related to seasonal effects, and (iii) TPP and PCV are associated with the PPER. Our hypothesis was that all ewes lambing out-of-season would experience a PPER, and that ewes not bred or in early gestation during the spring would experience an increase in fecal egg shedding related to seasonal effects. Furthermore, we hypothesized that low concentrations of TPP and PCV would be associated with the PPER.

2. Materials and methods

2.1. Number and selection of sheep farms

A longitudinal study was conducted between December 2009 and June 2011 in which six farms were purposively selected in south-western Ontario; the sample size was dictated by logistical and financial constraints. The farms were selected based on their willingness to participate in the study, distance from University of Guelph (within a 200 km radius) due to a requirement for frequent sampling, compliance to withhold routine use of anthelmintics, and known history of GIN parasitism on the farm. The latter was