# The role of suckling on the parasite status of very young lambs infected with *Teladorsagia circumcincta*

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## ABSTRACT

This study investigated the importance of suckling for the resistance and/or resilience of very young lambs to *Teladorsagia circumcincta* nematode infection. Thirty, 6-week old twin-born lambs were allocated to four treatment groups in a 2 x 2 factorial design in which groups continued to suckle (S-) or were weaned (W-), and concurrently not infected (-N) or infected (-I) with 1000 L3 larvae of *T. circumcincta* per day while grazing 'clean' pasture for six weeks, and then slaughtered. There was a significant infection by time interaction on faecal egg counts (FEC; $P < 0.001$). Suckling/weaning had no effect on FEC. Worm burdens were similar in suckled-infected (SI) and weaned-infected (WI) lambs (8029 $\pm$ 1502 vs 12228 $\pm$ 1704 worms, SEM; $P > 0.05$), respectively. Eggs *per utero* were significantly greater (29 $\pm$ 6 vs 15 $\pm$ 1 eggs, SEM; $P < 0.05$) in SI than WI lambs, while length of female worms was similar in both groups (10.2 $\pm$ 0.2 vs 9.7$\pm$0.3mm, SEM; $P > 0.05$), respectively. The two suckled groups progressively gained more weight ($P<0.001$), while uninfected lambs of both groups were heavier ($P < 0.05$) from day 28 onwards. Weight gain averaged 122, 282, 98, and 240g day$^{-1}$ for the WN, SN, WI, and SI lambs, respectively. The study has not shown any advantage of suckling while grazing for lambs' resistance or resilience to larval intake within the 12-week post lambing period.

Keywords: *Teladorsagia circumcincta*

## INTRODUCTION

The need to develop sustainable approaches to parasite control that are less reliant on anthelmintic use has generated interest into research on the enhancement of immune competence with nutritional interventions. Immunity to parasitic infection has been considered to be a function which competes with other body functions for nutrients with a degree of success that may vary with physiological status (Coop & Kyriazakis, 1999). Several studies have shown that protein supply can influence this interaction (Bown *et al.*, 1991; Donaldson *et al.,* 2001).

Milk contains a high ratio of protein to energy - 10.7g amino acid N/MJ ME (Geenty & Sykes 1983) and, in addition, normally by-passes the rumen and is not degraded in suckling young ruminants. It may therefore ensure an ample supply of fuel for the developing immune system. Recent data have suggested that lambs fed bovine milk, without solid feed, are less susceptible to larval establishment of *Teladorsagia circumcincta* than their weaned counterparts; though lambs fed bovine milk in combination with solid feed did not have such protection (Zeng *et al.,* 2001). Anecdotal evidence also suggests that lambs are less likely to show signs of parasite infection while suckling than after weaning. The present study investigated the importance of milk for the resistance and/or resilience of very young lambs to infection with *T. circumcincta* nematode.

## MATERIALS AND METHODS

Thirty, 6-week old twin-born Coopworth lambs were allocated to one of four treatment groups, while grazing 'clean' pasture, in a 2 x 2 factorial design in which groups continued to suckle (S-) from their dams or were weaned (W-) while being concurrently infected (-I) or not (-N) with nematode larvae. This created 4 groups (WN, SN, WI and SI) comprising 7, 7, 8 and 8 lambs, respectively.

Live weight was measured weekly. Infected lambs received a trickle infection of 2333 *T. circumcincta* L3 larvae/dose (Lincoln Kumeroa strain PB252/13) given in three doses each week (equivalent to 1000 L3 larvae per day). Faecal samples were taken directly from the rectum at weekly intervals and faecal nematode egg count (FEC) measured using a modification of the McMaster method (MAFF, 1979) and expressed as eggs per gram of fresh faeces (epg). Lambs were slaughtered at day 42, and worm burden, worm length, and eggs *per utero* were measured as described by Donaldson *et al.* (2001).

The experiment was carried out under the authority of the Lincoln University Animal Ethics Committee.

### Statistical analyses

Data were analysed using the Restricted Maximum Likelihood (REML) routines within the Genstat suite of statistical packages (GenStat Release 7.2 Copyright 2004, Lawes Agricultural Trust, Rothamsted Experimental Station). All data were tested for normality and only FEC had to be log-transformed [$LOG_{10}$ (count+1)] before analysis, and presented as

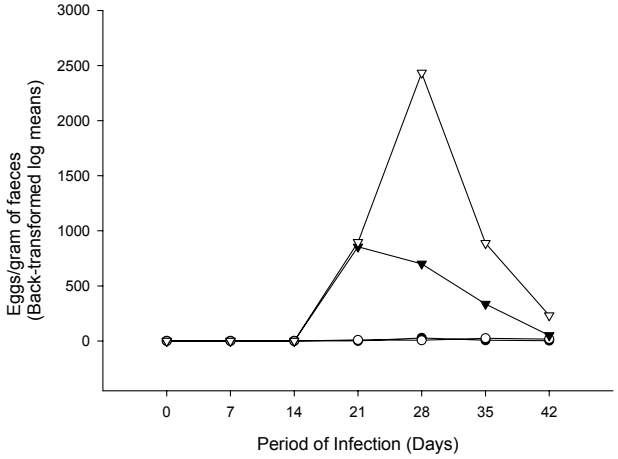
back-transformed means. Weekly FEC and cumulative live weight gains were analysed as repeated measures with antedependence structure.

## RESULTS

None of the lambs showed any clinical symptom of infection, such as diarrhoea or breech soiling. Faecal egg counts (as back-transformed means) are shown in Figure 1. Nematode eggs were detected in the faeces from day 21. There was a highly significant interaction effect of infection and time ($P < 0.001$) on FEC, with the SI lambs having the highest FEC from day 28 onwards. Faecal egg counts in the SI and WI groups rose sharply from day 21 to day 28, peaking at 2433 epg on day 28 for the SI and at 855 epg on day 21 for the WI lambs. Faecal egg counts dropped to 232 and 51 on day 42 for the SI and WI lambs, respectively.

Cumulative live weight gains are shown in Figure 2. There were highly significant interaction effects of suckling and time ($P < 0.001$), and infection and time ($P < 0.001$) on cumulative live-weight gain. The two suckled groups progressively gained more weight ($P < 0.001$), with the uninfected groups being heavier ($P < 0.05$) than their infected suckled and weaned counterparts from day 28 until the end of the experiment. Weight gain averaged 122, 282, 98, and 240 g day$^{-1}$ for the WN, SN, WI, and SI lambs, respectively.

**FIGURE 1:** Nematode eggs per gram of faeces (as back-transformed log means) of lambs weaned at six weeks and not infected (—●—) or infected (—▼—), and those suckled throughout and not infected (—○—) or infected (—▽—) with the equivalent of 1000 L3 *Teladorsagia circumcincta* larvae per day



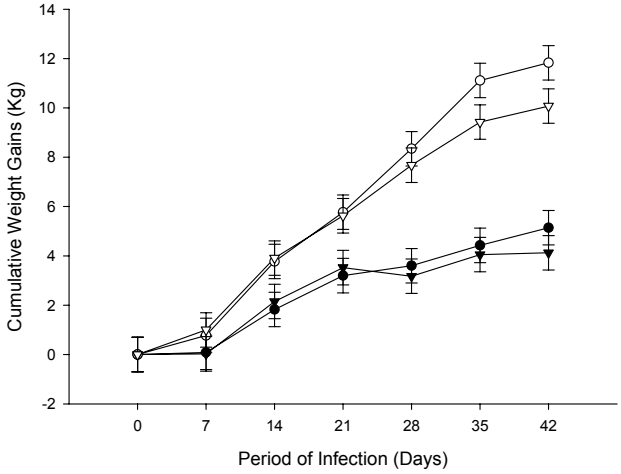

Data for worm counts, eggs *per utero*, and worm length are shown in Table 1. Burdens in the infected lambs were significantly greater ($P < 0.001$) than those in uninfected lambs, but similar for the SI and WI lambs (8029 ± 1502 vs 12228 ± 1704 worms; $P > 0.05$), respectively. Egg numbers *in utero* were significantly greater (29 ± 6 vs 15 ± 1 SEM; $P < 0.05$) in the SI than the WI lambs, while length of female worms were similar in both groups (10.2 ± 0.2 vs 9.7 ± 0.3 mm; $P > 0.05$, respectively).

**TABLE 1:** Worm counts, eggs *per utero* and worm length in lambs (± SEM) weaned at six weeks and not infected (WN) or infected (WI), and those suckled throughout and not infected (SN) or infected (SI) with the equivalent of 1000 L3 *Teladorsagia circumcincta* larvae per day.

| Treatment groups | Worm count | Eggs *per utero* | Worm length (mm) |
|---|---|---|---|
| WN | 207 ± 89[a] | * | * |
| SN | 387 ± 179[a] | * | * |
| WI | 12228 ± 1704[b] | 15 ± 1[a] | 9.72 ± 0.3[a] |
| SI | 8029 ± 1502[b] | 29 ± 6[b] | 10.17 ± 0.2[a] |
| SED | 1731 | 6 | 0.39 |

Values in the same column bearing different superscript letters are significantly different, $P < 0.05$

**FIGURE 2:** Cumulative live-weight gain (kg) of lambs weaned at six weeks and not infected (—●—) or infected (—▼—), and those suckled throughout and not infected (—○—) or infected (—▽—) with the equivalent of 1000 L3 *Teladorsagia circumcincta* larvae per day




## DISCUSSION

The evidence in this study that suckling deters the establishment and development of *T. circumcincta* infection in lambs, or is beneficial for lambs' resilience to infection is inconclusive. As anticipated, growth of lambs was reduced by early weaning. Surprisingly, however, the superimposition of infection on weaning had no adverse effect, apart from a slight reduction in live weight gain, as no death arose from parasitism nor any clinical symptoms of infection such as breech soiling. This suggests that all the lambs, even those

weaned, were able to tolerate the level of infection adopted in this trial. The very low FEC and worm burdens in the uninfected lambs confirms that the pasture was reasonably 'clean'; conditions which would allow maximum expression of the effects of the imposed infection. Moreover, there was no evidence that weaning reduced the resilience of the lambs to larval intake, as evidenced by the smaller difference in performance between the uninfected and infected weaned lambs, compared to the difference between their suckled contemporaries.

Withdrawal of milk in the weaned lambs would have been associated with a marked reduction in protein supply to the intestine, which may be expected to reduce resistance and resilience to infection as a consequence of reduced protein supply (Sykes & Coop, 1977; Poppi *et al*., 1986; Kambara *et al*., 1993; Houdijk *et al.,* 2001). Lack of change in resilience may, however, reflect the immune status of the lambs. In earlier work, Bown *et al*. (1991) and van Houtert *et al*. (1995) have observed that the effect of additional protein is to enhance or speed the development of resistance, and maybe also resilience, rather than enhance innate resistance. These were very young lambs and it is possible that they had limited ability to respond immunologically at this stage, a phenomenon observed by Kambara *et al*. (1993).

The lack of breech soiling in either group may well be indicative of a feeble immune response. In view of the recent findings of Greer *et al.* (2005) that the depression of appetite characteristic of nematode infections is associated with the acquisition phase of development of immunity, and that there is a nutritional cost to acquisition and maintenance of immunity to GI nematodes, it may well be that the lack of an immune response in such very young animals allowed them to cope with infection without effect on performance.

The parasitological data do not refute this but suggest a more dynamic interplay between nutrition and infection. Examination of faecal egg count alone suggests that the lambs which continued to suckle were less resistant to the larval challenge than their weaned contemporaries (Figure. 1). However, worm burdens suggest that this reflected greater egg laying by a numerically smaller but physiologically better developed nematode population. There is evidence in periparturient ewes, with a previously established but currently relaxed immunity, that additional dietary protein can enhance the ability of the host to withstand establishment of incoming larvae (Donaldson *et al*., 2001). If this was the situation in the present lambs, and there is evidence from *in vitro* and *in vivo* studies that milk may have antiparasitic properties (Zeng *et al*., 2001, 2003), then one can envisage a scenario in which fewer nematodes would be established in the suckled lambs. As a consequence, this may have led to more favourable conditions for development of the established nematodes, either because of less crowding or a more favourable nutritional environment. Multiplication of worm burdens by eggs *in utero* (Table 1) for the WI (183420 eggs) and SI (232841 eggs) lambs suggests that daily egg production should have been similar. It may well be that a lesser faecal mass in the suckled lambs, due to reduced forage intake, could have resulted in the higher concentration of nematode eggs.

There are several conclusions from this work. Firstly, faecal egg count may be a poorer indicator than previously supposed of resistance of the young host to nematode infection. Secondly, that while milk may have some antiparasitic properties, the supposed greater resilience of lambs to infection while suckling may owe more to the absence of a strong immune response at this age than to the beneficial effects of milk *per se*. It may well be, however, that competition for nutrients between immunity and other body functions will occur during the phase of acquisition of immunity at a later age than that of the present lambs (Coop & Kyriazakis, 1999). At that stage the nutritional advantage of milk may well confer greater resilience on the suckling lambs. This has formed the hypothesis of a follow-up trial, the outcome of which is expected to better clarify the role of suckling on resistance and resilience of lambs to *T. circumcincta* infection.

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