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Exposure to pasture borne nematodes affects individual milk yield in Swedish dairy herds

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ABSTRACT

The association between exposure to gastrointestinal nematode (GIN) parasitism, indicated by elevated individual optical density ratio (ODR) to *Ostertagia ostertagi*, and individual milk production was analysed in dairy cows. The multivariable analysis also accounted for other sources of variation than exposure to GIN parasitism. Intra- and inter-herd variation in parasite exposure was also evaluated. Organic and conventional herds located in south-east Sweden (13 herds per system) were visited during the housing period 2009–2010. Levels of all major pasture-borne helminths in Sweden (*O. ostertagi*, *Fasciola hepatica* and *Dictyocaulus viviparus*) were determined in bulk tank milk, cow milk and serum (only for *O. ostertagi*). Their specific antibodies were detected using three different ELISAs (Svanova Biotech) and the optical density of the sample was expressed as ODR. Positive cases of *Dictyocaulus* and *Fasciola* were seldom found. Variation in ODR in serum samples for *Ostertagia* was higher within herds than between herds. Correlations between ODR for *Ostertagia* in serum and milk parameters were significant and negative. In the multivariable analysis, two models were performed separating data from primiparous and multiparous cows. Results from mixed models showed that daily milk yield was significantly influenced by *Ostertagia* ODR for multiparous cows. No interactions were found between *Ostertagia* ODR values and herd type.

1. Introduction

The current views on health management in dairy herds are characterised by an integrated, holistic, data-driven and economically framed approach to prevent disease and enhance performance (Charlier et al., 2009). Nowadays, definition of disease includes subclinical conditions and the current trend in health management considers limits of animal and herd performance as a component of disease (LeBlanc et al., 2006). Over the past few years, studies have examined the impact of gastrointestinal nematode (GIN) infections on milk yield (Charlier et al., 2005a) and on other production indices of dairy cows (Bennema et al., 2010). Whilst parasitic diseases may not have a high incidence, economic losses may be large (Younie et al., 2003) since animals can deal with parasite infection but infections potentially limit milk production in adult dairy cattle. However, the effect of parasitoses is still generally difficult to assess quantitatively. Experimental studies with infections of *O. ostertagi* have demonstrated significant reductions in live weight gain both in first- and second-season grazing cattle (Larsson et al., 2007). Also a drop in milk yield has been demonstrated in untreated, naturally infected, dairy cows compared to treated controls (Forbes et al., 2004).

Ostertagia ostertagi constitutes one of the most important constraints on the productivity of grazing cattle in temperate regions, including Sweden (Höglund, 2010). Recent studies, mainly in Canada and Belgium, have found an inverse relationship in particular between the antibody

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levels against *O. ostertagi* in bulk tank milk (BTM), measured as optical density ratio (ODR) by a enzyme-linked immunosorbent (ELISA) assay, and total milk production of the herd (Guitián et al., 2000; Sanchez and Dohoo, 2002; Sanchez et al., 2002; Charlier et al., 2005b). This suggests a negative effect of exposure to this nematode infection on milk yield. Recent advances in the monitoring of subclinical GIN infection levels have led to the identification of animals and herds where these infections induce production losses (Charlier et al., 2007). Within herds with either low or high ODR in BTM, there is a large variation in individual ODR values (Charlier et al., 2007). Consequently, the distribution of individual ODR values within a herd might provide better insights into the parasite status of the herd than single BTM samples as Charlier et al. (2010) reported for first-season grazing cattle. However, only a few studies have established the relationship between individual cow infection and productivity (Sanchez et al., 2002, 2005).

Individual variation in coping with parasite burden is regulated by internal physiological mechanisms such as stage of lactation, age of the animal, genetics (Kloosterman et al., 1993) and unknown factors (Charlier et al., 2010). It is well known that lactation imposes great physiological demands on the body's homeostatic mechanisms. High yielding dairy cows have difficulties in consuming sufficient energy and nutrients to meet their requirements for maintenance and milk production (McNamara et al., 2003), which is accompanied by a clear increase in the risk of subclinical and clinical diseases. In this context, Perri et al. (2011) have demonstrated that the detrimental effect of parasites on milk production during the peripartum period may be mediated by metabolic and galactopoietic hormones such as growth hormone, type I insulin-like growth factor and prolactin.

The aim of the present study was to investigate the association between ODR and milk production on a cow level basis, accounting for additional sources of individual variation.

2. Materials and methods

2.1. Data collection

The field study was carried out in 13 organic and 13 conventional herds in south-east Sweden selected from another study that involved 20 organic and 20 conventional herds investigated for general and reproductive health (Fall et al., 2008a,b). The inclusion criteria for the original study were: written consent, more than 40 lactating cows on a yearly basis and participation in the Swedish Official Milk Recording Scheme.

From October 2009 to February 2010, the selected herds were all visited once by a team of one veterinarian and one animal scientist. The herds were located in the Swedish provinces of Småland ($n = 1$), Sörmland ($n = 4$), Uppland ($n = 10$) and Östergötland ($n = 11$). According to Swedish animal welfare legislation, all cattle older than 6 months, bulls excluded, must have outdoor access during the grazing season for at least 2–4 months depending on the region (DFS, 2007:5). However, there was no guarantee that eligible animals had been managed by grazing before sampling, which in this case was carried out during the housing period.

On each herd visit, blood samples were taken from ≈10 randomly chosen cows to obtain serum. According to the stage of lactation, sampled cows were distributed as follows: 3 from 0 to 6 weeks in milk, 3 from 6 to 24 weeks in milk, 2 from 24 to 42 weeks in milk and finally 2 dry cows. In addition, one BTM sample and individual milk samples were taken from up to 3 first-parity cows per herd. Milk samples were collected in specific tubes with the preservative Bronopol (2-bromo-2-nitropropane-1.3-diol). All samples were refrigerated and transported to the laboratory of the Department of Clinical Sciences at the Swedish University of Agricultural Sciences (SLU) and stored at −20 °C for up to 5 months before analysis at the Department of Biomedical Sciences and Veterinary Public Health, Section for Parasitology, SLU.

2.2. Analyses of milk and blood

Antibody levels to all major pasture-borne helminths in Sweden were determined in milk (*O. ostertagi*, *Fasciola hepatica* and *Dictyocaulus viviparus*) and serum samples (only for *O. ostertagi*) according to Höglund et al. (2010) using three different ELISAs. Two tests are commercially available and were used and interpreted according to the manufacturers' instructions. First, specific antibodies against the stomach worm *O. ostertagi* were detected using the SVANOVIR® *Ostertagia*-Ab ELISA kit (Svanova Biotech, Uppsala, Sweden), which is based on a crude adult worm capture antigen. The optical density (OD) of the sample was expressed as a ratio (ODR) calculated according to the formula $ODR = (sample_{OD} - NC)/(PC - NC)$, where NC and PC are the OD of negative and positive test control samples included on each plate. Secondly, antibodies to *F. hepatica* were detected with the Institut Pourquier fasciolosis kit (Idexx Laboratories, Montpellier, France), which is based on a purified f2 capture antigen and where results were expressed as a ratio of sample OD to a PC included on each plate. Cut-off values above 30% give adequate sensitivity, whereas ODs between 100 and 200% show moderate and >200% strong *F. hepatica* infection levels. Finally, *D. viviparus* infection was tested in an indirect ELISA based on a recombinant major sperm fusion protein (rMSP) as described by Goździk et al. (in press). It has been shown that specific IgG1 can be detected in milk by 30 (±5) days post-infection and for up to 2–6 months post-infection in experimentally infected cows using rMSP as the capture antigen (Fiedor et al., 2009). When the reading was below the blanks on the same plate, OD was taken as zero.

Herd data on annual average milk yield and herd size and individual cow data, such as age, breed, calving date, parity and individual milk yield from test-milking occasions (from 1 October 2009 to 28 February 2010; last period of data recording), were obtained from the Swedish Dairy Association.

2.3. Statistical analyses

All statistical analyses were performed using the program STATA Software v. 11 (Stata Corporation, College