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Research paper

Patent gastrointestinal nematode infections in organically and conventionally pastured dairy cows and their impact on individual milk and fertility parameters

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ABSTRACT

Infections with gastrointestinal nematodes (GIN) can lead to production losses and impacts on product quality in affected cows, which has mainly been demonstrated during deworming experiments or via herd-level measurements. Here, a field study was carried out to explore the association between GIN infection status and milk production as well as fertility parameters in individual dairy cows. Different selection lines of Black and White cows were included in the study, which were distributed among 17 small and medium-sized organic and conventional German grassland farms. Faecal samples of 1166 dairy cows were examined twice, in July and September 2015. Nematode eggs were found in the faeces of 473 (40.6%) cows. As expected, strongylid eggs (Trichostrongylidae or *Oesophagostomum* and *Bunostomum* spp., respectively) were the predominant morphotype, followed by *Strongyloides papillosus* and *Capillaria* spp. eggs. In July, cows kept under organic conditions had a significantly lower GIN prevalence in comparison to cows kept on conventional farms. Faecal egg counts were generally low, with the highest value in September and an arithmetic mean of 11.3 eggs per gram faeces (EPG) for all observations. The relationships between GIN infection status and milk yield (kg milk/cow/day), milk protein content (%) and milk fat content (%) for each first test-day record after parasitological assessment were estimated by using linear mixed models. Milk protein content was estimated 0.05% lower in GIN positive compared to GIN negative cows, whereas no significant effect on milk yield or milk fat content was observed. The impact of GIN infection status on success in first insemination (SFI) was estimated by using a threshold model. No significant association was demonstrated between GIN infection status and SFI. Unexpectedly, the fertility parameter days from calving-to-first-service (CTFS) showed a significantly shorter average interval in GIN positive cows. However, these data on reproductive performance need to be considered preliminary as long-term studies are needed to allow a firm prediction of the impact of GIN infection status on dairy cow fertility parameters.

1. Introduction

Pasture based dairy cow production systems are accompanied with gastrointestinal nematode (GIN) infections. *Ostertagia ostertagi* is the most common species with herd prevalences of up to 98% (Bloemhoff et al., 2015) and prevalences of up to 89% in individual cattle (Bellet et al., 2016). For other gastrointestinal nematodes (e.g. *Cooperia* spp., *Trichostrongylus* spp.), prevalences of up to 20% are reported (Agneessens et al., 2000; Borgsteede et al., 2000). Even though GIN infections in adult cattle seldom produce clinical signs and faecal egg counts are generally low (Eysker et al., 2002; Nødtvedt et al., 2002), subclinical infections may negatively impact milk production and fertility of dairy cows, resulting in economic losses for affected farms. In several studies, a positive effect of anthelmintic treatment on milk production was found (Michel et al., 1982; Walsh et al., 1995; Gross et al., 1999; McPherson et al., 2001; Forbes et al., 2004; Ravinet et al., 2014). Nødtvedt et al. (2002) reported that milk yield of pastured dairy cows treated at calving was on average 0.94 kg/day higher than in the untreated control group, whereas no effect on milk composition was found. Lower GIN antibody values and an increase in milk yield of 1.2 kg/cow/day in herds treated with eprinomectin in comparison to non-treated herds, but again no effect on milk protein percentage or milk fat percentage was observed by Charlier et al. (2007). A positive influence of anthelmintic treatment on reproductive performance in

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adult dairy cows has also been reported (Holste et al., 1986; Stuedemann et al., 1989; Hawkins, 1993). Sanchez et al. (2002a) used an *Ostertagia ostertagi* antibody ELISA to assess GIN infection status and observed a significant treatment effect on the calving-to-conception interval, but no effect on the calving to first service interval. Other studies examined the relationship between GIN infections and milk production parameters in untreated, pastured dairy cows using herd antibody levels measured in bulk tank milk (BTM) and reported significant negative associations between GIN antibody levels and milk yield as well as other milk production parameters such as protein or fat percentage (Sanchez and Dohoo, 2002; Sanchez et al., 2002b; Charlier et al., 2005). Guitián et al. (2000) observed a significant association between BTM antibody levels and milk production in summer, but no relationship between antibody levels and annual milk yield or seasonal decline in milk production.

Fewer studies have estimated the association between infection status and milk yield in untreated dairy cows on the individual level (Sanchez et al., 2002b; Perri et al., 2011, Blanco-Penedo et al., 2012). Perri et al. (2011) estimated a significantly lower milk production in GIN positive cows in comparison to GIN negative cows around parturition. In contrast, Blanco-Penedo et al. (2012) showed a significant negative effect of GIN infection status − as assessed by the use of an *O. ostertagi* antibody ELISA − on milk production in multiparous, but not in primiparous cows. However, there is a substantial gap addressing the association between GIN infection status as assessed by the number of eggs per gram faeces (EPG) and fertility or milk production parameters including milk quality in untreated individual dairy cows. EPG likely represents a better indicator of concurrent infection than antibody titres, which persist even after the infection has been eliminated. Therefore, the objectives of the present study were twofold: First, to estimate associations between GIN infection status and main milk production parameters such as milk yield, milk protein content and milk fat content in individual untreated dairy cows; and second, to investigate the influence of a concurrent GIN infection on the most important fertility parameters such as interval from calving to first service (CTFS) and success in first insemination (SFI).

2. Material and methods

2.1. Farms and animals

The present study included 13 organic and 4 conventional German dairy herds in North-West Germany, distributed over 4 federal states: Hesse (HS, n = 2), Lower Saxony (LS, n = 8), North Rhine-Westphalia (NRW, n = 5) and Schleswig-Holstein (SH, n = 2). Herd sizes ranged from 19 to 215 lactating cows, with an average of 72 cows per farm. The selected farms were participants of a “pasture genetics project” with the aim of line comparisons between different selection lines of Black and White dairy cattle in regard to endoparasite infections (May et al., 2017). Therefore, several selection lines per farm were one selection criterion. Other requirements for herd selection were i) no treatments with anthelmintics in the sampling year, and ii) access to pasture not later than 1st of June. Four selection lines of Black and White cattle were included in the study: line 1 = German Holstein cow (GHC) x New Zealand Holstein (NZH) sires (HF-NZ; 72 cows), line 2 = GHC x German Holstein sires with high breeding values for milk yield (HF-GHm; 639 cows), line 3 = GHC x German Holstein sires selected for pasture conditions (HF-GHp; 70 cows). A fourth selection line included local Black and White dual-purpose cows of the *Deutsche Schwarzbunte Niederungsrind* (DSN; 363 cows), the founder of the modern Holstein breed. Some cows fell into the category ‘mixed breed’ (Crosses; 22 cows). They included Jersey, Angler and other crossbreds such as beef cattle mixed with dairy cows.

2.2. Faecal sampling and transport

In total, 1997 faecal samples from 1166 cows were collected in July and September 2015. In July, 16 farms were included in the study and 17 farms in September. As an exception, one of the 16 farms was visited on 29th June in the first sampling period but added to “July” and in the “September” sampling period one of the 17 farms was visited on 5th October. The interval between faecal examinations in July and September was approximately 8 weeks for each farm. Samples were instantly cooled to 4 °C and transported to the Institute for Parasitology, University of Veterinary Medicine Hannover, within 3 h after collection.

2.3. Faecal examinations

Faecal samples were processed on the day of collection or the following day after overnight storage at 4 °C. To estimate the number of gastrointestinal nematode eggs per gram faeces

(EPG) and oocysts per gram faeces (OPG), 4 g faeces were analysed with a modified McMaster technique according to Thienpont et al. (1979), using saturated NaCl as flotation solution. Sensitivity of the technique was 25 EPG. In total, 961 faecal examinations were conducted in July and 1036 in September. Repeated sampling was feasible for 831 cows. Cows with only one parasitological measurement were dry cows on inaccessible pastures or those which left the farm due to health problems.

2.4. Milk production and fertility data of individual cows

The test-day and individual cow data, such as selection line, parity, days in milk (DIM) or fertility information, were provided from the National Genetic Evaluation Center (Vereinigte Informationssysteme Tierhaltung, VIT). Individual test-day cow production data of interest were monthly records of milk yield (kg milk/cow/day), milk protein content (%) and milk fat content (%). For test-day production parameters, a dataset was created including the first test-day after each parasitological examination for each cow. Records with a time span over 40 days between parasitological examination and test-day date were excluded from the analyses. Days in milk was divided into five lactation stage classes according to Huth (1995): ≤14, 14–77, 78–140, 141–231, > 232 days after calving. All cows as of parity five were classified in parity number > 4. The fertility parameters of interest were the interval between calving to first service (CTFS) and the binary coded success in first insemination (SFI) of the current lactation.

2.5. Statistical analysis

All statistical analyses were performed by using the statistical software SAS version 9.4 (SAS Institute; Cary, NC, USA). Descriptive statistics were analysed with FREQ and MEANS procedures. Differences between sampling occasions (July and September) between EPG values of repeatedly sampled cows for each farm were tested by using a Wilcoxon matched-pairs test. The cows were classified in two classes by their GIN infection status (EPG = 0 classified as ‘GIN negative’; EPG ≥25 classified as ‘GIN positive’). Differences between sampling occasions (July and September) for GIN infection status of repeatedly sampled cows and repeatedly sampled farms were assessed by McNemar test, while differences between herd type (organic vs. conventional) were analysed using a Chi squared test. *P*-values ≤ 0.05 were regarded as significant for all analyses.

To test the association between GIN infection status (independent variable) and milk production parameters (dependent variables), the SAS MIXED procedure was used. Based on individual test-day records, the first test-day after each parasitological examination for each cow