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Change in milk production after treatment against gastrointestinal nematodes according to grazing history, parasitological and production-based indicators in adult dairy cows

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ABSTRACT

To investigate future tools for targeted selective treatment against gastrointestinal nematodes (GIN) in adult dairy cows, we evaluated herd and individual cow factors associated with the post-treatment milk production (MP) response over time. A field trial involving 20 pasturing dairy herds in Western France was conducted in autumn 2010 and autumn 2011. In each herd, lactating cows were randomly allocated to a treatment group (fenbendazole) (623 cows), or a control group (631 cows). Daily cow MP was recorded from 2 weeks before until 10 to 14 weeks after treatment. Individual serum anti-*Ostertagia* antibody levels (expressed as ODR), pepsinogen levels, faecal egg count (FEC), and bulk tank milk ODR were measured at the time of treatment. Moreover, in each herd, information regarding heifers' grazing and treatment history was collected to assess the Time of Effective Contact (TEC, expressed in months) with GIN infective larvae before the first calving. TEC was expected to reflect the development of immunity against GIN, and TEC = 8 months was a cautious threshold over which the resistance to re-infection was expected to be established. Daily MP averaged by week was analyzed using linear mixed models with three nested random effects (cow within herd and herd within year). The overall treatment effect was significant but slight (maximum = +0.85 kg/d on week 6 after treatment), and the evolution of treated cows' MP differed significantly according to several factors. At the herd level, cows from low-TEC herds responded better than cows from high-TEC (≥8 months) herds; cows from herds in which the percentage of positive FEC was >22.6% (median value) responded better than those from herds where it was lower. At the individual cow level, primiparous cows, cows with days in milk (DIM) < or = 100 at the time of treatment, and cows with low individual ODR (< or = 0.38) responded better than multiparous cows, cows with DIM > 100, and cows with higher ODR, respectively.

These results highlight the variability of the treatment response, suggesting that whole herd anthelmintic treatment are not always appropriate, and propose promising key criteria for targeted selective treatment for GIN in dairy cows. Particularly, the TEC is an original criterion which lends support for a simultaneous on-farm qualitative analysis of grazing management factors.

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1. Introduction

The prevalence of gastrointestinal nematodes (GIN) infection can be high in pasturing adult dairy cows. In abattoir surveys carried out in Belgium, in The Netherlands and in France, worms were found in 91%, 96% and 84% of the abomasa examined, respectively, *Ostertagia ostertagi* being the most frequently recovered species (Agneessens et al., 2000; Borgsteede et al., 2000; Chartier et al., 2013). Although this infection is considered to be subclinical in most adult cattle, it can induce a decrease in milk production (MP) and could be responsible for chronic and insidious economic losses in adult dairy cows (Gross et al., 1999; Sanchez et al., 2004a; Charlier et al., 2009). Whole-herd anthelminthic treatments have often been proposed as control measures, due to their relatively low cost, ease of use and lack of effective alternative options. However, this blanket application of chemical treatments shows serious potential drawbacks. (i) It could exercise a heavy selection pressure leading to possible emergence and diffusion of anthelmintic resistance, particularly when persistent activity pour-on products are used (Sutherland and Leathwick, 2011; Demeler et al., 2009). (ii) It can leave unwanted residues harmful for the environment (Lumaret et al., 2012). (iii) It can also negatively impact the image of vets and farmers, especially with the increasing societal demand for circumspect use of drugs. A reduction in the use of anthelmintics is therefore needed.

The distribution of parasites in adult dairy cows is overdispersed: a majority of cows has a low parasitic burden due to their resistant status to new infection, whereas some cows have a parasitic burden supposed to be high enough to negatively impact MP (Agneessens et al., 2000; Borgsteede et al., 2000). Thus, at the individual cow level, we can hypothesize that the impairment of MP is variable. Moreover, at herd level, a between-herd variability of this negative impact on MP has been also reported (O'Farrell et al., 1986; Ploeger et al., 1989, 1990; Mason et al., 2012). Consequently, we need indicators to discriminate herds and cows within herds that would benefit from a targeted selective treatment.

Several studies have focused on the relationships between parasitological indicators and MP response to anthelmintic treatment. The value of the anti *O. ostertagi* antibody level (in serum or milk) to predict MP response has been widely examined, with inconclusive results. At the individual cow level, several studies have suggested that a beneficial treatment response can be expected for cows with high milk *O. ostertagi* antibody levels (Sanchez et al., 2002, 2005; Vanderstichel et al., 2013). However, Charlier et al. (2010) highlighted that the value of this parasitological indicator remains equivocal to predict individual MP response. At the herd level, the mean herd serum *O. ostertagi* antibody titre and the bulk tank milk (BTM) *O. ostertagi* antibody level were found to be potentially good predictors of the MP response (Ploeger et al., 1989; Kloosterman et al., 1996; Sithole et al., 2005; Charlier et al., 2007); but these results, depending on studies, were either not confirmed (Ploeger et al., 1990), or lacked statistical significance (Kloosterman et al., 1996; Sithole et al., 2005), or were not fully consistent (Charlier et al., 2007). The values of faecal egg counts (Michel et al., 1982; O'Farrell et al., 1986; Sithole et al., 2005) and serum pepsinogen concentrations (O'Farrell et al., 1986; Ploeger et al., 1989, 1990) were only investigated at the herd level and were not related to the treatment response. Among herd level indicators, the duration of contact with GIN larvae before the first calving (grazing history), reflecting at least in part the resistance to reinfection (Vercruysse and Claerebout, 1997), has never been studied regarding its relation with treatment response. However, we can assume that it could contribute to explain the variability of the effect of anthelmintic treatment on MP.

Production-based indicators have also been investigated for their impact on MP response to anthelminthic treatment. Parity was reported to be related to the treatment response by Charlier et al. (2010) and McPherson et al. (2001), with a better response for multiparous cows, whereas in other studies parity did not influence the MP response (Mason et al., 2012; Ploeger et al., 1990; Michel et al., 1982; O'Farrell et al., 1986). Similarly, production level was found to be positively and significantly linked to the treatment response in one study (Ploeger et al., 1989), but did not interact with treatment in other studies (Ploeger et al., 1990; Mason et al., 2012). Finally, it was suggested that a positive MP response only occurred when the treatment was performed in the first half of lactation (Charlier et al., 2010), or that cattle responded maximally to treatment during mid lactation (Mason et al., 2012).

When studying relationships between indicators and MP response to anthelmintic treatment, different approaches have been used (Ploeger et al., 1989, 1990; Charlier et al., 2007; Vanderstichel et al., 2013). However, there is no study in which grazing history, individual cow production-based indicators as well as individual and herd-level parasitological indicators have been examined all together in the same sample.

The objectives of this study were, in adult pasturing dairy cows, (1) to assess the effect of an anthelmintic treatment on MP over time, (2) to identify factors associated with the treatment response at both the herd and individual cow level, by investigating, on the same sample, the relationships between treatment response and grazing history, production-based as well as parasitological indicators. The factors identified could then be candidate indicators for targeted selective treatment against GIN.

2. Materials and methods

2.1. Farms and animals

The study sample was a convenience sample, constructed thanks to a network of contacts between the Nantes-Atlantic College of Veterinary Medicine and Food Sciences and Engineering (Oniris), veterinarians and farmer organizations. The major herd recruitment criteria were the breed (Holstein), an access to pasture during a large grazing season (at least 4 months on pasture with a use of grass in the diet), the absence of anthelmintic treatment on adult dairy cows, and a daily recording of milk production (automatic milking system, or milking parlor with milk meters). In each farm, the majority of the lactating