Risk of gastrointestinal nematodes infection during the first grazing season of dairy calves raised by nurse cows in organic farms

Introduction

The rearing of dairy calves with nurse cows has been implemented by farmers and is increasingly widespread in the West part of France, particularly in organic farms. This technique is perfectly suited to highly grassy systems on organic farms where calves have a long first grazing season with their nurse. Infections by gastrointestinal nematodes (GIN) are very common in grazing cattle in temperate regions. Among GIN species, *Ostertagia ostertagi* is the most pathogenic and is responsible for production losses, or even diarrhea in naïve first grazing season cattle (Ploeger and Kloosterman 1993). No study is available on the dairy calves/nurse cows system on pasture; thus, the objective of our study was to assess the impact of such a management on the GIN infection of calves.

Focus on gastrointestinal strongyles in grazing calves

The *Ostertagia ostertagi* cycle consists of two phases (fig. 1): a free (external) phase in pasture during which eggs excreted in the faeces evolve into the infective L3 larval stage, and a parasitic (internal) phase in cattle during which L3 larvae ingested by the bovine evolve into adult worms in the abomasum. The duration of the external phase is strongly influenced by temperature (5-7 days at 22-25°C). The internal phase lasts on average 21 days during the grazing period, but it can be lengthened in winter by the phenomenon of hypobiosis: the larvae become encysted in the wall of the abomasum and do not resume their development until the beginning of the following spring.

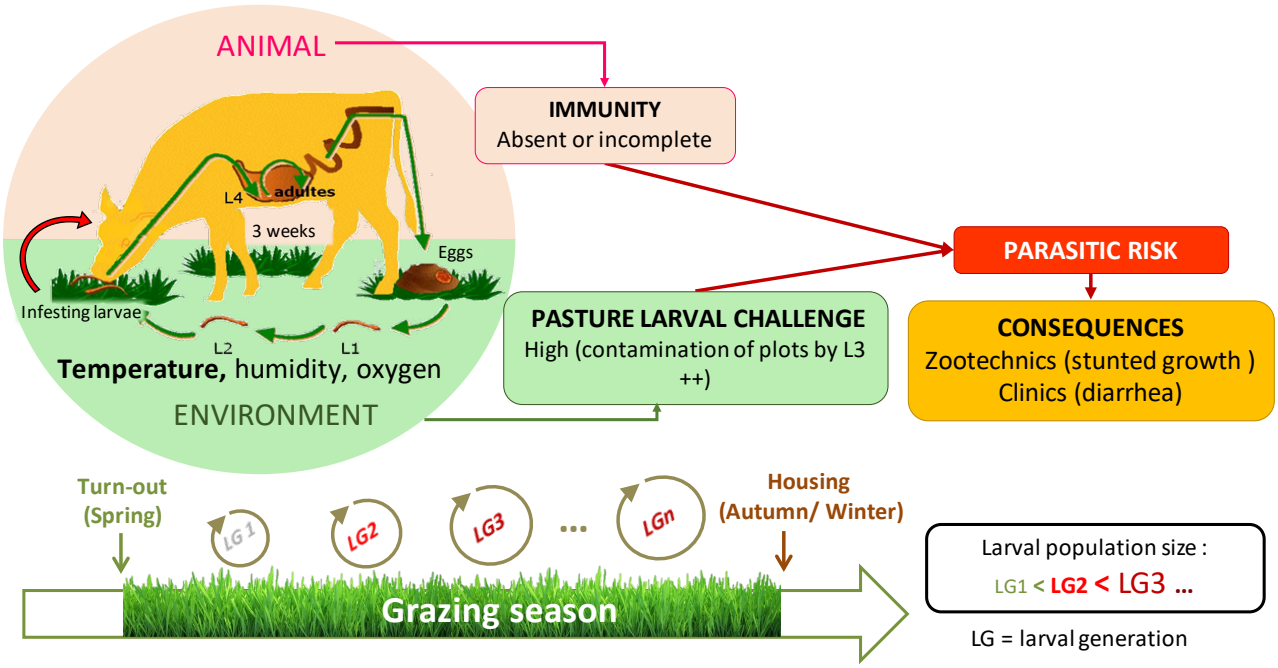

Figure 1. *Biological cycle of* Ostertagia ostertagi*, increased infection pressure for a group of young non-immune cattle and components of the parasitic risk related to digestive worms (LG = larval generation=1 full cycle including internal and external phases)*

Six to ten months of contact with the infective larvae is necessary for immunity to develop gradually in cattle. This immunity, usually acquired during the second grazing season, does not prevent the infestation, but limit the worm burden.

The parasitic risk associated with GIN is the likelihood that the infestation will result in growth retardation or even diarrhea. This risk will be greater if animals have no or incomplete immunity and graze on paddocks with high L3 (high infestation pressure) contamination. In a group of non-immune heifers, the parasite risk increases during the grazing season. Indeed, parasite cycles follow one another and generate several larval generations (GL) on the pasture: GL1 when the first cycle of the year is completed, then GL2 at the end of the second cycle, then GL3, etc. From one parasite cycle to the next, the size of the larval population on the paddocks increases and the infestation pressure increases (fig. 1).

Study design

Our study sample included 38 groups of calves reared with nurse cows from 30 organics dairy farms located in the northwest of France (464 calves and 204 nurse cows in total). These calves were mainly cross-bred (83%). The number of calf per group varied from 2 to 39 (average 12.2) and the number of nurses per group varied from 1 to 18 (average 5.4), with a mean ratio of 2.6 calves per nurse. Only 17 calves (3%) were treated with anthelmintics during the grazing season.

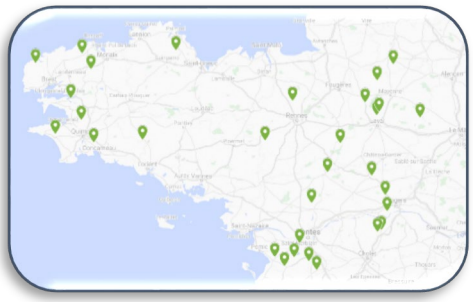

Figure 2. *Geographical distribution of the farms included in the study*

Each farm was visited twice. The first visit in August 2018 aimed at collecting all the information regarding the rearing and grazing management practices (period of birth, dates of turnout, weaning and housing, number of paddocks used, time spent on each paddock…). The second visit occurred at the end of the grazing season (from the end of October 2018 to mid-January 2019) to collect blood and faecal samples for each calf.

The number of GIN eggs per gram of faeces (epg) was determined in each faecal sample (Mini-FLOTAC technique with a sensitivity of 10 epg) (Cringoli et al. 2017). The mean egg output and the % of calves shedding more than 100 epg was calculated in each group. This % was categorized in two classes according the median value. Individual serum pepsinogen concentrations were determined according to Kerboeuf et al. (2002), and expressed as units of tyrosine (U Tyr). The serum pepsinogen level is an indicator of abomasum mucosa damage and a predictor of the number of abomasal worms at the end of the grazing season. The mean pepsinogen level was calculated in each group and was categorized in two classes according to the threshold 1.5 UTyr which is closed to the limit of 2.0 indicating type I ostertagiosis (Kerboeuf et al. 2002).

Table 1. *Benchmarks for interpreting the 3 indicators in first season grazing heifers (opg: eggs per gram of feces).*

Risk interpretation	Pepsinogen (U Tyr)	Coproscopy (eggs per gram of faeces)	Maximum number of larval generations on pasture
Low	0.6 to 1.5	Less than 50	0 to 2
Medium	1.5 to 2.0	50 to 200	3 to 4
High	More than 2.5	More than 200	More than 4

To estimate in each group the pasture infectivity level, i.e. the level of GIN infective larvae on pasture, a model was used (Parasit'Sim) (Chauvin et al. 2009). The pasture infectivity was modeled by calculating the number of biological *Ostertagia* cycles (= Larval Generation) realized since turnout on each paddock, taking into account local daily average temperatures (nearest station to the farm) and the grazing management practices described for each group. As each biological cycle produces a new *Ostertagia* larval generation (LG) on pastures, this model could simulate the maximal number of LG met by the animals since turnout (LG1, LG2, etc…).

Description of the grazing management indicators

32 groups were composed of calves mainly born in Spring and 6 groups of calves born in Autumn. Thus, turnout took place from the end of February to the beginning of October, at the age of 44 days on average (0-195 days). The mean duration of the grazing season was 195 days (70-302 days). Calves were mainly

weaned at housing, except in 5 groups where the weaning took place during the grazing season (from May to October) with a post-weaning grazing period without nurse cows afterwards.

Grazing management practices did not differ according to the calving season. Continuous grazing was used for only 3 groups whereas 14 groups grazed on successive paddocks without return and 21 groups were conducted on rotational grazing.

Thus, the majority of the dairy calves raised with nurse cows had a long first grazing season and a turnout at an early age compared to conventional system where heifers graze alone (Merlin et al. 2016). This could clearly increase the risk of higher gastrointestinal nematodes infection on pasture. Since weaning was carried out in most cases during the winter season indoors, most calves were with nurse cows throughout their first grazing season.

Description of parasitic indicators

By modelling the grazing management using Parasit'sim, two-thirds of the groups (26 /38 groups) met at least the 4th larval generation during their first grazing season which is normally considered as a high risk situation (Chauvin et al., 2009; Merlin et al., 2017).

However, the average values per group of serum pepsinogen were low (1.12 U Tyr) compared to other studies of dairy heifers in the first grazing season in organic or conventional farms: 2.4 U Tyr and 2.0 U Tyr respectively (Merlin et al. 2018). This value was below the threshold of 1.5 U Tyr for 26 batches (70% of the batches) and the other values did not exceed 2.5 U Tyr. It was strongly associated with pasture infectivity: the higher the number of larval generations the higher the pepsinogen levels (odds ratio = 13.4), although it is quite unexpected to observe 14 batches displaying low pepsinogen levels despite a pasture infectivity ≥4 (Table 2).

Table 2: *Distribution of study batches according to the maximum number of larval generations encountered on the grazed paddocks and according to their pepsinogen value.*

	Low risk			Medium risk		High risk		
Maximum number of larval generations on pasture	LG0	LG1	LG2	LG3	LG4	LG5	LG6	LG7
Number of batches	1	2	5	4	11	6	7	2
Number of batches with pepsinogen <1.5 U Tyr	12				14			
Number of batches with pepsinogen ≥ 1.5 U Tyr	0				12			

Lastly, the average egg excreted per batch was medium (130 +/ 125). The percentage of animals that excreted more than 100 epg was on average 38% animals per batch with a median of 36% animals. Only 9 calves excreted more than 500 epg. This egg excretion level is in the lower range of what was observed in other studies in suckler or dairy herds (Shaw et al. 1997; O'Shaughnessy et al. 2015).

Hypothesis of a dilution effect related to cow-calf grazing system on the parasite dynamics

EPG and pepsinogen values measured in our study indicated a low GIN infection when calves are reared with nurse cows. However, the estimation of the number of larval generations on the paddocks indicated a high grass infectivity according Parasit'Sim. Globally, our results suggest that the presence of the nurses could have a diluting effect on the parasitic risk to the calves.

Nurses cows, that have acquired immunity against GIN, would ingest large number of larvae from the pasture but would excrete only small amounts of eggs. They would therefore have a kind of sanitizing effect on the paddocks. In addition, since the calves are not weaned, they drink milk from the nurse's udder, thus ingesting less grass and would therefore be less exposed to the larvae present in the paddock. On the other hand, ingestion of milk by calves during the grazing period could have an adverse effect on parasite infection as it has been demonstrated in lambs with *O. circumcincta* (Zeng et al., 2001).

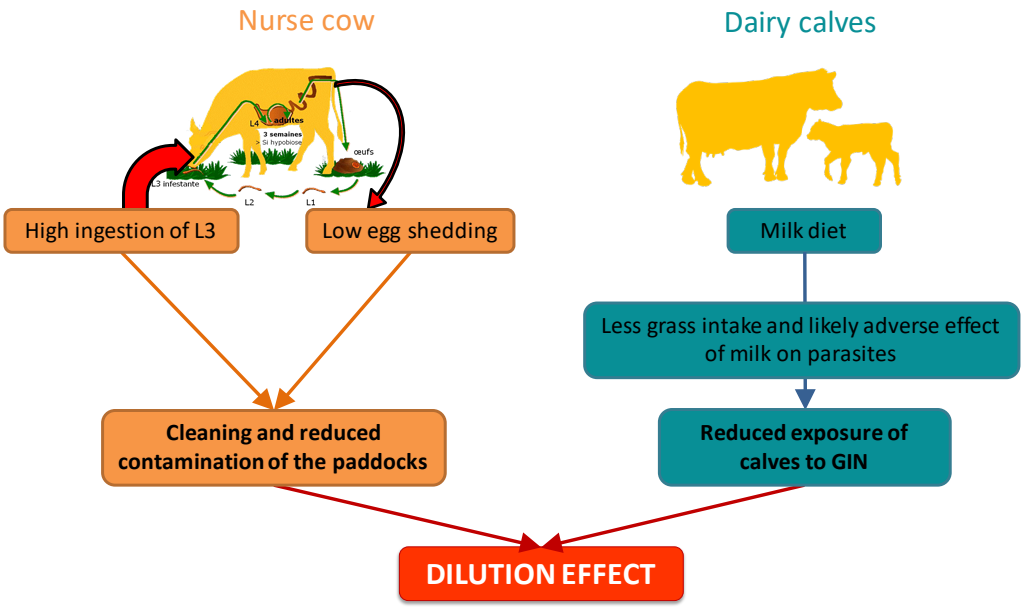

Figure 3. *Hypothesis to explain the low GIN infestation in calves with nurse cows*

This study is still on going. The calves will be followed during their second year of grazing, after weaning, to assess the level of GIN infection and more widely the influence of this innovative rearing practice on animal health and performance.

Bibliographical references

Chauvin A, Vermesse R, Lardoux S, Masson M & Ravinet N (2009) Parasit'Info: un système expert d'aide à la gestion du risque des strongyloses disgestives et de la fasciolose en élevage bovin. Le Point Vétérinaire 40, 29–30.

Cringoli G, Maurelli MP, Levecke B, Bosco A, Vercruysse J, Utzinger J & Rinaldi L (2017) The Mini-FLOTAC technique for the diagnosis of helminth and protozoan infections in humans and animals. Nature Protocols 12, 1723–32.

Kerboeuf D, Koch C, Le Dréan E & Lacourt A (2002) Méthode simplifiée de mesure de la concentration en pepsinogène dans le sérum. Revue Médecine Vétérinaire 153,707–712.

Merlin A., Chauvin A., Lehebel A., Brisseau N., Froger S., Bareille N. & Chartier C (2017) End-season daily weight gains as rationale for targeted selective treatment against gastrointestinal nematodes in highly exposed first-grazing season cattle. Preventive Veterinary Medicine, 138, 104-112.

Merlin A., Chauvin A., Madouasse A., Froger S., Bareille N. & Chartier C (2016) Explaining variability in first season grazing heifer growth combining individually measured parasitological and clinical indicators with exposure to gastrointestinal nematode infection based on grazing management practices. Veterinary Parasitology, 225, 61-69.

Merlin A., Ravinet N, Madouasse A, Bareille N, Chauvin C & Chartier C (2018) Mid-Season targeted selective anthelmintic treatment based on flexible weight gain threshold for nematode infection control in dairy Calves. *Animal* 12, 1030–40.

O'Shaughnessy, J, Earley B, Mee FL, Doherty ML, Crosson P, Barrett D & De Waal T (2015) Nematode control in suckler beef cattle over their first two grazing seasons using a targeted selective treatment approach.*Irish Veterinary Journal* 68.

Ploeger HW & Kloosterman A (1993) Gastrointestinal nematode infections and weight gain in dairy replacement stock: first-year calves. Veterinary Parasitology 46, 223-41.

Shaw, DJ, Vercruysse J, Claerebout E, Agneessens J & Dorny P (1997) Gastrointestinal Nematode Infections of First-Season Grazing Calves in Belgium: General Patterns and the Effect of Chemoprophylaxis. *Veterinary Parasitology* 69, 103–16.

Zeng S, Lawton DEB, Przemeck SMC, Simcock DC & Simpson HV (2001): Reduced Ostertagia circumcincta burdens in milk-fed lambs, New Zealand Veterinary Journal, 49, 2-7.

This study was conducted within the BIOEPAR research unit in Nantes, by Caroline Constancis, Morgane Leligois, Nadine Brisseau, Anne Lehebel, Alain Chauvin, Nathalie Bareille, Christophe Chartier and Nadine Ravinet, with the technical assistance of Déborah Menard. This epidemiological study could not have been done without the valuable participation of French organic dairy farmers.

For more information:

Caroline Constancis: PhD student INRAE caroline.constancis@oniris-nantes.fr

Christophe Chartier: Professeur ONIRIS christophe.chartier@oniris-nantes.fr

Nadine Ravinet: Lecturer ONIRS nadine.ravinet@oniris-nantes.fr