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Consequences of the regular distribution of sainfoin hay on gastrointestinal parasitism with nematodes and milk production in dairy goats☆

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Abstract

The objectives of the current study were to examine the potential effects of distribution of sainfoin hay on nematode parasitism in a producing herd and to measure the consequences on milk production. The survey was performed in an experimental herd of 120-dairy-goat farm during a whole 9-month grazing season. Every month, 60 goats received indoors on average 1.36 kg of sainfoin hay for 10 days whereas the 60 remaining goats were used as controls, thus receiving the same amount of lucerne hay at the same time. The nutritional values of both hays were comparable except that concentrations of condensed tannins was higher in sainfoin than in lucerne hay, i.e. 2.52% versus 0.7% of diet DM. Intakes of the two types of hay were recorded along with each period. Individual faecal and blood samples were performed monthly to compare parasitological and pathophysiological parameters in the two groups. Milk yield, fat and protein contents were measured fortnightly. A higher consumption of hay was repeatedly recorded in the sainfoin versus the control group. Irrespective to dietary treatment, nematode egg excretions were low during the whole season. Meanwhile, egg output was significantly lowest in the sainfoin group, but the composition in nematode genera was similar among the two groups. Based on a semi quantitative index for assessment of faecal consistency, a lower faecal dry matter content was also found in goats from the sainfoin group. The two animal groups exhibited similar milk yield, fat and protein contents. The differences in egg excretion between the two groups might be due to higher intake of hay in the barn thus to low consumption of grass, a source of parasite infection, or to the effect of some secondary compounds, like tannins. Whatever the mechanism involved, our results suggest that a regular distribution of sainfoin hay to dairy goats might be associated with a reduction in parasitism with gastrointestinal nematodes, without negative consequences on milk production.

Keywords: Sainfoin; Tannins; Gastrointestinal parasites; Milk production; Grazing dairy goats

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1. Introduction

The use of chemical treatments to control nematode infections of the gastrointestinal tract of dairy goats in France is nowadays impaired by several limits. Some benzimidazole molecules remain the only broad spectrum anthelmintics still authorized without withdrawal time during lactation. However, recent surveys on anthelmintic resistance in French dairy goat farms indicated a high prevalence of benzimidazole resistance in worm populations (Chartier et al., 1998, 2001). Therefore, this phenomenon limits severely the efficiency of the chemical treatments to control nematode parasitism (Jackson and Coop, 2000). Moreover, the concern of consumers on the use of drugs in farm industry is increasing. These reasons explain why novel alternative methods to control parasitic nematodes are particularly needed in the French dairy goat industry. Recent studies (see reviews by Kahn and Diaz-Hernandez, 2000; Min and Hart, 2002) showed the negative effects of feeding several tanniferous plants, mainly legume forages, on host parasitism. Goats experimentally infected and receiving quebracho, a condensed tannin source, showed significant decrease of egg excretion and/ or worm numbers (Paolini et al., 2003b,c). Some traits of worm biology were significantly affected in does naturally infected and given sainfoin during short periods (Paolini et al., 2003a, 2005). However, these results were obtained on non lactating, culled goats and on a relatively short period of survey.

The objectives of the current study were to examine the positive effects of the consumption of sainfoin hay on nematode parasitism in a producing herd and to assess the consequences on milk production during a whole grazing season, as information on the use of tanniferous plants in dairy lactating infected animals were still lacking.

2. Materials and methods

2.1. Experimental design

A survey was performed in an experimental farm in the south-east of France, from end of March to November 2003. The goats were free of trichostrongyle infections at the start of the grazing season, having been treated indoors with an anthelmintic during winter. The 120-dairy goat herd was first grazing for 1 month on different pastures to homogeneise the infection level. In early April, the herd was divided into two equal groups, which were balanced according to age and milk production at the start of the assay. The two groups grazed on separate sets of pastures but with similar stocking rates and grass composition. The grazing chronology and experimental design is summarised in Table 1. Group S, which was composed of 60 goats, received indoors sainfoin hay for 10 days every month. Meanwhile, the control group (Group C), composed with the 60 remaining goats, received lucerne hay for the same period. On each period, similar amount of hay were distributed per group, i.e. on average 1.36 kg/(goat day) (Table 1). Overall, the nutritional values of the two hays, sainfoin and lucerne, were comparable, except for the tannin contents. The condensed tannins were extracted and analysed according to the procedure of the European Pharmacopea (2001). The sainfoin and lucerne hays contained respectively 2.52 and 0.7% of tannins (DM basis).

2.2. Measurements

The hay refusals per group were measured daily throughout each 10-day period of distribution. Individual samples of faeces and blood were collected from groups S and C at the start of experiment and then, monthly, after each period of hay distribution. The samples were used for measurements which were related either to the nematode populations or to the pathophysiological consequences of parasitism for the host (consistency of faeces, blood pepsinogen and phosphate values). Individual egg excretion was measured according to a modified Mc Master technique described by Raynaud (1970), using NaCl with a density of 1.22 as the flotation medium. Larval cultures were performed and the larvae were identified.

The consistency of faeces was evaluated through a semi quantitative method of evaluation (Cabaret et al., 2002; Cabaret, 2004), scoring the faeces from 0 to 4, with the higher values corresponding to softer faeces. Seric pepsinogen values were determined according to the method described by Berghen et al. (1987). Phosphate values were determined as described by Robinson et al. (1971). Milk yield, fat and protein contents were measured fortnightly on each group.

Table 1
Summarised experimental design and feeding calendar of the two experimental groups

	Group	3rd March/3rd April Period 1	4th April/8th June Period 2			9th to 30th June Period 3	1st July/14 th Sept. Period 4		15th Sept./31st Oct. Period 5	
Type of management	S	Common grazing: gramineous pasture	Gramineous pasture			Lucerne	Indoors		Gramineous pasture	
	C		Gramineous pasture			Lucerne	Indoors		Gramineous pasture	
Hay			D1	D2	D3	D4	D5	D6	D7	D8
Hay offered/(goat day) (kg)	S		1.24	1.26	1.18	1.40	1.46	1.57	1.27	1.54
	C		1.24	1.27	1.13	1.41	1.52	1.53	1.29	1.60
% Refusals/(goat day)	S		11.6	11.4	13.7	5.3	13.0	NP	NP	11.0
	C		18.3	25.2	19.7	8.0	5.3	NP	NP	15.0

The whole grazing season was divided into five main periods. During period 1, all the goats grazed together the same pastures in order to homogeneise the contamination with nematodes. The goats were maintained indoors on period 4 due to the lack of grass. The second experimental groups of goats grazed separate pastures of similar size on period 2, 3 and 5. The eight periods of distribution of sainfoin or lucerne hay are indicated from D1 to D8. During the whole grazing season, the goats received indoors 0.7 kg of a mixture of commercial concentrate and cereals. In addition, during two periods, each goat received indoors 2 kg (period 1) or 2.5 kg (period 4) of lucerne hay/day.

2.3. Statistical analysis

Data on faecal egg counts were transformed as log 10 $(x+1)$ before being analysed. The comparisons between the two groups for egg excretion, pepsinogen and phosphate values, scores of faecal consistency, milk yield, fat and protein contents were performed using variance analysis on repeated values (Systat 9.0 Software for Windows; SPSS Inc., Chicago, USA). In addition, the comparison of nematode genus composition between the two experimental groups was performed using the X^2-test using the same software.

3. Results

Throughout the whole experiment, goats consumed more sainfoin hay than lucerne. Refusals at the different periods averaged 11.0% in the sainfoin group and 15.3% in the lucerne group (Table 1).

The levels of nematode infections, indicated by egg excretion, were low throughout the whole grazing season. The peak of egg output observed in october did not exceed 400 eggs per gram (epg). Group S exhibited lower ($P<0.05$) egg excretion than group C (Fig. 1). This decrease in egg output was not associated with any change in the composition of nematode genera (Fig. 2). The majority of larvae recovered was composed of *Teladorsagia*, which was abundant in spring and *Trichostrongylus*, which increased in autumn.

The indexes of faecal consistency was lower ($P<0.05$) in sainfoin hay group than in lucerne group (Fig. 3). Indexes were higher in spring indicating the presence of softer faeces, then back to lower values in summer, when goats of both groups were maintained indoors. In contrast, a similar pattern was observed in the evolution of pepsinogen and phosphate values in the two groups.

Milk yield and milk protein and fat contents were similar among the two groups (Table 2).

4. Discussion

The particularly dry climatic conditions in summer 2003 and the lack of grass explain the nearly 10-week indoor maintenance of the goats from July to mid September. These factors explain that the level

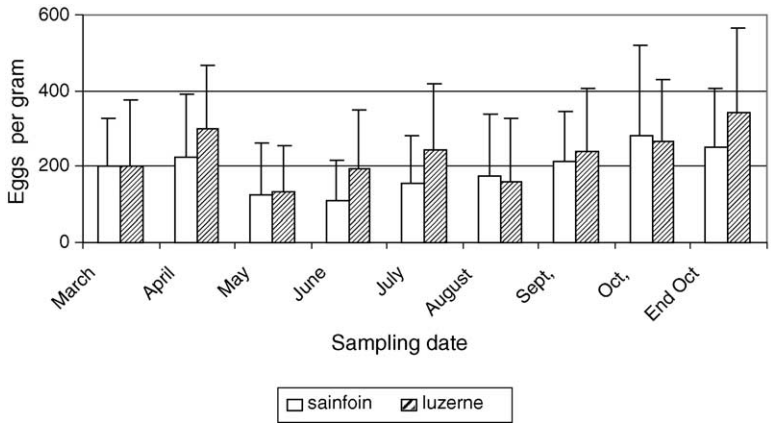

Fig. 1. Comparison of faecal egg counts (mean values + S.D.) in goats receiving or not sainfoin hay. The samples were performed at the start of the experimental period of study and after each 10-day period of hay distribution. The statistical analysis of variance on repeated measurements have shown a significant difference between the two groups ($P < 0.05$).

of nematode infection was exceptionally low in 2003, particularly in autumn, when compared to previous epidemiological data obtained on the same goat farm (Hoste et al., 1999). Nevertheless, despite this low parasitic challenge, egg excretion in does fed on sainfoin hay was significantly lower than that measured in the lucerne group. This result suggests that the regular distribution of sainfoin hay might contribute to modulate the epidemiology of trichostrongyle infections, by decreasing nematode egg excretion and therefore, by limiting the pasture contamination. These findings are in line with previous data obtained in stall-fed (Paolini et al., 2003a) and in grazing goats (Paolini et al., 2005) given sainfoin hay. Similarly, the consumption of *Lespedeza cuneata* hay by Spanish × Boer goats resulted in a significant decrease of parasite egg output (Shaik et al., 2004).

Sainfoin is a condensed tannin-rich legume forage (Bate-Smith, 1973; Borreani et al., 2003). Several circumstancial evidence, obtained with other tanniferous legume forages, e.g. sulla (*Hedysarum coronarium*), birdsfoot trefoil (*Lotus corniculatus)*, maku (*Lotus pedunculatus*), or *Sericea lespedeza* suggest that condensed tannins (CT), might have some anthelmintic

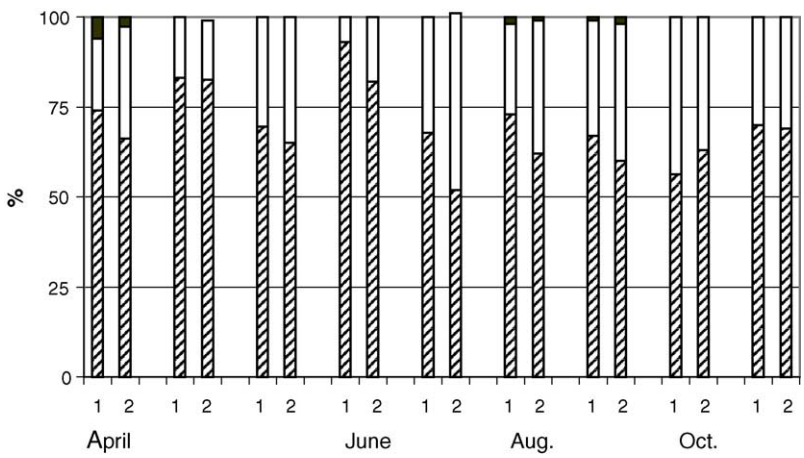

Fig. 2. Composition of nematode genera obtained from larval culture performed on the pooled faeces from the two experimental groups from beginning of April to October: (▨) *Teladorsagia*, (□) *Trichostrongylus*, (■) *Nematodirus*; (sainfoin = 1; control = 2).

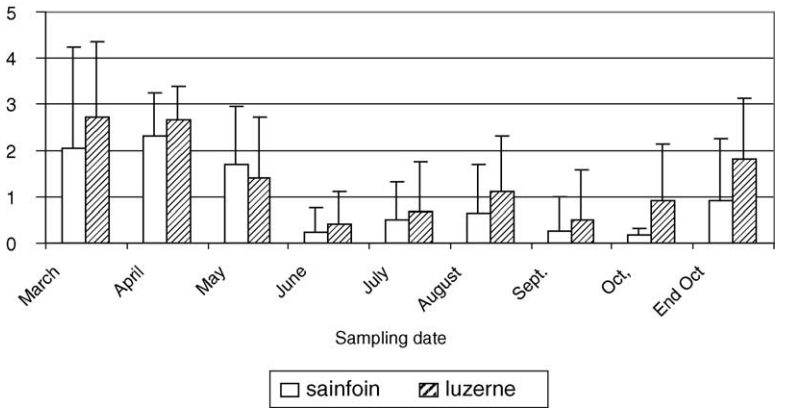

Fig. 3. Comparison of the semi quantitative evaluation of faecal consistency (mean values + S.D.) in the two groups of goats receiving or not sainfoin hay on a monthly basis. Higher scores correspond to softer faeces. Statistical analysis of variance on repeated measurements have shown a significant difference between the two groups ($P < 0.05$).

properties affecting the biology of parasitic nematodes (Athanasiadou et al., 2003; Kahn and Diaz-Hernandez, 2000; Niezen et al., 1998a,b, 1995; Marley et al., 2003; Min et al., 2003b). This has been partly confirmed through in vitro studies where the activity against trichostrongyles of extracted CT or monomeric units of these polyphenolic compounds has been examined (Molan et al., 2000, 2003). Consequently, the hypothesis that sainfoin CT might be responsible for the moderate decrease in egg output observed in the current study, can be put forward. On the other hand, the fact that the indoor consumption of sainfoin hay was higher than for the lucerne hay has also to be taken into account. This could lead in the sainfoin group to a lower consumption of grass when grazing and therefore a decreased challenge with infective third stage larvae present on pastures. Further studies using PEG, a tannin-deactivating agent, are needed to discriminate between these two hypotheses.

The moderate levels of parasite infection observed during the study explain the mild changes related in the pathophysiological consequences. Despite this, some of the current results suggest a positive effects on the host resilience, as illustrated by the better faecal indices observed in the goats fed sainfoin. Under severe conditions of nematode parasitism, the consumption of tannin-rich forages or woody plants (Kabasa et al., 2000; Paolini et al., 2005) was also associated with a better ability of the hosts to withstand the negative effects due to the parasitic challenge. This was

Table 2
Comparison of milk parameters in the two experimental groups of dairy goats receiving or not sainfoin hay at monthly intervals for the whole experimental period

	1	2	3	4	5	6	7	8	9	10	11	12
Milk yield (l)												
Sainfoin	4.61	4.56	4.57	4.67	3.72	4.37	3.74	3.64	3.78	3.24	3.06	2.57
Control	4.62	4.65	4.48	4.73	3.86	4.39	3.92	3.49	3.71	3.54	3.12	2.67
Fat content (g/l)												
Sainfoin	36.0	34.6	33.6	34.9	32.7	29.8	29.8	31.8	31.4	28.3	32.4	33.0
Control	38.2	37.3	34.3	35.5	32.5	31.8	31.1	33.5	32.6	28.6	32.6	34.3
Protein content (g/l)												
Sainfoin	32.4	32.7	31.1	30.4	29.3	29.5	29.3	29.6	30.6	30.3	33.2	36.8
Control	32.9	33.3	31.9	30.8	29.8	29.9	29.1	30.1	30.5	30.2	33.3	35.8

The measurements were performed at fortnightly interval, from the beginning of April (Date 1) to the end of November (Date 12).

assessed either through measurements of pathophysiological blood parameters, clinical signs or production criteria.

To our knowledge, this study was the first one to investigate the effect of feeding tanniferous forages on milk production in goats infected with nematodes of the gastro-intestinal tract. Our results suggest that the concentration of CT in the diet is a major factor to consider to explain the antiparasitic activity. At high concentrations CT (>6–7% of diet DM), negative effects on protein digestibility have been mentioned in ruminants (Barry and McNabb, 1999; Min et al., 2003a), with negative consequences on milk production evoked in dairy goats (Decandia et al., 2000). In contrast, at lower concentrations, positive effects of CT on by-pass proteins and milk production have been described in dairy cattle (Woodward et al., 1999; Min et al., 2003a) or in dairy ewes (Wang et al., 1996). In the current study, the data acquired on milk underlined that the consumption of sainfoin was not associated with any detrimental consequence on both milk yield and quality (fat and protein contents).

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