Sainfoin – New Data on Anthelmintic Effects and Production in Sheep and Goats

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Abstract

Gastrointestinal nematodes (GIN) are one of the most important problems affecting health and therefore performance and welfare in small ruminant husbandry. The control of these parasites in the past strongly relied on the repeated use of anthelmintic drugs. This has led to nematode populations which are resistant to most of the currently available anthelmintics. Furthermore customer's demands for organic and residue free animal products are increasing. The aforementioned problems have given a strong impetus for the development of new non-chemical strategies to control GIN. Previous research has pointed out the anthelmintic potential of sainfoin (*Onobrychis viciifolia)* and other tanniferous (CT) feed sources in goats and lambs infected with GIN. A recent Swiss experiment focussed on the use of sainfoin and field bean (*Vicia faba*, cv. Scirocco) as single CT sources as well as in combination for additional synergic effects, to reduce periparturient GIN egg rise of ewes in late gestation and early lactation. Another experiment with Alpine goats concentrated on the influence of sainfoin on milk performance and cheese quality. The results of these experiments will be presented and discussed in connection with previous knowledge on (i) anthelmintic effects of sainfoin and (ii) the influence of sainfoin administration on performance.

Introduction

Infections with nematode parasites remain a major threat to small ruminants worldwide. This is particularly relevant in grazing livestock systems. As organic farm animals should have daily access to pasture (or an open-air based exercise area), contact and therefore infection of goats and sheep with pasture borne-parasites is unavoidable. At the same time, the IFOAM Basic Standards for Organic Production (IFOAM, 2005) suggests the use of natural remedies and treatments. This commits organic farmers to use preventive procedures to minimise the use of chemotherapeutic treatments. However, the abdication of anthelmintics only works to some extent, as therapeutic application often remains essential to cure livestock suffering severe infection with gastrointestinal nematodes (GIN) (Waller and Thamsborg, 2004). The emphasis on preventive procedures on the one hand and increasing nematode populations resistant to anthelmintics on the other hand (Besier and Love, 2003; Jackson and Coop, 2000; Voigt et al., 2012; Waller et al., 1996), constrains farmers and scientists to find novel solutions for a sustainable control of GIN. Promising approaches such as grazing management, genetic selection, nutrition and nutraceuticals have been investigated (Hoste and Torres-Acosta, 2011). Nutraceuticals amongst other, refer to feeds containing plant secondary metabolites such as condensed tannins (CTs). CTs are assumed to have a direct anthelmintic effect (Hoste and Torres-Acosta, 2011). In Central Europe (e.g. France, Switzerland) studies have focused on the anthelmintic effect of the tannin containing legume sainfoin (*Onobrychis viciifolia*) of the *fabaceae* family (Heckendorn et al., 2007; Heckendorn et al., 2006; Paolini et al., 2005). The choice of this species is mainly linked to its comparatively good agronomic properties under Central European climate conditions (Häring et al., 2007), amongst which the tolerance of *O. viciifolia* to cold, drought and low nutrient status are of particular importance (Carbonero et al., 2011).

Although a substantial body of knowledge on anthelmintic properties of sainfoin have been compiled with respect to lambs, the impact of sainfoin feeding on periparturient egg rise (PPR) in ewes or the effect of sainfoin administration on product quality of dairy sheep and goats (e.g. milk, cheese) have not been investigated so far. We therefore designed a study (Study 1) to investigate the effect of the administration of a sainfoin diet to reduce parasite egg excretion of PPR ewes and its potential to minimise pasture contamination during PPR when animals are turned out on pasture after lambing. Additional to sainfoin, in this study, the anthelmintic properties of a tannin rich concentrate (*Vicia faba*) was investigated. The rationale of the PPR is, that ewes in late gestation and early lactation often show an increased susceptibility to nematode infection. In another experiment (Study 2) we looked at the impact of sainfoin administration on the quality of goat milk and cheese. The background of this work was the reluctance of farmers to use sainfoin as fodder with anthelmintic properties without knowing the effect this might have upon product quality.

Study 1: Effect of sainfoin and faba bean on GIN in periparturient ewes

A herd of Red Engadine ewes in late gestation was randomly distributed to four comparable groups. To allow a differentiation of the effect of single CT sources (e.g. sainfoin and faba bean) and their combination, the following groups were established: A control group (C) received a ryegrass and clover mixture (n = 21). A sainfoin group (S; n = 19). A faba bean group (B) fed with 500 g faba bean pellets per day and a ryegrass/clover mixture (n = 19). Furthermore, a combined sainfoin/faba bean group (SB) fed with sainfoin and 500 g faba bean pellets (n = 19). Total trial time was 29 days. Feeding start was at day 4 of the experiment. Ewes were naturally infected by grazing and experienced an additional super infection with 1500 *H. contortus* infective third-stage larvae (L3) 20 days before trial start. During the 29 day trial faecal sampling took place every 3^{rd} to 4^{th} day. Individual faecal egg counts were performed using a McMaster technique at a sensitivity of 50 eggs per gramm faeces. A corresponding subsample of faeces was dried at 105°C to constant weight for dry matter assignment and FEC was corrected for dry matter content and expressed as Faecal Egg Count Dry Matter (FECDM).

Statistics

Data were analysed using a linear mixed model (LMM), where FECDM was the repeatedly measured dependent variable from trial days 1 to 29. All analyses were performed at animal level:

$$Y_{ij} = \mu + group_j + lamb_j + time_{ij} + group_j{*}time_{ij} + id_j + \epsilon_{ij}$$

where y = dependent faecal egg count with dry matter correction (FECDM) for every individual (i) at occasion (j), μ = overall mean effect (intercept), *group* = group affiliation effect for every individual (i), *lamb* = effect of number of lambs for every individual, *time* = effect of changes of the repeated dependent variable for every individual (i), *id* = control for the characteristics of the individual at occasion (i) (random intercept) and ϵ = error term for every individual (i) at occasion (j). The two way interaction between *time* and *group* was included in the model.

Results

Considering change in FECDM over trial period, significant differences were found in slope for groups S and SB (- 1.51 and + 18.56 per day, respectively) compared to C (+ 224.09 per day). In contrast, change in group B (+ 244.03 FECDM per day) was not statistically different from C. Having two or more lambs increased FECDM about 727.34 versus having a single lamb, however difference was not significant. FECDM data are displayed in figure 1. Independent variables, standard errors and corresponding p – values are shown in table 1.

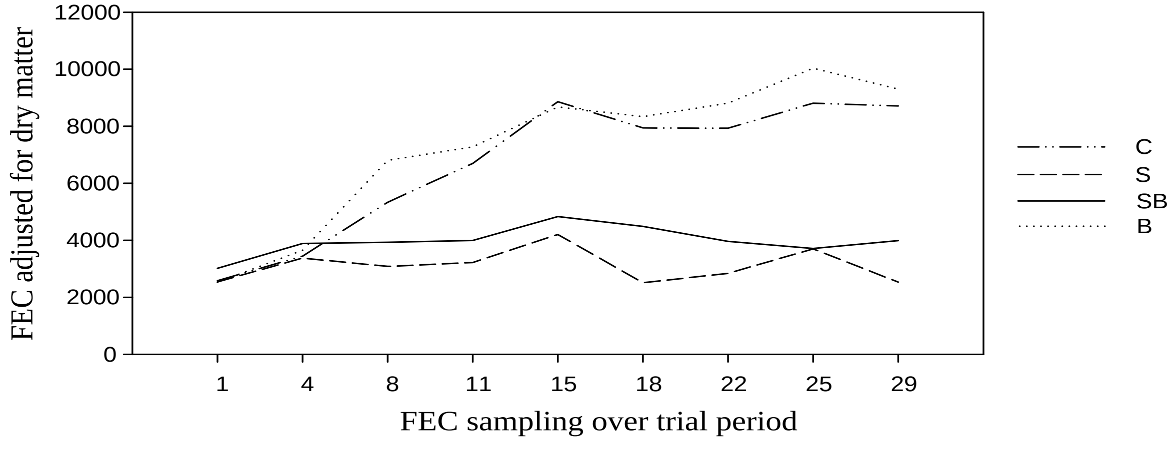

Figure 1. Faecal egg count [FEC; adjusted for dry matter (FECDM)] development of feeding groups over total trial period (original data) for groups SB (sainfoin & faba bean), B (faba bean), S (sainfoin) and C (control). Average lambing date was day 14.63 ± 1.67. Error bars are not displayed due to clarity of illustration.

Table 1. List of independent variables, their coefficients, standard errors and corresponding p – value explaining correlation in FECDM

Variable	Coefficient	Standard Error	P - value
Group S	- 295.19	953.47	0.757
Group SB	239.60	956.00	0.802
Group B	193.76	953.74	0.839
> one lamb	727.34	687.74	0.290
Time	224.09	20.21	< 0.001
Time x Group S	- 225.60	29.30	< 0.001
Time x Group SB	- 205.52	29.30	< 0.001
Time x Group B	19.94	29.30	0.496
Constant	2892.35	800.53	< 0.001

Study 2: Influence of sainfoin on goat cheese quantity and quality

Twelve lactating Alpine goats (mean 2.6 lactations) were used for the study. All animals were group fed with dehydrated alfalfa and ryegrass hay for a period of 15 days (control feeding period, CFP). Thereafter the feeding was switched to sainfoin hay for another 15 days period (sainfoin feeding period, SFP). Rations administered in CFP and SFP where balanced with commercial concentrates in order to assure isoproteic and isoenergetic feeding throughout the experiment. On day 10 of the respective feeding period, milk yield was determined for every goat and milk was analysed for fat, protein and urea content. Furthermore, milk collected between day 4 and 15 of the respective feeding period was separately transformed to cheese and matured for 8 weeks. The matured cheese resulting from the CFP and the SFP period were subjected to sensory analysis using 12 panellists and the two-out-of-five test with corresponding statistical analysis (Hough, 2012). Feed and milk data were analysed with paired T-Tests and p-values were corrected for multiple testing using the Bonferroni procedure (Hochberg, 1988).

Results

Mean daily feed intake for CFP and SFP and corresponding nutritive values are given in table 2. During the SFP animals ingested significantly less fibre ($p<0.05$) when compared to CFP. There were no statistical differences with respect to DM, energy and protein intake.

Table 2. Mean feed intake during CFP and SFP and corresponding nutritive values.

	Intake			
Experimental period	Kg DM	Energy[1] (MJ/kg)	Protein[2] (g/kg)	Fibre (g/kg)
CFP	2.5	13.3	221.0	675.4
SFP	2.1	12.0	231.3	486.9*

[1]Net energy lactation, [2]Protein absorbable at duodenum, * = significant difference at $p < 0.05$

There was no difference in milk yield between CFP and SFP (table 3). However, sainfoin feeding was associated with significantly increased milk protein and milk fat contents ($p<0.01$ and $p<0.05$) while urea levels were comparable between CFP and SFP.

Table 3. Mean milk yield and milk contents in CFP and SFP.

	Yield (kg)	Fat %	Protein %	Urea (mg/dl)
CFP	1.56	4.13	3.06	52.9
SFP	1.37	3.55**	3.79*	50.9
Difference	-0.19	-0.58	+0.73	-2.0

* = significant difference at $p < 0.05$; **significant difference at $p < 0.01$

Sensory analysis revealed a significant difference in flavour of the cheese produced during CFP compared to the one produced during SFP ($p<0.05$). However, there was no preference for either type of cheese.

Discussion

The results of the first study demonstrate that sainfoin feeding in the case of the PPR significantly reduced egg excretion (-55%) in comparison to a control feed. A reduced number of excreted eggs not necessarily implies a reduction in worm burden. However, a reduction of this magnitude may downsize infection risk for parasite naïve animals grazing the pasture subsequently. Our results are in line with the findings of other studies which found a FEC reduction of comparable size in lambs (Heckendorn et al., 2007) and goats (Paolini et al., 2005). The administration of faba bean did not have an effect on egg excretion. Neither separately nor in addition to sainfoin. One possible explanation for this finding might be the low tannin content of the used batch of beans, which was approx. 1.5-fold lower compared to sainfoin forage. Bean intake of ewes in the SB group presumably reduced sainfoin intake and thus might have lowered total CT ingestion. The absence of an effect on egg output in group B may have been due to a dilutive effect of tannin concentration by control feed. The faba bean variety 'Scirocco' was promising in order to test its anthelmintic properties (Makkar et al., 1997). However, tannin concentrations in literature are difficult to compare due to methodological and laboratory distinctions. Equally important is the immense structural diversity of tannins in feeds (Mueller-Harvey, 2006). Therefore an alternative explanation for the lack of effect of faba bean could be the tannin structure which might not be suitable for nematode control.

The second study showed that sainfoin feeding does not negatively impact either on milk yield or on milk quality. On the contrary, our results suggest that the administration of sainfoin is associated with increased milk protein content and decreased milk fat content. Although cheese production parameters were not determined in this study, it is possible that the higher protein content in the milk of sainfoin fed goats may lead to a higher cheese yield. Panellists could not point to a preference of the cheese produced from animals fed alfalfa/hay when compared to sainfoin. Nevertheless they were able to discern the two types of cheese, which in turn may also be beneficial from a commercial point of view, because diversity in taste is in demand by consumers.

The fibre intake in SFP was low when compared to the intake in CFP. This most probably is a result of the feeding habits of goats, which are highly selective (Jalali, 2012). We found that most of the leaves within the sainfoin hay where consumed by the animals while the stems where left over. The selection of leaves in the sainfoin ration was much easier than in the alfalfa ration as the sainfoin hay was not chopped before administration while alfalfa was. For future experiments where balanced feeding is of importance, it is suggested to find ways of sainfoin administration which reduce selective feeding.

Our study on milk and cheese quality showed that sainfoin feeding does not negatively influence product quality. Moreover the PPR study has shown the potential of sainfoin feeding as a preventive procedure to lower pasture contamination. Overall, administration of sainfoin may be a useful strategy to avoid/reduce anthelmintic treatments.

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