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Effects of condensed tannins towards dairy caprine gastrointestinal nematodes

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Abstract: In order to evaluate condensed tannins (CT) effect on dairy goat gastrointestinal nematodes (GIN) under a grazing and confined systems, two experiments (E1 and E2) were made. On both, goats were kept in two groups of 10 animals each. Groups were: control, without treatment (CG) and CT supplemented (CTG) daily with 25 g (1,25%) in E1 and 75 g (2%) in E2. During the E1, feeding was based on Lucerne (*Medicago sativa*) grazing and supplementation with 500 g of corn grain and during the E2, stabled milking goats ate 500 g of corn grain and ad libitum lucerne hay. Biweekly, faecal egg counts (FEC) and coprocultures were made. In addition, FAMACHA© technique, body condition score (BCSS) and ingested food were recorded each two weeks during the 90 days (E1) and 76 (E2) days of trial. The FEC values in most of the study were low and no significant differences ($p<0.78$) were detected between groups. Mean FEC were 534 (CTG) and 357 (CG) during E1 and 509 (CTG) and 484 (CG) during E2. The predominant NGI genera were *Trichostrongylus* sp. (48.1%), *Haemonchus* sp. (39.9%) and *Teladorsagia* sp. (12.0%). FAMACHA© scores did not show significant ($p<0.41$) differences between groups, but the CG (median=3) showed a BCS significantly ($p<0.05$) higher than those of CTG (median=2.5). The average milk production did not present statistically significant differences between groups ($p<0.57$), between sampling dates ($p<0.23$) and group x sampling dates ($p<0.65$). Under the conditions of these studies 25g or 75 g of CT in the diet had no anthelmintic or productive effects.

Keywords: Gastrointestinal nematode; Dairy goat; Condensed tannin; Production

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Introduction

The gastrointestinal nematodes (GIN) infections remains as one of the most important health problems of goats managed under grazing systems and this problem is relevant in farms carried out in temperate, subtropical and tropical areas of the world [1-3]. In Argentina the GIN also are one of the main productive constraints associated with the extensive or intensive small ruminant raising [4]. The negative effect of GIN infections on health and meat and milk production is known, acting as a productive constraint of the systems located in northwestern Argentina [5,6]. In this region goat production is mostly meant for milk and cheese production, for on-farm consumption and/or commercialization. This activity is based on extensive breeding of goats by small-holders and just few farms are based on more intensive systems by small dairy industries that have invested in capital and inputs. Despite the differences between goat systems, GIN affect the health of dairy goats and reduce the competitiveness of this activity [7]. Control of GIN infections programs have been only largely based on the use of anthelmintics. In Argentina in general, deworming in ruminants is applied too frequently, without the support of epidemiological knowledge, without previous diagnosis and with little participation of veterinarians [8,9]. Due to the increasing demand of the consumers to limit the use of chemical substances in domestic farm animal since the risk of residues in food products and because of the development of anthelmintic resistance, especially in small ruminants [10-12], there is currently a need to investigate other or complementary solutions to the control of gastrointestinal parasitism. Amongst these alternative procedures or products to complement the anthelmintics, the use of condensed tannins (CT) has been investigate in several studies [13]. Condensed tannins, are polyphenolic compounds present in many plant species, that have the ability to bind to dietary protein and protecting it from rumen degradation, increasing protein availability in the abomasum and small intestine of the host [14]. There is evidence that CT could act through direct anthelmintic activity [15-18] but might also act indirectly through increasing host resilience by reinforcing immunological responses [19], however these positive effects can vary with the CT diet concentrations, parasite and host health or physiological conditions [13,20]. Due to the general variability in certain results and the scarcity of regional research the objective of the present study was to investigate the effect of CT in two diet concentration on dairy caprine GIN and production parameters.

Material and Methods

Experimental design and flock management

Two sets of experiments were conducted at the Dairy Goat Unit of Salta Agricultural Experimental Station, located in Valle de Lerma, northwestern Argentina, at 1050 m a.s.l. (24°53'32. 65°28'26.4"W) with Saanen goats. Rainfall in this temperate valley is concentrated in the summer, with a dry period from April to November. Mean annual rainfall is 800 mm and mean temperature is 17° C (maximum: 36; minimum: -6). In the 1st experiment (E1, from March to late May 2018) 20 pregnant goats were divided in two groups balanced according body condition score (BCS) and the level of faecal egg counts (FEC), whose management was based on lucerne (*Medicago sativa*) grazing supplemented with 500 g of ground corn. CTG, group supplemented daily with 25 g (1,25%) of CT in 500 g of corn and CG, control group without treatment. In the 2nd experiment (E2, from June to September 2018) 20 housed milking goats (kidding in late June - early July) were divided in two groups according BCS, milk yield and FEC whose diet was based on a ration of lucerne hay and corn grain. CTG, group supplemented daily with 75 g (2,2%) of CT and CG, control group without treatment. The product used to add the CT to the diet was obtained from the aqueous extraction of the heartwood of the “quebracho colorado chaqueño” tree (*Schinopsis balansae*) and the experiments started after a period of 7 days of goat habituation to the CT.

Parasitological measurements

Individual faecal nematode egg counts per gram (FEC) were determined each 14 days using the modified McMaster technique [21]. Faecal cultures were similarly performed fortnightly per goat group to assess the generic composition of nematode populations according to Suarez [22]. Data on the parasitic state of the goats were recorded biweekly using the FAMACHA© clinical evaluation system [23,24]. Those animals over 3000 of FEC or anaemics were treated in a preventive way.

Evaluation of performance

Milk yield per goat was measured biweekly from the start of milking until the dry period and the end of lactation. Milk yield was estimated following Fleischmann method [24] using New Zealand goat milk meters (Waikato MKV Milk Meter). Biweekly body condition score (BCS) of all the goats were evaluated according Russel *et al*. [25].

Statistical analyses

Milk production comparisons were performed using a repeated measure analysis of variance and FEC, BCS and FAMACHA© scores were compared by the non-parametric Mann and Whitney test of of InfoStat Statistical Software [26]. In both experiments, before analysis, data for FEC were (log (x+1)) transformed to normalize their distribution.

Results

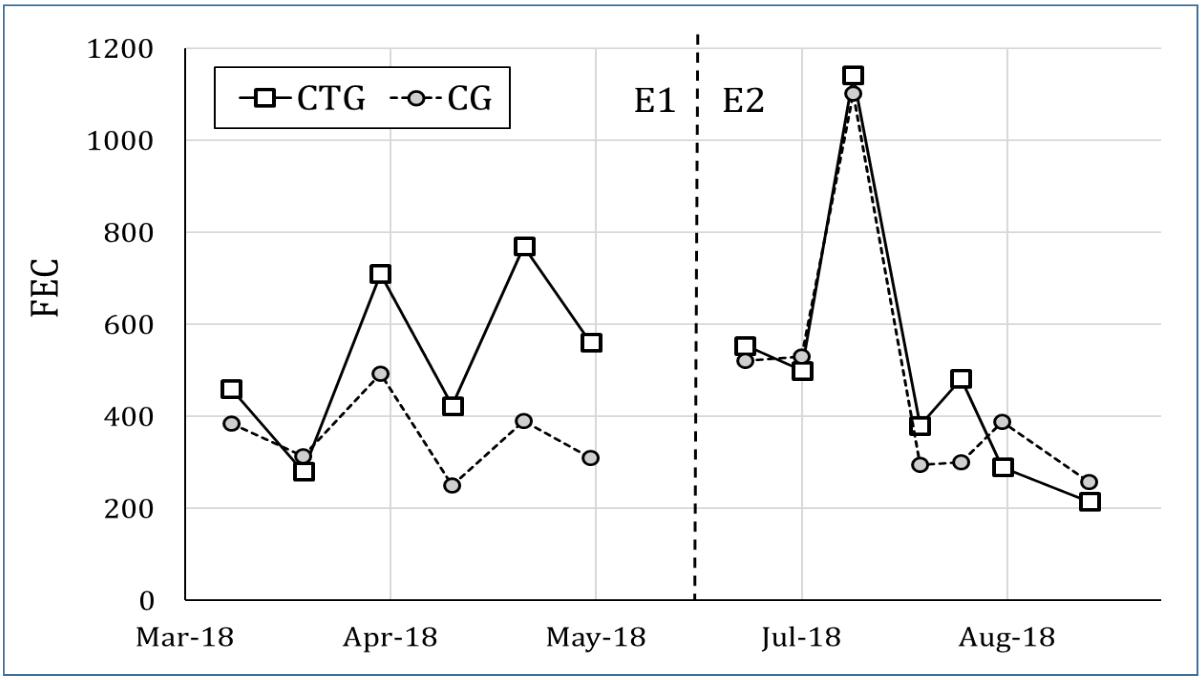
During the whole trial the goat flock was in good body condition score with a median of 3, ranging from 2 to 4, without clinical signs of GIN infection, showing a normal consumption of the diet with and without CT. However, during E2 one goat of each group had to be dewormed postpartum because they presented high (>5000) FEC counts. Figure 1 shows worm faecal egg counts of groups of E1 and E2 throughout the trial. In general, the FEC showed low values throughout the trial, except for a postpartum peak observed in mid-July. Towards the end of the observations, egg counts dropped again to low levels in housed goats. No significant differences ($p<0.78$) were observed between group FEC values. Mean FEC were 534 (CTG) and 357 (CG) during E1 and 509 (CTG) and 484 (CG) during E2. *Trichostrongylus* sp. (48.1%), *Haemonchus* sp. (39.9%) and *Teladorsagia* sp. (12.0%) were the dominant nematode genera recovered from faecal cultures of both groups during the entire trial. The percentages of GIN genres were similar between groups. FAMACHA© scores did not show significant ($p<0.41$) differences between groups. FAMACHA© medians and extreme values of CTG and CG were equal, presenting a median of 2 and extreme values 1 and 3. During E1 the CG (median= 3; extreme values=2 and 4) showed a BCS significantly ($p<0.05$) higher than those of the CTG (median= 2.75; extreme values= 2 and 4). Median, extreme values and quartiles are presented in Figure 2.

Figure 3 shows the mean milk production of the goat groups during E2. The average milk production did not present statistically significant differences between groups ($p<0.57$), between sampling dates ($p<0.23$) and between group x sampling dates ($p<0.65$); the liters of milk produced were for CG of 2.92 ± 0.27 and for CTG of 2.70 ± 0.26.

Discussion

The seasonal variability of the FEC and the genera of predominant GIN genres was similar to the epidemiological patterns previously described [6,7]. Under a subclinical infection plane, the lack of parasitological and productive responses was confirmed by the results of the FEC and FAMACHA© score as well as milk production. The present results showed that the dose of CT used which was 1.25%, estimating a daily intake per head of 1.5 kg of alfalfa dry matter (DM) in the field plus 0.5 kg of supplement had no effect against GIN. It should be noted that in grazing goats it was not possible to give more than 25 g in 500 g of corn because they rejected it and reduced food intake. On the other hand, in the stabled goats it was possible to offer up to 75 g, which represented 2% of the total diet, although similarly without anti-parasitic effects. The absence of response of the present investigation coincided with the results of Athanasiadou *et al*. [27], where experimentally infected sheep grazing forages rich in secondary tannin metabolites did not show egg counts, immature and adult parasites differences. This lack of efficiency was also observed by Ferreira *et al*. [28] where they evaluated the anthelmintic effect of the dividivi (*Caesalpinia coriaria*) tannin in lambs. However, the present results contrast with many other *in vitro* [29,30] or *in vivo* [31,32,33] studies that show the anti-parasitic effect on small ruminant both with the dosage of CT extracts or under grazing plants rich in CT. *Schinopsis* sp. extracts administered *per os* in goats affected the worm establishment acting on third stage larvae and seem to have mainly affected the worm reproductive function [34]. Goats grazing *Lespedeza cuneata* a CT containing forage, reduced GIN fecal egg production and reduced hatch and development of larvae [35].

Figure 1: Mean faecal egg counts (FEC) of supplemented with condensed tannin group (CTG) and without condensed tannin control group (CG) during the two experiment periods (E1 and E2).



Although most of the references give positive results from the use of CT, they also show great variability. These differences would be related to the concentration of CT in the diet or to host diet factors. The concentration and the structure of the condensed tannins present in the different goat E1 and E2 diets seem to be the two major factors of the efficacy against nematodes. In vivo studies in sheep and goats involving tannin-rich *Schinopsis* sp. bark extract or plants containing condensed tannins suggests that a threshold of at least 30-40 g of condensed tannins per kg DM (3-4 %) has to be reached to anti-nematode activity [13,36,37]. These works would be demonstrating that the concentrations reached in the present trial would not have effects on the GIN infections.

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Figure 2: Body condition score of supplemented with condensed tannin group (CTG) and without condensed tannin control group (CG) during the experiment period E1. First and third quartiles, median and maximum and minimum values.

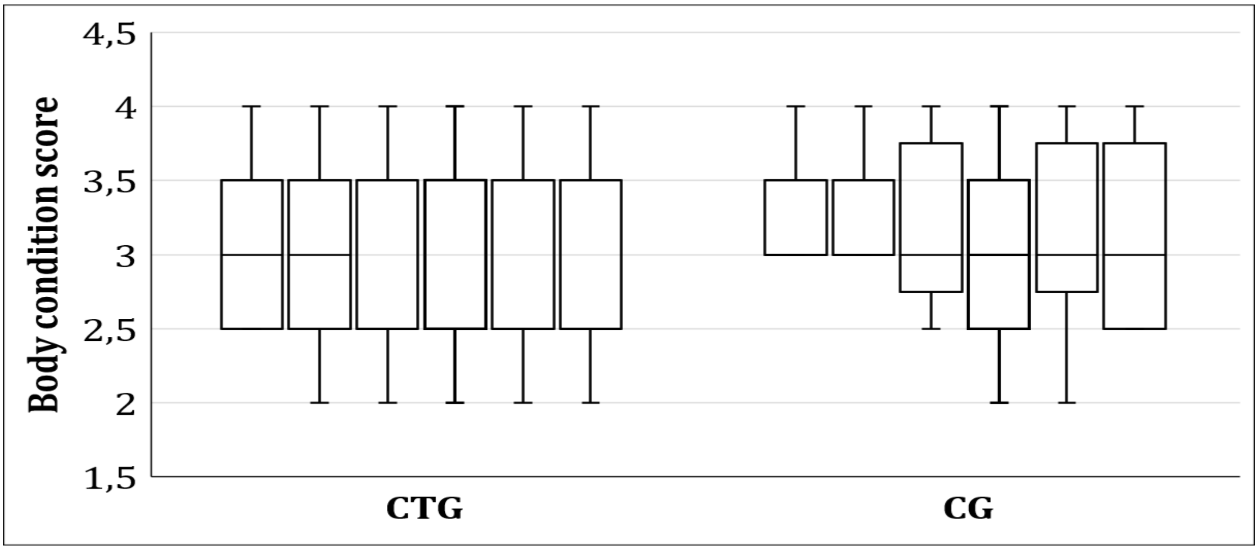
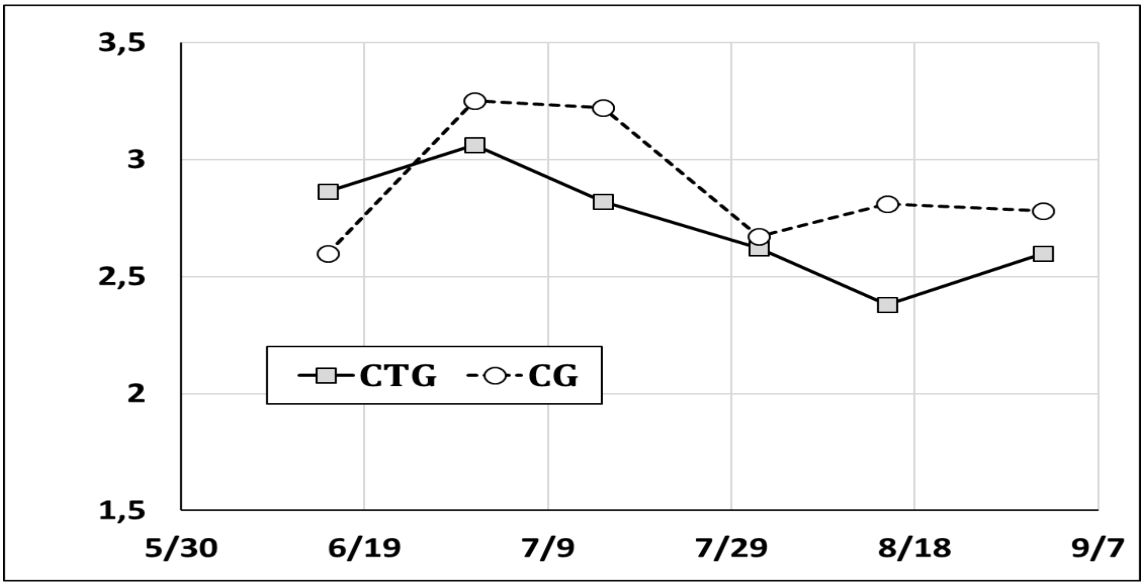


Figure 3: Mean milk production of supplemented with condensed tannin group (CTG) and without condensed tannin control group (CG) during the experiment period E2.



On the other hand, CT plant content can vary seasonally from fertility, pH, humidity and soil temperature or according to the age or part of the plant [20,38]. Another source of variation could be a possible GIN adaptation to tannins, which was suggested by the observations of Calderón-Quintala *et al*. [39] where different *Haemonchus contortus* strains showed dissimilar sensitivities to tannin rich extracts. In addition, high concentrations of certain types of condensed tannins have been considered responsible for causing toxic effects in ruminants [40]. Athanasiadou et al. [15] refer to the toxicity of 16% Quebracho extract tannins with decrease in food consumption, however, the concentrations in the present trial were well below those considered toxic and the lack of anti-parasitic effect would not be attributable to a probable harmful effect. Finally, another explanation for the lack of responses could be due to the high protein content of alfalfa supplied to the goats; the high protein diet could have enhanced the immune response in the control group against the parasitic challenge [41]. The high protein intake of alfalfa could also have overlapped a direct productive and indirect antiparasitic mechanism that has been evoked from stable CT-protein complexes that protect proteins against ruminal degradation for its subsequent dissociation in the acidic conditions of the abomasum [17,42-44].

Conclusion

It is concluded that under the conditions of the present study of low parasitic infestation, 25 g of CT extract in 500 g of supplement added to the lucerne consumption in the field or 75 g of CT in the total diet represented a low dose without anthelmintic effect since no significant differences between groups could be observed on the parasitic and productive parameters. On the other hand, under Argentina grazing systems is very difficult to be able to supply higher concentrations of CT extracts in the diet supplement and for goats to accept it.

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