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A note on defleecing of Angora and Spanish goats using Leucaena

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ABSTRACT

Thirty Angora (16±2 kg) and 20 Spanish (19±2 kg) 8-month-old doelings, having not previously consumed *Leucaena leucocephala*, were used to determine effects of dietary inclusion of a moderate level of Leucaena on fleece shedding and subsequent fibre characteristics. A diet of 22.5% Leucaena leaf meal (0.17% mimosine in total diet dry matter) was consumed *ad libitum* for 8 days starting on November 13, with daily mimosine intake in the first 3 d averaging 56 mg/kg body weight. At d 10, fleece shedding was clearly visible in 17 of the 30 Angora doelings and in 9 of the 20 Spanish doelings. Doelings in which the visual shedding score was above 2 (5-point scale: 1 = no shedding and 5 = excessive shedding; mean of cashmere and guard shedding scores for Spanish doelings) on d 19 were categorized as exhibiting a shedding response to Leucaena. By d 35, six Angora and three Spanish doelings had completely shed fleece. Clean mohair growth rate in Angora doelings was lower ($P<0.05$) for shedding vs nonshedding doelings on d 8 to 40 (0.29 vs 0.68 mg/(cm^2 d^{-1})) but similar ($P>0.10$) between shedding groups on d 41 to 63 (1.51 vs 1.46 mg/(cm^2 d^{-1})), although cashmere growth rate was not different ($P>0.10$) between shedding groups on either d 8 to 40 or d 41 to 63. Secondary follicle activity was lower ($P<0.05$) on d 8 for shedding than for non-shedding Angora doelings (89 vs 99%), but activity on d 63 was similar (95 and 96%, respectively). Secondary follicle activity for Spanish does was similar between shedding groups on d 8 and 63 ($P>0.10$). In conclusion, feeding of Leucaena holds promise as a means of inducing fleece shedding in goats, apparently without marked subsequent effects on productivity. However, further research with higher dietary levels of mimosine is necessary.

KEY WORDS: goats, fleece, mimosine, Leucaena

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INTRODUCTION

Leucaena leucocephala is a tropical tree legume with a high nutritive value (e.g., 14 to 30% crude protein), which is often used in ruminant diets in drought-prone areas of developing countries (Hammond, 1994). However, Leucaena contains mimosine, a free amino acid that can be toxic to unadapted ruminants (Jones and Hegarty, 1984). Mimosine is an antimitotic agent that arrests cells in the interchange between G and S stages of cell division (Hughes and Cook, 1996). Although, at 24 h after the introduction of dietary mimosine, ruminal microbes have adapted to convert ingested mimosine to 3,4-dehydroxy-4-(1H)-pyridone (DHP) (Hegarty et al., 1964; Reis et al., 1975a). While 3,4-DHP is a potent goitrogen, it does not induce alopecia in sheep (Reis et al., 1978) or goats (Reis et al., 1999).

In wool follicle bulbs, mimosine inhibits DNA synthesis and, hence, cell division (Ward and Harris, 1976). Following mimosine treatment, dividing fibre-producing follicles of sheep (Hegarty et al., 1964; Reis et al., 1975a) and goats (Reis et al., 1999) have shed their fibres. Similarly, it is conceivable that mimosine could be used with goats to remove cashmere from active secondary follicles without loss of guard hair in seasonally inactive primary follicles, and perhaps true mohair could be separated from undesirable kemp fibres in the Angora goat as well. However, economical means of mimosine delivery have not yet been established. Leucaena feeding may hold promise in this regard. Therefore, objectives of this experiment were to determine effects of the dietary inclusion of a moderate level of Leucaena on fleece shedding and subsequent fibre characteristics of Angora and Spanish goats.

MATERIAL AND METHODS

Thirty Angora (16±2 kg initial body weight) and twenty Spanish doelings (19±2 kg initial body weight), approximately 8 months of age, which had not previously consumed Leucaena were used. Doelings were maintained in individual pens, had free access to water, and were subjected to ambient temperature and natural photoperiod. Beginning on November 13, doelings consumed *ad libitum* a diet consisting of (%): cottonseed hulls 67, Leucaena leaf meal 22.5, ground maize 5, urea 0.5, molasses 3.5, dicalcium phosphate 0.5, pellet binder 0.5, trace mineral premix 0.4, and vitamin premix 0.1. Two-thirds of the cottonseed hulls (i.e., 50% of the total diet) was mixed in the loose form with the other 50% of the diet that was in pellet form. The total diet averaged (%): crude protein 13, neutral detergent fibre 55, acid detergent fibre 41, and mimosine 0.169 (dry matter basis).

Many of the procedures have been described by Yami et al. (1999). On d 7 after Leucaena introduction to the diet, a 15 × 15 cm area on the right mid-side was clipped to skin level. At 40 and 63 d after Leucaena introduction to the diet, fibre regrowth rate and diameter were measured by clipping this area. Greasy and clean fibre weights were determined according to ASTM (1988). Fibre diameter and cashmere yield were determined with an optical fibre distribution analyzer (OFDA 100; Zellweger Uster, Inc., Charlotte, NC, USA). For Spanish goats, fibres less than 20 μm in diameter were considered cashmere, with coarser fibres being guard hair.

On d 19, 40, and 63, goats were scored for shedding (5-point scale: 1 = no shedding; 5 = excessive shedding) of guard hair, down or cashmere (Spanish goats), and mohair (Angora goats) by plucking fibre from the right side of the goat. The area of skin over which the fleece was cast was estimated by sketching on drawn outlines of goats on d 19, 28, and 35.

Biopsy punch (8 mm) skin sections were taken (1 mL lidocaine) on d 8, 45, and 63. Skin samples were fixed (10% buffered formalin; weight/volume), processed through graded alcohols, and embedded, epidermal surface uppermost, in paraffin wax. The skin was then serially sectioned (8 μm) in the transverse plane and stained with adapted Sacpic stain (Nixon, 1993). Primary and secondary follicle activities were assessed according to staining characteristics of the inner-root sheath (Nixon, 1993).

Goats in which the visual shedding score was above 2 (mean of cashmere and guard shedding score in Spanish goats) on d 19 were categorized as exhibiting a shedding response to Leucaena feeding. Data were analyzed using General Linear Models procedures of SAS (1990). First, subsequent treatments of Yami et al. (1999) did not influence responses in this experiment and, therefore, were not considered. Data were analyzed by breed as a split-plot with a model containing shedding status (main plot), time after initial Leucaena consumption (subplot), and their interaction. Data were analyzed separately for each time when effects of any of these sources of variation were significant ($P<0.05$).

RESULTS

Shedding

Shedding was first observed in some goats at 10 d after the initial feeding of Leucaena. At d 19, fleece shedding was clearly visible in 17 of the 30 Angora doelings (55%) and in 9 of the 20 Spanish doelings (45%). By d 35, fleece had been cast over approximately 50% of the area of responsive goats (data not shown), although fleece was only fully cast in six Angora (20%) and three Spanish doelings (15%).

Angora

Clean mohair growth rate was considerably lower ($P<0.05$) for shedding vs nonshedding doelings on d 8 to 40 but similar ($P>0.10$) between shedding groups on d 41 to 63 (Table 1). Mohair mean fibre diameter was greater ($P<0.05$) on d 63 than on d 40. The percentage of kemp was greater ($P<0.05$) for shedding vs nonshedding goats on d 40, and a similar trend ($P>0.10$) existed on d 63. Primary follicle activity was similar ($P>0.10$) between shedding groups on d 8. Primary follicle activity was greater on d 63 than on d 8, but the difference was much greater for shedding vs nonshedding doelings; thus, activity was greater ($P<0.05$) for the shedding group. Secondary follicle activity was 10 percentage units lower ($P<0.05$) on d 8 for shedding than for nonshedding doelings, although the percentage was similar ($P>0.10$) between groups on d 63. Shedding score was greater ($P<0.05$) for shedding vs nonshedding doelings on d 19 and 40 but similar ($P>0.10$) between groups on d 63.

Spanish

Guard hair growth rate was lower ($P<0.05$) for shedding vs nonshedding doelings on d 8 to 40 but similar ($P>0.10$) between shedding groups on d 41 to 63. Cashmere growth rate did not differ between shedding groups on either d 8 to 40 or 41 to 63 ($P>0.10$). Cashmere mean fibre diameter was similar ($P>0.10$) between shedding groups on d 40 but greater ($P<0.05$) on d 63 for shedding doelings. Neither activity of primary nor secondary follicles was affected by shedding group on d 8 or 63 ($P>0.10$). On d 19, guard hair and cashmere shedding scores were greater ($P<0.05$) for shedding vs nonshedding goats. A similar difference for guard hair occurred at d 40 ($P<0.05$), although for cashmere the shedding score was only numerically ($P>0.10$) greater for shedding doelings. Guard hair and cashmere shedding scores were similar ($P>0.10$) between shedding groups on d 63.

DISCUSSION

Similar to results of the present experiment, shedding has occurred in sheep and goats at 7 to 10 d after systemic infusion of mimosine (Reis et al., 1975a,b, 1999; Reis, 1978), commencing at the neck and underbelly and progressing backwards and upwards in a pattern identical to that of follicle initiation in the foetus. The duration and magnitude of the elevation in plasma mimosine concentration is most important in the triggering of alopecia. In sheep, plasma mimosine concentration must be greater than 100 μmol/L for more than 36 h (Reis et al., 1975a). In this regard, Reis et al. (1975b) induced full fleece casting in sheep following two

TABLE 1

Effects of short-term feeding of Leucaena on fibre characteristics in Angora and Spanish goats

Item	Time	Shedding status[2]		Effect (P <)[3]		
	d[1]	non-shedding	shedding	shedding	shedding	shedding x time
Angora goats						
Clean mohair growth rate, mg/(cm² d⁻¹)	8-40	0.68[a]	0.29[b]	NS	0.01	0.04
	41-63	1.46	1.51			
Mohair mean fibre diameter, μm	40	25.1	24.2	NS	0.01	0.10
	63	26.3	26.5			
Kemp, %	40	0.11[b]	0.20[a]	0.01	NS	NS
	63	0.11	0.19			
Primary follicle activity, %	8	28	33	NS	0.01	0.05
	63	47[b]	82[a]			
Secondary follicle activity, %	8	99[a]	89[b]	0.03	NS	0.02
	63	96	95			
Shedding score[4]	19	1.7[b]	4.3[a]	0.01	0.01	0.01
	40	1.0[b]	3.1[a]			
	63	1.2	1.7			
Spanish goats						
Guard hair growth rate, mg/(cm² d⁻¹)	8-40	0.18[a]	0.11[b]	NS	0.01	NS
	41-63	0.27	0.36			
Cashmere growth rate, mg/(cm² d⁻¹)	8-40	0.05	0.04	NS	0.01	NS
	41-63	0.07	0.09			
Cashmere mean fibre diameter, μm	40	16.6	17.0	NS	0.20	0.04
	63	17.0[b]	18.4[a]			
Primary follicle activity, %	8	27	54	NS	NS	NS
	63	46	58			
Secondary follicle activity, %	8	84	97	NS	NS	NS
	63	97	81			
Guard hair shedding score	19	2.4[b]	3.8[a]	0.01	0.01	0.02
	40	1.1[b]	2.2[a]			
	63	1.0	1.0			
Cashmere shedding score	19	1.0[b]	2.2[a]	0.07	0.36	0.04
	40	1.0	1.7			
	63	1.5	1.2			

[1] days after initial feeding of a diets with 22.5% Leucaena leaves

[2] goats with a shedding score of less than 2 on d 19 were classified as nonshedding, and ones with a shedding score of 2 or greater were classified as shedding

[3] NS = nonsignificant (P>0.10)

[4] 5-point scale: 1 = no shedding; 5 = excessive shedding

[a,b] within an item and day grouping, means without a common superscript letter differ (P<0.05)

consecutive daily oral mimonsine doses of 300 mg/kg body weight. In the present experiment, dry matter intake in the first 3 d averaged 0.71 kg, providing approximately 68 mg/kg body weight of mimosine. Hence, the lack of responsiveness of all goats to Leucaena and incomplete shedding in some of the responsive ones may be partially accounted for by the relatively low dose of mimosine and high level of feed intake. Our experiment was with 8-month-old doelings consuming the diet at approximately 4% of body weight. In lambs compared with adult sheep and with feed intake above vs at or below that required for body weight maintenance, higher infusion rates of mimosine are required to elevate plasma concentrations of mimosine to equivalent levels (Reis et al., 1978; Reis and Tunks, 1978). Differences between goats and sheep are possible as well. Recently, Reis et al. (1999) noted that higher dose rates of ingested mimosine were required to induce shedding in goats than sheep, and mimosine appears to be cleared from the blood more rapidly with goats (Jacquemet et al., 1990; Smuts et al., 1995).

Typically, wool growth in sheep ceases after 36 h of mimosine infusion and regrowth begins between 6 and 14 d later (Reis, 1978). In accordance, mimosine-induced shedding in the present experiment did have some effects on subsequent fibre characteristics, which appeared more prevalent or slightly greater for Angora vs Spanish goats. However, on d 41 to 63 after initial Leucaena feeding, neither the growth rate of clean mohair nor of cashmere was influenced by shedding group. Furthermore, cashmere growth rate was not different between shedding and nonshedding doelings on d 8 to 40. Secondary follicle activity was similar between shedding groups on d 63 for both Angora and Spanish doelings. The only fleece quality trait in regrowth fibre adversely affected by Leucaena-induced shedding was a greater number of kemp fibres in fleece grown from d 8 to 40 in shedding compared with nonshedding doelings. Kemp fibres are produced in primary follicles and to a greater extent during periods of rapid fibre growth (Nixon et al., 1991).

CONCLUSIONS

Results of this experiment indicate potential for use of fed Leucaena as a source of mimosine to induce fleece shedding in goats similar to that for sheep. Future research should entail higher dietary levels of mimosine, through greater inclusion of Leucaena or use of Leucaena higher in mimosine. In addition, results of this experiment suggest that further experimentation with Leucaena and mimosine to defleece should consider both mohair- and cashmere-producing goats, because of possible differences in responsiveness to mimosine in shedding and carryover effects.

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STRESZCZENIE

Usuwanie runa u angorskich i hiszpańskich kóz przy zastosowaniu leukeny

Na trzydziestu 8-miesięcznych kózkach angorskich (16±2 kg) i 20 hiszpańskich (19±2 kg), nie otrzymujących wcześniej leukeny (*Leucaena leucoceptala*), oznaczano wpływ umiarkowanego dodatku tej rośliny do dawki na oddzielanie runa i charakterystykę włókna wełny. Dawkę, zawierającą 22,5 % mączki z liści leukeny (0,17% mimozyny w s.m. dawki) podawano do woli przez 8 dni, poczynając od 13 listopada, tak że dzienna ilość zjadanej mimozyny w ciągu pierwszych 3 dni wynosiła 56 mg/kg masy ciała. Dziesiątego dnia widoczne było wyraźne oddzielanie się runa u 17 spośród 30 kózek angorskich i u 9 spośród 20 kózek hiszpańskich. Kózki, u których w 19 dniu widoczne oddzielanie się runa wynosiło powyżej 2 (5-cio punktowa skala: 1 = nie oddzielające się runo do 5 = całkowite oddzielanie się; średnia dla kaszmiru i punktacja tracenia runa u kózek hiszpańskich) zaklasyfikowano jako osobniki reagujące na leukenę. W 35 dniu 6 kózek angorskich i 3 kózki hiszpańskie były całkowicie pozbawione runa. Tempo przyrostu czystego moheru u kózek angorskich było mniejsze (P<0,05) u kózek pozbawionych niż nie pozbawionych runa między 8 a 40 dniem (0,29 vs 0,68 mg/(cm^2 d^{-1})), lecz podobne (P>0,10) między grupami tracącymi runo od 41 do 63 dnia (1,51 vs 1,46 mg/(cm^2 d^{-1})), chociaż nie różniło się (P>0,10) pomiędzy tymi grupami zarówno między 8 a 40, jak i 41 a 61 dniem.

Aktywność wtórnych torebek włosowych była niższa (P<0,05) 8-go dnia u kózek angorskich pozbawionych niż nie pozbawionych runa (89 vs 99%), lecz 63 dnia była podobna (95 i 96%, odpowiednio). Aktywność ta u kózek hiszpańskich była podobna w grupach bez runa 8-go i 63-go dnia (P>0,10).

Stwierdzono, że podawanie leukeny może być obiecujące jako sposób powodowania oddzielania runa u kóz, pozornie bez znaczących dalszych efektów na produkcyjność. Dalsze badania z większymi dziennymi dawkami mimozyny są jednak konieczne.