



The Effect of Supplementation with Fresh Browse of *Ziziphus mauritiana* or *Combretum aculeatum* on Feed Intake, Nitrogen Utilization and Growth of Grazing Range Sheep

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ABSTRACT

The influence of 0, 60 or 120 min access to a grove of either *Ziziphus mauritiana* (*Ziziphus*) or *Combretum aculeatum* (*Combretum*) on forage intake and on the digestibility, growth and excretion of nutrients was determined using 40 Oudah rams grazing for 7 h/day on poor-quality dry season pasture in the Sahel. The effects of browse species and browsing duration (0, 30, 60 or 120 min) on the ruminal ammonia content were also evaluated using 8 mature fistulated rams. *Ziziphus* increased both total digestible organic matter and total dry matter intakes per (kg live weight)^{0.75} without decreasing herbage intake, whereas 60 or 120 min access to *Combretum* reduced herbage intake by 6.3% and 4.2%, respectively. The digestibility of the diet decreased ($p < 0.05$) with the duration of access to the groves. Despite the provision of more nitrogen (N) than in the control diet, ruminal NH₃-N decreased 24 h after browsing commenced. The reduced live weight gain of sheep browsing *Combretum* may indicate more deleterious compounds in *Combretum* than in *Ziziphus*. *Ziziphus* appears to have more potential than *Combretum* to increase sheep production in low-input crop/livestock systems.

Keywords: browse, digestibility, nutrition, pasture, ruminal ammonia, sheep

Abbreviations: DM, dry matter; DOM, digestible organic matter; FDM, faecal dry matter; LW, live weight; LWG, live weight gain; N, nitrogen; NDF, neutral detergent fibre

INTRODUCTION

Although the contribution of foliage from woody plants within natural forage resources is considered to be modest (Le Houérou, 1980; Piot *et al.*, 1980; Breman and de Ridder, 1991; Hiernaux *et al.*, 1994), such plants are often considered to be an important resource in the arid and semi-arid tropics, especially during the dry season. This is because many browse species retain some green foliage during part or all of the dry season (Hiernaux *et al.*, 1994), and because of the N content in the foliage and

other parts browsed by livestock (young twigs, flowers, pods), which remains high during the dry season when the dry herbage and crop residues have a concentration of N lower than 0.6%. Some local woody plants are propagated in agroforestry programmes as windbreaks or to protect soil from erosion, and also with the intention that they can contribute supplementary N to livestock during the dry season. In most nutritional trials, the foliage of woody plants is cut, dried and carried to the animals.

However, some studies have shown that many African browse species contain high levels of polyphenols (Reed *et al.*, 1990), which may affect the intake and degradability of roughage (Tanner *et al.*, 1990; Wiegand *et al.*, 1995), the protein digestibility and nitrogen metabolism in ruminants (Woodward and Reed, 1989; Degen *et al.*, 1995) and, subsequently, the animals' performance. The effect of phenolics can vary widely with the mode of administration of the woody plant, namely whether it is offered as the sole feed or as a supplement to roughage (Reed *et al.*, 1990; Girdhar *et al.*, 1991; Degen *et al.*, 1995; Kaitho *et al.*, 1998), as green foliage (browsed on trees), or dried and/or treated in some way (Palmer and Schlink, 1992; Bonsi *et al.*, 1995; Ahn *et al.*, 1997).

This study was aimed at determining the effects of daily access by sheep to a browse grove of either *Ziziphus mauritiana* (*Ziziphus*) or *Combretum aculeatum* (*Combretum*), as a complement to 7 h grazing on a poor-quality range during the dry season, on their intake, growth and cycling of nutrients.

MATERIALS AND METHODS

Site

The experiment was carried out during the dry season (January to March 1997), at the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) (13°15'N, 2°18'E), Niger, West Africa. The average annual rainfall is 560 mm and 95% of the rainfall occurs from May to September (Powell *et al.*, 1998). During the rainy season prior to this experiment, the rainfall was 543.9 mm.

Treatments, animals and feeding

Forty Oudah rams, 15–18 months of age, with an average initial live weight (LW) of 23.8 kg (SD = 1.7), were allotted to five treatments in groups of 8. The experiment lasted 75 days. The treatments consisted of a factorial combination of three durations of access (0, 60 and 120 min) and two planted browse groves (*Z. mauritiana* or *C. aculeatum*). The control (Pn), with no access to the browsed groves, was common to the two experimental groups. The sheep were otherwise herded on natural pasture (basal diet) for 7 h per day (from 10:00 to 17:00) and were penned during the night from 17:00 to 08:00. They had free access to water available on the edges of the natural pasture and the groves, and to mineral blocks during the night.

The estimated herbage mass at the onset of the experiment was 2697 (\pm 347 SE) kg/ha. Thirty-seven plant species were identified, of which 23 were dicotyledons and 14

were grasses or sedges. The more common species were *Hibiscus sabdariffa* (31.3% of total plant area), *Jacquemontia* sp. (18.2%), *Cenchrus biflorus* (9.4%), *Ctenium elegans* (7.2%), *Merremia pinnata* (6.9%), *Ipomaea vagans* (5.5%), *Pennisetum pedicellatum* (4.9%) and *Eragrostis tremula* (4.9%).

As well as the feeding trial, 8 sheep with ruminal fistulae were used in a double Latin square $2 \times (4 \times 4)$ design to evaluate the effect of four access durations (0, 30, 60 and 120 min) to the two browsed groves on the ruminal content of $\text{NH}_3\text{-N}$. Ruminal liquor from the fistulated sheep was taken 6 and 24 h after browsing on *Ziziphus* or *Combretum* and acidified with 4% sulphuric acid (1 ml H_2SO_4 +24 ml rumen liquor).

The rams (intact or fistulated) allowed to browse for 120 min, 60 min or 30 min, were respectively introduced in the groves from 08:00 to 10:00, from 09:00 to 10:00 or from 09:30 to 10:00).

Measures

Every two weeks, the sheep were weighed after 12 h of fasting on three consecutive days. The intake (I) of natural pasture forage (herbage) and browse was calculated from the relation: $I \text{ (g DM/day)} = M \times \text{Dur} \times \text{LW}^{0.75}$, where M = intake per min (DM in g/(kg LW)^{0.75} per min), Dur = grazing or browsing duration (min), and (kg LW)^{0.75} = metabolic live weight of sheep. The grazing and browsing durations were determined by systematic observation of each of the 40 sheep from 08:00 to 17:00 for seven days. The intake per min was previously determined by weighing the extrusa, while grazing or browsing, from four sheep with oesophageal fistulae. The digestibility (D) of the herbage and of each of the browses was measured on the extrusa samples from sheep with oesophageal fistulae that only had access to either herbage or to one of the browses. Digestibility was determined using the gas-production method (Menke *et al.*, 1979), modified by incubating syringes containing samples of the feeds in a water bath at 39°C). The digestibility of the diets selected by the sheep that had access to both herbage and browse was determined by difference. The sheep were fitted with faecal collection bags for seven consecutive days. The faecal output was weighed twice a day, and 10% subsamples were taken for each animal and frozen for subsequent analysis.

At the end of the experiment, the animals were kept in individual metabolic cages for a seven-day N balance trial. Their feed intake and faecal and urinary output were measured. The urine was collected in buckets containing hydrochloric acid (20% HCl) to prevent volatilization of the ammonia N ($\text{NH}_3\text{-N}$). The daily output of urine was measured each morning. The volume of urine was standardized to 3 litres by adding distilled water, and a subsample of 50 ml was taken for analysis.

Chemical analyses

Faeces and extrusa were analysed for dry matter (DM), organic matter (OM), nitrogen (N Kjeldahl), total phosphorus (P) and neutral detergent fibre (NDF; Van Soest *et al.*, 1991). The nitrogen concentration in the urine, NDF and ruminal liquor were also determined. The tannin contents of the browse were not determined.

Statistical analysis

The data were analysed using the GLM procedures of SAS (1989). The model used in the feeding trial was $Y_{ijk} = \beta_0 + \beta_1(w'-W) + \beta_2S + \beta_3\text{Dur} + \beta_4\text{Dur}^2 + \beta_5\text{SDur} + \beta_6\text{SDur}^2 + \varepsilon_{ijk}$, where Y_{ijk} was the dependent variable, W was the initial weight of the animal and w' its average weight, S was the effect of the browse species (*Z. mauritiana* or *C. aculeatum*), Dur was the browsing duration, β_0 was the intercept, β_1, \dots, β_6 were regression coefficients, and ε was the error term. The model used to analyse the effect of treatments on the $\text{NH}_3\text{-N}$ concentration in the rumen liquor was $Y_{ijk} = \beta_0 + \beta_1S + \beta_2\text{Dur} + \beta_3\text{Dur}^2 + \beta_4\text{Dur}^3 + \beta_5\text{SDur} + \beta_6\text{SDur}^2 + \beta_7\text{SDur}^3 + \varepsilon_{ijk}$. The terms in the model that were not significant ($p > 0.05$) were deleted from subsequent analyses.

RESULTS

The chemical composition of the selected forages is presented in Table I.

TABLE I

Dry matter (DM, g/kg⁻¹), organic matter (OM, g/(kg DM)), neutral detergent fibre (NDF, g/(kg DM)), nitrogen (N, g/(kg DM)), phosphorus (P, g/(kg DM)), NDF-N (g/(kg DM)) in natural pasture roughage and in browses at Sadoré

Forage	DM	OM	NDF	N	NDF-N	P
Natural pasture	931	846	528	12.2	6.7	3.9
<i>Ziziphus mauritiana</i>	934	875	500	19.4	10.7	2.9
<i>Combretum aculeatum</i>	938	879	389	22.8	6.2	3.6

Intake and digestibility of diets

Herbage intake was affected ($p < 0.05$) by browse species, but there was no interaction between browse species and browsing duration (Table II). Indeed, unlike *Ziziphus*, 60 min or 120 min of access to *Combretum*, resulting respectively in 18% and 29% of *Combretum* foliage in the diet, reduced the intake of forage in the pasture by 6.3% and 4.2%, respectively ($p < 0.05$). The total intake of digestible organic matter (DOMI, g/(kg LW)^{0.75}) was affected by the browse species and browsing duration, and by a browse species \times browsing duration interaction during the feeding trial as well as in the N balance trial (Tables II and III). However, the intake was 65% higher during the feeding trial (first four weeks) than during the balance trial (last six weeks of the experiment). The total intake of dry matter (g DM/kg LW) increased with the duration of access to the groves, irrespective of the browse species. The intake of browse was

affected ($p < 0.05$) by the browse species and browsing duration, with a significant effect from the interaction between these two factors. In fact, the intake of *Combretum* foliage was 20% higher ($p < 0.05$) than that of *Ziziphus*. Also, the sheep that browsed for 120 min consumed about 95% more foliage than those that browsed for 60 min, irrespective of the browse species (Table II). Intakes of nitrogen and NDF were affected by the browse species and browsing duration. Compared with the control, access to *Combretum* and *Ziziphus* increased ($p < 0.05$) N intake by 56% and 50%, respectively (Table II). Animals fed *Combretum* ingested 9% less NDF than those fed *Ziziphus*.

The digestibility of the diet was higher in the controls and decreased linearly ($p < 0.05$) with browsing duration, with a significant effect from browse species and a species \times duration interaction (Tables II and III). The relationship between the digestibility of the diet (Y) and the amount of browse ingested (S ; g/(kg LW)) was given by $Y = 548.869(\pm 1.601) + 1.055(\pm 1.598)S - 0.281(\pm 0.012)Dur + 0.536(\pm 0.017)S \times Dur$ ($p < 0.01$; $R^2 = 0.99$).

TABLE II

Natural pasture (Pn), browse (Br) and total dry matter intake (g DM/(kg LW)⁻¹), digestible organic matter (g DOM/(kg LW)^{0.75}), NDF (g/d) and N (g/d) intake and DM digestibility (g DM/kg)

Browse species	Browsing duration (min)	Grazing duration (min)	Intake						
			Pn ^a	Br ^{abd}	Total ^b	DOM ^{abd}	NDF ^{ab}	N ^{ab}	DMD ^{abd}
None	0	420	28.4	–	28.4	32.8	366	8	557
<i>Ziziphus</i>	60	420	28.4	4.8	33.2	36.8	428	11	532
	120	420	28.6	9.2	37.9	40.9	493	13	515
<i>Combretum</i>	60	420	26.6	5.7	32.3	32.9	392	11	536
	120	420	27.2	11.3	38.4	41.8	455	14	523
SEM			0.2	0.6	0.6	0.6	8.6	0.4	2.3

^aEffect of browse species

^bLinear effect of browsing duration

^cQuadratic effect of browsing duration

^dInteraction between browse species and browsing duration ($p = 0.05$)

SEM, standard error of treatment mean

TABLE III

Nitrogen intake (Ni, g/day), faecal N (Nf, g/day), urinary N (Nu, g/day) and N retained (Nr, g/day) during the balance trial, and live weight gain (LWG, g/day) at 30 and 75 days

Browse species	Browsing duration (mins)	Grazing duration (mins)	N Balance				LWG	
			Ni ^{a,b,c}	Nf ^{a,b,d}	Nu ^{a,b}	Nr	30 days	75 days
None	0	420	2.5	2.5	0.6	-0.6	35	-30
<i>Ziziphus</i>	60	420	3.7	4.6	0.8	-1.7	30	-39
	120	420	4.9	5.3	1.0	-1.5	48	-19
<i>Combretum</i>	60	420	3.9	3.3	1.9	-1.3	23	-30
	120	420	5.5	3.2	3.4	-1.0	24	-37
SEM		0.6	0.7	0.9	0.9	2.3	4.5	

^aEffect of browse species

^bLinear effect of browsing duration

^cQuadratic effect of browsing duration

^dInteraction between browse species and browsing duration ($p < 0.05$)

SEM, standard error of treatment means

Utilization and excretion of nitrogen

Nitrogen retention was negative for all treatments. The faecal N output (g/day) was higher ($p < 0.05$) for the sheep browsing *Ziziphus* than for those browsing *Combretum* or for those fed herbage only. Conversely, the urinary N output (g/day) was highest ($p < 0.05$) for the sheep browsing *Combretum*. The animals fed on the control diet had the lowest nitrogen loss ($p > 0.05$). Fibre-bound N in the faeces as a fraction of the total faecal N was greatest ($p < 0.05$) in the sheep browsing *Ziziphus*, followed by those only grazing and finally by those browsing *Combretum*. The amount of faecal NDF-N expressed as a fraction of the faecal dry matter ($\text{g}/(\text{kg FDM})^{-1}$) followed the same trend (Table IV). The nitrogen content of the faecal dry matter ($\text{g}/(\text{kg FDM})^{-1}$) increased with browsing duration, but there was no interaction between the browse species and browsing duration (Table IV). *Combretum* increased the faecal P concentration ($\text{g}/(\text{kg FDM})^{-1}$), and *Ziziphus* decreased it relative to sheep with no access to browse (Table IV).

TABLE IV

Faecal dry matter excreted (FDM, g/(kg LW), faecal N (Nf, g/(kg FDM), faecal neutral detergent N (NDF-N, g/(kg FDM), percent faecal neutral detergent N (% NF) and faecal P (Pf, g/(kg FDM))

Browse species	Browsing duration (mins)	Grazing duration (mins)	FDM ^{bcd}	Nf ^b	NDF-N ^{abd}	%Nf ^{ad}	Pf ^{ad}
None	0	420	16.7	16.9	8.0	47.3	3.2
<i>Ziziphus</i>	60	420	15.7	20.7	10.7	51.4	2.9
	120	420	18.6	23.7	11.7	49.8	3.0
<i>Combretum</i>	60	420	15.3	21.9	6.1	28.1	3.7
	120	420	16.4	23.0	6.7	29.3	4.1
SEM			0.5	0.8	0.1	6.2	0.4

^aEffect of browse species

^bLinear effect of browsing duration

^cQuadratic effect of browsing duration

^dInteraction between browse species and browsing duration ($p < 0.05$)

SEM, standard error of treatment means

Growth rate

The growth rate did not differ significantly between the treatments (Table III) during the initial 30 days of the experiment, although the sheep browsing *Ziziphus* gained on average 11% more than the controls and those browsing *Combretum* gained on average 50% less than the controls. Doubling the duration of access to the groves from 60 to 120 min increased ($p > 0.05$) the live weight gain of the sheep grazing *Ziziphus* by 60% but had almost no effect on the sheep grazing *Combretum* (Table III). The live weight gain decreased with time, and the cumulative gain after 75 days was negative and unaffected by treatment (Table III). However, allowing sheep to browse *Ziziphus* for 120 min per day reduced ($p > 0.05$) the weight loss by 37%, whereas with *Combretum* the weight loss increased by 23% compared to the control. Hence, increasing the duration of access to the *Combretum* grove from 60 to 120 min increased the weight loss by 23%, whereas browsing on *Ziziphus* reduced weight loss by 42%.

Rumen ammonia-N level (NH₃-N)

The sheep that had access to a grove consumed 50–60% more N than the controls that were only allowed to graze. Six hours after grazing or browsing, the sheep browsing on *Ziziphus* (60 and 120 min) or *Combretum* (60 and 120 min) had respectively 56% and 22% ($p > 0.05$) more ruminal NH₃-N than the controls (Table V). However, 24 h later, the ruminal contents of NH₃-N had dropped significantly ($p < 0.05$) to 33% and 31% less than that for the control.

TABLE V

Effect of browsing duration and browse species (*Ziziphus* or *Combretum*) on the concentration of rumen ammonia N (mg/L) 6 h and 24 h after browsing

Browse species	Browsing time (mins)	Grazing time (mins)	Rumen ammonia N	
			6 h	24 h ^a
None	0	420	60	68
<i>Ziziphus</i>	30	420	63	43
	60	420	97	50
	120	420	91	52
<i>Combretum</i>	30	420	41	43
	60	420	67	51
	120	420	79	53
SEM			4.4	8.3
CV			68	33

^aEffect of browse species; $p < 0.05$

SEM, standard error of treatment means

CV, coefficient of variation

DISCUSSION

The effect of access to browse on herbage intake and on digestibility and growth rate

The main objective of having access to browse in this experiment was to provide additional N and other nutrients essential for the growth of ruminal microbes, so enhancing ruminal degradation and forage intake during the dry season. The lower ruminal NH₃-N content 24 h after the supply of N from browsing indicates a depressive effect from *Ziziphus* and *Combretum* on proteolysis and subsequent poor microbial growth and poor digestion of fibre in the rumen. Such a depressive effect is

often associated with the occurrence of tannins in browsed forage (Barry and Manley, 1984; Mangan, 1988; Woodward and Reed, 1989, 1995; Reed *et al.*, 1990; Tanner *et al.*, 1990; Ash, 1995; Norton and Ahn, 1997). Despite the provision of at least 50% more N than the control, *Ziziphus* did not affect the intake of the herbage, whereas *Combretum* depressed it. The decrease in the intake of the herbage by the sheep browsing *Combretum* could be attributed to the negative effect of tannins on the ruminal environment and its functions as reported earlier (Waghorn and Shelton, 1995; Wiegand *et al.*, 1995; Norton and Ahn, 1997). The lack of effect of the interaction between browse species and the duration of access to browse on herbage intake indicates that the depression by *Combretum* of the intake of herbage was mainly due to intrinsic factors in the *Combretum* foliage consumed. The lack of depressive effect of *Ziziphus* on the intake of herbage may be attributed to a chemical difference in the tannins or other antinutritional factors in the two browse species. This observation was corroborated by the poorer growth rate of the sheep browsing on *Combretum*, despite their higher total DOM intake, compared to either the sheep browsing on the *Ziziphus* or those only allowed to graze. Likewise, the decreasing trend in LWG with increasing duration of access to *Combretum* contrasted with the increasing trend in LWG for sheep browsing on the *Ziziphus*. The higher total DM, total DOM and N intake by the sheep that had access to browse, compared to the sheep that only grazed, were due to the additional supply from the *Ziziphus* and *Combretum* foliage consumed. The decrease in the total intake (DM, DOM and N) during the last six weeks of the experiment and the subsequent weight loss were due to a reduction in the availability and quality of the feed on the pasture grazed by the animals towards the end of the dry season.

Utilization of nitrogen

For the sheep browsing on the *Ziziphus*, most of the N was excreted via the faeces and was evenly distributed between faecal NDF-N (fibre-bound N) and faecal soluble N (microbial N + endogenous N). For the sheep browsing on the *Combretum*, more than 66% of the faecal N was in a soluble form ($100\% - \text{faecal NDF-N}\%$). These findings indicate that the NDF content in the *Ziziphus* (Table I) contributed more than tannins to the high faecal NDF-N. The high proportion of soluble faecal N in the sheep browsing on *Combretum* may have been derived from N released by rupture of the tannin-protein complex (microbial and endogenous N) in the acid environment of the hind-gut (Reed *et al.*, 1990). The negative N balance for the animals on all the treatments resulted from a low N intake due to the low feed intake and the low N content of the basal diet during the last weeks of the trial.

Effects of Combretum and Ziziphus on nitrogen cycling

The cycling of organic matter by livestock through excreta that fertilize soils is an important link between crop and livestock production in semi-arid West Africa

(Powell *et al.*, 1994). However, the fate of the nutrients voided depends on their chemical forms in the animals' excreta. During this experiment, sheep with equal browsing duration had the same content of faecal N ($\text{g}/(\text{kg FDM})^{-1}$) and a similar N output (g/day). However, access to *Ziziphus* reduced the urinary N (15% of total N excreted) output and increased the faecal N, evenly distributed in the soluble and fibre-bound insoluble N fractions. In contrast, urinary N, which is more susceptible to volatilization, represented 36–50% of the N excreted by the sheep browsing on *Combretum*, and about 70% of this faecal N was in a soluble form. Thus, the sheep having access to *Ziziphus* distributed N better between that which would volatilize and which was slowly and readily available to plants, and would probably enhance nutrient cycling in a mixed farming system.

Further studies are needed to determine the nature of the deleterious compounds in the browses used in relation to their phenological state.

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Effet d'un supplément alimentaire avec de l'herbe pâturée fraîche de *Ziziphus mauritania* ou de *Combretum aculeatum* sur l'apport alimentaire, usage fait de l'azote et croissance des moutons

Résumé – L'influence de 0, 60 ou de 120 minutes d'accès à un bosquet de *Ziziphus mauritania* (*Ziziphus*) ou de *Combretum aculeatum* (*Combretum*) sur l'apport en fourrage et sur la digestibilité, la croissance et l'excrétion de substances nutritives a été déterminée en utilisant 40 béliers Oudah qui ont brouté pendant 7 heures/jour sur une pâture de qualité médiocre en saison sèche dans le Sahel. Les effets de l'espèce de la pâture et de la durée du broutage (0, 30, 60 et 120 minutes) sur le contenu en ammoniacque ruminal ont également été évalués en utilisant 8 béliers fistulés plus âgés que la moyenne. *Ziziphus* a augmenté à la fois la matière organique digestible totale et les apports totaux en matière sèche par (kg de poids vif) 0,75 sans diminuer l'apport en herbage, tandis qu'un accès de 60 ou de 120 minutes au *Combretum* a diminué l'apport en herbage de 6,3% et de 4,2% respectivement. La digestibilité du régime alimentaire a diminué ($p < 0,05$) avec la durée d'accès aux bosquets. En dépit de l'apport de plus d'azote (N pour *nitrogen*) dans la nourriture témoin, le $\text{NH}_3\text{-N}$ ruminal a diminué 24 heures après que le broutage a commencé. Le gain de poids vif réduit des moutons broutant le *Combretum* peut être révélateur de la présence de plus de composés nuisibles dans le *Combretum* que dans le *Ziziphus*. Le *Ziziphus* semble avoir plus de potentiel d'augmentation de la production de moutons dans les systèmes de récolte/d'élevage du bétail à faible apport que le *Combretum*.

Efecto de la suplementación con hojas tiernas frescas de *Ziziphus mauritiana* o *Combretum aculeatum* sobre la ingesta y la utilización de nitrógeno

Resumen – Se determinó la influencia del acceso durante 0, 60 o 120 min a *Ziziphus mauritiana* o *Combretum aculeatum*, sobre la ingesta de forraje, la digestibilidad, el crecimiento y la excreción de nutrientes en cuarenta moruecos de raza Uda. Los animales pastaron 7 horas al día en pastos de baja calidad durante la estación seca en el Sahel. También se evaluaron los efectos de la ingestión de hojas tiernas de dichas especies y la duración del ramoneo (0, 30, 60 y 120 min) sobre el contenido ruminal de amoníaco de ocho moruecos adultos fistulizados. El acceso a *Ziziphus* incrementó tanto la ingesta del

DOM total ($\text{g kg}^{-1} \text{ LW}^{0.75}$) como del DM total ($\text{g kg}^{-1} \text{ LW}$) sin disminuir la ingesta de hierba, mientras que un acceso de 60 o 120 min a *Combretum* redujo la ingesta de hierba en un 6,3% y en un 4,2% respectivamente. La digestibilidad de la dieta disminuyó ($p < 0,05$) con el tiempo de acceso a las plantas. A pesar de la provisión de más N que en la dieta control, el $\text{NH}_3\text{-N}$ disminuyó 24 h después del inicio del ramoneo. La reducida LWG de los moruecos que ingirieron *Combretum* puede indicar más componentes nocivos en *Combretum* que en *Ziziphus*. *Ziziphus* parece tener más potencial que *Combretum* para incrementar la producción en ganado ovino en sistemas agrícola-ganaderos de bajo coste.