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FOLIAGE OF TROPICAL ARBOREAL SPECIES IN FEEDING OVINES (*Ovis aries*): INTAKE, DIGESTIBILITY AND BALANCE NITROGEN*

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Abstract

Objective: To determine the effects of supplementation with three tropical arboreal species (*Guazuma ulmifolia, Gliricidia sepium* y *Tithonia diversifolia*) on intake, in vivo and in vitro digestibility in hair sheep. **Methodology:** The experiment was carried out in "*Las Brisas*" farm of Universidad del Tolima, Colombia. Twelve hair sheep, with an average weight of 22.2±2.5 kg, received four treatments in a 4×4 Latin square design with three sheep per experimental unit were used. The treatments consisted of: T1 = 100% *D. aristatum*; T2 = 50% *D. aristatum*, 25% *Guazuma ulmifolia* and 25% rice bran; T3 = 50% *D. aristatum*, 25% *Gliricidia sepium* and 25% rice bran; and T4 = 50% *D. aristatum,* 25% *Tithonia diversifolia,* and 25% rice bran. To determine the intake and digestibility of nutrients, the method of total collection of feces was used. It was observed that the intake and digestibility of dry matter, organic matter, crude protein, fraction of B3 of the protein and fiber in neutral detergent, increased in relation to the control group in the diets containing tree foliage (p<0,0001). **Main results:** There were no differences for the dry matter intake (p> 0.05) between the treatments containing tropical arboreal species *G. ulmifolia* (T2), *G. sepium* (T3) and *T. diversifolia* (T4). However, differences were observed between all treatments (p <0.05) for nutrients digestibility. **Conclusion:** The supplementation of hair sheep with foliage of tropical arboreal species is an interesting alternative to improve the intake and digestibility of diets which can contribute to the improvement of the productive indicators.

Key words: hair sheep, silvopastoral systems, small ruminants, tropical dry forest.

FOLLAJE DE ARBÓREAS TROPICALES EN ALIMENTACIÓN DE OVINOS (*Ovis aries*): CONSUMO, DIGESTIBILIDAD Y BALANCE DE NITRÓGENO

Resumen

Objetivo: Evaluar el efecto de la suplementación con tres especies arbóreas del trópico (*Guazuma ulmifolia, Gliricidia sepium* y *Tithonia diversifolia*) sobre el consumo, la digestibilidad *in vivo* e *in vitro* en ovinos de pelo. **Metodología:** El experimento se realizó en la granja "Las

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Brisas" de la Universidad del Tolima - Colombia. Se utilizaron 12 ovinos de pelo con peso promedio de 22,2±2,5 Kg distribuidos en un diseño cuadrado latino 4x4 con tres ovinos por unidad experimental. Los tratamientos consistieron en: T1= 100% heno de *D. aristatum*, T2= 50% heno de *D. aristatum*, 25% *Guazuma ulmifolia* y 25% de harina de arroz; T3= 50% heno *D. aristatum*, 25% de *Gliricidia sepium* y 25% de harina de arroz y T4= 50% heno de *D. aristatum* 25% de *Tithonia diversifolia* y 25% de harina de arroz. Para determinar el consumo y la digestibilidad de los nutrientes se utilizó el método de colección total de heces. Se observó que el consumo y la digestibilidad de la materia seca, materia orgánica, proteína cruda, fracción b3 de la proteína y fibra en detergente neutro, aumentó con respecto al grupo control en las dietas que contenían los forrajes de arbóreas ($p<0,0001$). **Principales resultados:** No hubo diferencias para el consumo de la materia seca ($p>0,05$) entre los tratamientos que contenían los forrajes de arbóreas *G. ulmifolia (T2), G. sepium (T3)* y *T. diversifolia (T4).* Sin embargo, se observaron diferencias entre todos los tratamientos ($p<0,05$) para la digestibilidad de los nutrientes. **Conclusión:** La suplementación de ovinos de pelo con especies arbóreas del trópico es una alternativa interesante para mejorar el consumo y la digestibilidad de las dietas, lo cual puede contribuir al mejoramiento de los indicadores productivos.

Palabras clave: arbóreas tropicales, pequeños rumiantes, sistemas silvopastoriles, suplementación en pastoreo.

INTRODUCTION

Small ruminant production in South American is a key component of production systems in dry areas. They are reared mainly by poor, small-scale producers and provide dietary protein and income for the household (IÑIGUEZ, 2011). In Colombia, most of the sheep production is managed in continuous grazing systems without any supplementation, making the productive indicators of these farms poor. On the other hand, the country's availability of grains and agro-industrial by products is scarce and expensive, which makes it unfeasible for farmers to use this kind of ruminant nutrition. Conversely, in the recent years there has been a great interest in knowing and incorporating alternative forage species in animal feed, which can positively influence the animal response, being effortlessly adapted to the environment, easier to establish and are being consumed by the animals. In addition, tropical forests are characterized by their high biodiversity of plant species, which have been poorly studied in relation to the nutritional potential that they have, in order to meet the protein and energy requirements of small ruminants. According to LARA *et al.* (2007), the foliage of shrub and leguminous trees have demonstrated its potential as a nutritional strategy in the supplementation of ruminants within the tropics, mainly during periods of forage shortage, where it has been constituted as an alternative supplementation. The Guazuma tree (*Guazuma ulmifolia*) has a large distribution within tropical livestock systems and is naturally associated with them as live fence or trees within the paddock. During the last years, nutritional properties have been studied in ruminants because it

is one of the little foliage that can be maintained especially in critical low precipitation times. The golden button (*Tithonia diversifolia*) is a shrub frequently used for ruminant feeding. It is native to Mexico and it has a wide distribution due to its capacity to adapt to different heights above sea level (ATANGANA *et al.*, 2014). The supplementation with golden button forage increases the weight gain at the fattening stage of steers in low tropical conditions (GONZÁLEZ *et al.*, 2014) by 135 g / day. Matarraton (*Gliricidia sepium*) is a specie with a high biomass production, it has been estimated that the crop yield is between 20,000 and 40,000 trees per hectare and produces about 20 t / leaves per year (ANIS *et al.*, 2016).

Lambs that have been fed with silages of Gliricidia have a better nutritional performance and, consequently, a better production performance compared to those fed with buffelgrass silage (CARVALHO *et al.*, 2017). Therefore, the purpose of this study was to evaluate the effect of the supplementation of three tropical tree species (*Guazuma ulmifolia, Gliricidia sepium* and *Tithonia diversifolia*) on in vivo and in vitro digestibility and nitrogen balance for hair lambs.

MATERIALS AND METHODS

Local, animals, diets and experimental design

The experiment was implemented according to bioethical normative for animal experimentation contemplated by the University of Tolima (agreement of the academic council number 0171 of October 29, 2008) and act number 02 of 2017 of the committee of bioethics. The experiment was carried out at "Las Brisas" farm, Ibague, Colombia; its geo-positioning is 04°26' north latitude and 75°13' west longitude. A 4x4 Latin square design was used within four periods, for four treatments and four experimental units each one with 3 lambs (12 Colombian hair lambs with 22 kg body-weight). The experimental periods were of 16 d each with the first 12 d, intended for adaptation to the experimental diets and the following 4 d for sample collection (feeds offered, orts, urine, and blood plasma). Before starting the experimental periods, the lambs were dewormed with 1 mL of Fenbendazol® that was orally ingested. Feed intake was adjusted to obtain 5-10% of orts from the total feed offered. During the adaptation phase, the lambs were kept in pens per treatment group (3 animals x pen), the pens had an area of 16 m2 and were provided with food and water bowls. From 12 d of each experimental period the lambs were placed in individual cage with 75 cm wide x 100 cm long, each cage was provided with trough, tray collecting stool samples and tray system for collection urine samples. The treatments evaluated were: T1 (control) = 100% *D. aristatum* Hay; T2= 50% Angleton Hay, 25% *Guazuma ulmifolia* and 25% Rice bran; T3= 50% Angleton Hay, 25% *Gliricidia sepium* and 25% Rice bran; T4= 50% Angleton Hay, 25% *Tithonia diversifolia* and 25% Rice bran. The experimental diets were not made to meet the requirements of energy and

protein in the lambs; they were formulated to simulate the typical condition of the study region (T1) and three possible applicable situations of supplementation in the same region (T2, T3; T4). The percentage and chemical composition of feeds used in the experimental diets are showed in Tables 1 and 2.

Table 1. Chemical composition of ingredients used in the experimental diets (gr/kg).

Nutriment	DM	CP	EE	MM	NDF	ADF	NFC
Angleton Hay	855	35	10	94	707	493	155
Guazuma ulmifolia	873	130	28	123	533	484	186
Gliricidia sepium	865	218	21	166	439	382	156
Tithonia diversifolia	866	179	26	191	445	407	156
Rice bran	924	120	131	130	375	336	239

[1]Abbreviations: DM= dry matter; CP= crude protein; EE= ether extract; MM= mineral matter; NDF= neutral detergent fiber; ADF= acid detergent fiber; NFC= non fiber carbohydrates.

Table 2. Ingredients and chemical composition of experimental diets used in the experiment.

	Experimental diets composition (%)			
	T1	T2	T3	T4
Angleton Hay	100	50.0	50.0	50.0
Guazuma ulmifolia		25.0		
Gliricidia sepium			25.0	
Tithonia diversifolia				25.0
Rice bran		250	25.0	25.0
	Chemical composition (gr/kg)			
Crude Protein	35	80	102	92
Ether Extract	10	44	43	44
Mineral Matter	94	110	121	127
Neutral Detergent Fiber	707	581	557	559
Acid Detergent Fiber	493	452	426	432
Non-Fiber Carbohidrates[1]	155	184	176	176

[1]Treatments: T1 = 100% *D. aristatum* hay, T2 = 50% *D. aristatum* hay, 25% *Guazuma ulmifolia* and 25% rice bran; T3 = 50% hay *D. aristatum*, 25% *Gliricidia sepium* and 25% rice bran; T4 = 50% of *D. aristatum* hay 25%; *Tithonia diversifolia* and 25% rice bran.

Measurements and samples' collection

Feed offered and orts were measured for each lamb and recorded daily through the experimental period to calculate DM intake. Daily feed intake was calculated as the difference between food supplied and feed rejected, based on the dry matter (DM). Intake was adjusted to provide 4% of live weight and allow at least 10% of orts based on DM. In order to determinate the digestibility of dry matter (DM), total dry matter intake (DMI), organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF) and non-fiber carbohydrates (NFC), the animals were fed twice daily (08.00 h and 16.00 h). Feed orts were collected from the feeders every day during the experiment, weighed and blended to carry out a compound sample per lamb during each period. Samples of Angleton hay, *Guazuma ulmifolia*, *Gliricidia sepium*, *Tithonia diversifolia* and rice bran were collected once per experimental period. Total feces were collected in collection bags from day 13th during 4 consecutive days. Feces were blended, and 100 g/kg were separated to form an integrated composite sample per each day. Samples of feeds, orts and feces were thawed, pre-dried for 48-72 h in an air circulation stove at 55°C and ground in Willey type mills (2 mm mesh). The samples were mixed based on the percentage of dry weight to obtain samples made up of sample per animal/ treatment/period. Samples of the feeds used in experimental diets, orts and feces were analyzed to determine DM, OM, PC, EE and ashes (AOAC, 2000), NDF and ADF (VAN SOEST *et al.*, 1991). The samples of experimental diets were exposed to in vitro digestion using an ANKOM Daisy II® incubator (ANKOM technology corporation Fairport NY, USA) by means of the method outlined by GOERING and VAN SOEST (1970). Briefly, approximately 0.50 g of each diet was weighed into separate ANKOM F57 filter bags. The bags were placed in digestion jars. Two buffer solutions were warmed to 39°C before setting up each in vitro digestion. The solutions were mixed in a 5:1 ratio, and 1800 ml of the mixed buffer solution was added to digestion jars. Digestion jars were sealed and placed in the preheated incubator for 20 min, allowing the temperatures of the incubator and vessels to reach 39°C. Rumen liquor was collected from a ruminally cannulated cow (400 kg live weight) 2h after morning feeding. The cow was fed with Angleton hay and 2 kg of animal feed with 18% of CP and 68% of TDN. The rumen liquor was strained through four layers of cheesecloth before mixing with the buffer solution. After 48h, the bags were removed from the digestion jars, rinsed and, then placed in an ANKOM 200/220 Fiber Analyzer (Ankom Technology Corporation). To determine nitrogen balance (NB) was collected the total amount of urine removed by each animal on a preservative (10% sulfuric acid) was collected daily during each period. A composite sample (per animal, per period) was collected and then stored. Then it was it was measured the daily amount per animal. The apparent nitrogen balance was

calculated taking into account the equations described by BEZERRA *et al.* (2010), expressed in g/day and gr / kg 0.75 / day: NB or N retained = intake N - (N in feces + N in urine). N absorbed = N intake - N in feces. N intake = N offerted – N orts. The nitrogen content of the orts, feeds, feces and urine were determined using the Kjeldhal method described by AOAC (2000).

Statistical analysis

The data was compared by ANOVA at a significance level of $P<0.05$. Differences between the treatments were analyzed using Tukey tests with significance declared at $P<0.05$. The statistical analysis was conducted using the SAS (Statistical Analysis System, version 9.1).

RESULTS

Intake and digestibility of nutrients are shown in Table 3. The DM, OM, NDF and EE intake was higher ($P>0.05$) in the treatments that received supplementation with the arboreal species (T2, T3 and T4). The DMI (as % live weight) were 1.86; 2.81; 3.21 and 3.20% for treatments T1; T2; T3 and T4 respectively. The DMI improved in the treatments with *G. sepium* and *T. diversifolia*, 705 and 704 g/day, respectively. The crude protein intake was higher in T3 and T4. However, digestibility of the B3 Fraction of crude protein was higher in T2, T3 and T4. The In vitro digestibility of dry matter (IVDDM) rice bran, *G. sepium* and *T. diversifolia* was higher ($p <0.0005$) than pasture (*Dichantum*) and *G. ulmifolia* (Table 4). G. *Sepium* delivered the best results of IVDDM (69.1%), higher than rice bran (66.2%). The IVDDM of *G. ulmifolia* was lower (46.5%) than *D. aristatum* (54%). Differences ($P<0.05$) were observed between the different treatments, in nitrogen balance variables. It was observed that the nitrogen ingested and retained was lower in control treatment (T1) in relation to the other treatments. Thus, the amounts of nitrogen excreted in the urine presented variances ($p<0.05$), observing that the diet with addition of *T. diversifolia* obtained the highest value with 5.03 g/day, while the animals fed with *G. Sepium* reached 2.83 g/day, which is different from the other diets. The control and *G. ulmifolia* treatments were similar with values of 1.26 and 1.22 g/day respectively. Among treatments with tropical tree fodder, the lowest nitrogen retained ($P<0.05$) was to *G. ulmifolia*, while treatments with *G. sepium* (T3) and *T. diversifolia* (T4) obtained similar retained nitrogen values. The efficiency in the use of nitrogen (N intake) was higher in diets that contained tropical tree fodder, the following values were observed: 62.1%, 89.3%, 89.6% and 85.9% for the controlled diet, *G. ulmifolia, G sepium* and *T. diversifolia* respectively.

Table 3. Intake (Int), (FF) fecal excretion and digestibility of matter (DM), organic matter (OM), crude protein (CP), crude protein fraction (B3) neutral detergent fiber (NDF) and ethereal extract (EE) in hair lambs fed with tropical tree fodder.

Variables	Treatments[1]				SEM[2]	P<
	1	2	3	4		
Dry matter						
Intake, g d^{-1}	409.7b	617.5a	705.3a	704.0a	151.9	0.001
Fecal excretion, g d^{-1}	221.3b	268.7ab	275.9a	268.6ab	51.79	0.026
Digestibility %	46.0c	56.3b	60.8a	61.7a	0.08	0.001
Organic matter						
Intake, g d^{-1}	353.9b	553.1a	618.1a	615.0a	135.2	0.001
Fecal excretion, g d^{-1}	186.9	221.6	228.8	213.5	44.98	0.062
Digestibility %	47.3c	59.8b	62.8ab	65.2a	0.091	0.001
Crude Protein						
Intake, g d^{-1}	14.65d	55.79c	77.39a	68.97b	25.11	0.001
Fecal excretion, g d^{-1}	15.10b	28.73a	31.41a	28.48a	7.724	0.001
Digestibility %	-2.4c	48.2b	59.4a	58.3a	0.267	0.001
Fraction B3 of CP						
Intake, g d^{-1}	4.02d	13.39c	20.18a	15.52b	0.884	0,001
Fecal excretion, g d^{-1}	162.3	160.9	172.6	160.9	0.112	0,159
Digestibility %	32.8b	48.0a	51.5a	55.8a	0.037	0,001
Neutral Detergent Fiber						
Intake, g d^{-1}	243.1b	317.7a	359.4a	365.6a	11.6	0.001
Fecal excretion, g d^{-1}	162.3	160.9	172.6	160.9	4.553	0.523
Digestibility %	32.7c	47.9b	51.4ab	55.7a	0.016	0.001
Ethereal extract						
Intake, g d^{-1}	3.70b	28.32a	30.81a	31.75a	1.781	0.001
Fecal excretion, g d^{-1}	13.01b	7.50c	22.38a	10.95b	0.913	0.001
Digestibility %	-252.0c	73.4a	27.2b	65.4a	0.2	0.001

[a–d] Means within a row with different superscripts differ ($P < 0.05$).[1]SEM: standard error of the mean. [1]Treatments: T1 = 100% *D. aristatum* hay, T2 = 50% *D. aristatum* hay, 25% *Guazuma ulmifolia* and 25% rice bran; T3 = 50% hay *D. aristatum*, 25% *Gliricidia sepium* and 25% rice bran; T4 = 50% of *D. aristatum* hay 25%; *Tithonia diversifolia* and 25% rice bran.

Table 4. In vitro digestibility of dry matter of the ingredients and experimental diets (treatments) used in hair lambs fed with tropical tree fodder.

Ingredient or treatment	Media ± DE	SEM	P<
Ingredient			
D. aristatum	54.0±1.1 cb		
Rice bran	66.2±9.5 a		
G. ulmifolia	46.5±1.8 c	2.5	0.0005
G. sepium	69.1±1.7 a		
T. diversifolia	64.5±0.7 ab		
Treatment			
T 1 - (control)	52.1±3.0 c		
T 2 - *G. ulmifolia (25%)*	52.7±1.9 cb		
T 3 - *G. sepium (25%)*	57.7±1.6 ab	1.1	0.0001
T 4 - *T. diversifolia (25%)*	57.9±0.2 a		

[a–d]Means within a row with different superscripts differ (P < 0.05). [1]SEM: standard error of the mean. 1Treatments: T1 = 100% *D. aristatum* hay, T2 = 50% *D. aristatum* hay, 25% *Guazuma ulmifolia* and 25% rice bran; T3 = 50% hay *D. aristatum*, 25% *Gliricidia sepium* and 25% rice bran; T4 = 50% of *D. aristatum* hay 25%; *Tithonia diversifolia* and 25% rice bran.

DISCUSSION

The improvement in intake is mainly due to the increase in the supply of crude protein in the diets. Several authors have shown that tree species which are rich in protein such as *G. sepium* and *T. diversifolia* can improve the intake and digestibility of dry matter in small ruminants, due to a higher rate of ruminal degradation, higher contribution of N for microorganisms and lower percentages of NDF and ADF in their composition (LARA *et al.*, 2007; LIU *et al.*, 2001; MARTÍNEZ *et al.*, 2012). Most of the published studies have been carried out in tropical areas of the world where the availability of conventional raw materials is scarce or highly expensive, but there is a great biodiversity of species that have potential for use in ruminant feeding, mainly due to their protein content. In this sense, LIU *et al.* (2001) replaced a protein source with leaves of Morera (*Morus alba*) a tropical species rich in protein in Huzhou lambs (18 kg), observing that the supplementation with *Morus alba* leaves, increased the intake from 451 to 591 g/day DM for treatments 0 and 240 g respectively. Therefore, LARA *et al.* (2007) supplementing pelibuey sheep with *Morus alba* leaves observed increased dry matter intake and performance. MARTÍNEZ *et al.* (2012) supplementing 18 kg lambs with multi-nutritional blocks based on tree leaves (*G. ulmifolia, L. leucocephala* and *A. cochliacantha*) observed that DM intake increased. In a similar study, ALAYÓN *et al.* (1998) using levels of *G. sepium* in the diet of pelibuey sheep observed a positive linear effect as *G. sepium* levels in the diet increased; the same authors observed an increase in the levels of purine derivatives, which explains for a greater contribution of microbial protein, something that probably can also be happening in this experiment.

In general, this data corroborates the importance that tree species can have in the nutritional improvement of sheep in the tropics. Furthermore, de CARVALHO *et al.* (2017) report in vivo digestibility data for cattle for *G. sepium* of 79%, 77%, and 52% for DM, CP and NDF, respectively, values similar to those obtained in this study. SOTO *et al.* (2009) studying the IVDDM of several tropical species concluded that the best values are reported for *G. sepium* and *M. alba* with values of 65 and 74% at 10 weeks of cutting. The IVDDM values of *G. sepium* were higher than those reported by SALAZAR *et al.* (2008), which observed values of 46.9% for leaves of *G. sepium* using the technique of TILLEY & TERRY (1963). However, it is important to consider that the leaf digestibility of tree species depends to a great extent on the age of regrowth. SOTO *et al.* (2009) observed IVDDM values of 65.3%, 55.7%, 50.1%, 50.5% and 53.2% of *G. sepium* cut at 10, 14, 18, 22 and 26 weeks respectively, clearly observing that as the time of regrowth decreases the IVDDM, and in this study the age of regrowth was 8 weeks. The lower IVDDM in this in the *G. ulmifolia* is explained by the lower protein content and higher FDN and FDA in its composition. FLORES *et al.* (1998) when evaluating the nutritional value of some tropical species observed IVDDM values for *G. ulmifolia* of 43.8%, similar to that it was observed in this study. The same authors observed that there is a negative correlation between NDF content and IVDDM, concluding that forages with high concentrations of fiber are slowly digested by the rumen and their maximum utilization requires several days or weeks. Meanwhile, RIVERA *et al.* (2012) observed in situ degradability values at 96 hours for *G. ulmifolia* from 57.07%. It was observed that *T. diversifolia* had the highest digestibility values both in vivo (Table 3) and in vitro (Table 4) tests. Like the other species studied, several authors report that the digestibility of *T. diversifolia* depends to a great extent on the age of regrowth and the contents of FDN and FDA. LA *et al.* (2012) observed DIVMS values of *T. diversifolia* of 72.25% and 79.77% for cuts made in the rainy period, respectively. SOTO *et al.* (2009) observed IVDDM values of *T. diversifolia* of 50, 48.9, 46.2, 36.3 and 45.8% and *G. sepium* 65.3, 55.7, 50.1, 50.5 and 53.2% for prunings made at 10, 14, 18, 22 and 26 weeks. The same authors reported that the decline in digestibility is observed as forage matures and older leaves and stems appear. The results obtained demonstrate the nutritional potential for feeding ruminants of tree species and especially *Gliricidia* and *Tithonia*. Meanwhile, it is necessary to study the digestibility of *G. ulmifolia* at different cutting ages. On the other hand, the low nitrogen consumption in the T1 can be explained by the poor protein intake of the hay (Table 5). This condition could have influenced the flow of nitrogen for the metabolic processes that were present in the studied sheep. In the meantime, it can be evidenced that by including forage species that provide better levels of protein in the diet than grazing, causing an increase of the animal's nitrogen flow indicators, which would be an interesting practice for the producers in the region. Treatments including *G. Ulmifolia, G. sepium* and *T. diversifolia*, contributed 5.7; 7.8 and 7.1 times more nitrogen ingested respectively, relative to the control treatment. These increases of ingested, absorbed and retained nitrogen

can be explained by the increase of crude protein in diets containing *G. Ulmifolia, G. sepium* and *T. diversifolia*, which is in agreement with KIKELOMO (2014) who reports that the nitrogen ingested in animals is directly related to the proportion of nitrogen in the diet and also that the high value of nitrogen retained in the diets with species that improve the percentage levels of nitrogen is due to the efficiency of the use of the protein as a result of supplementation. MUPANGWA *et al.* (2000) reported that this situation provides a better balance of nutrients through improved ruminal fermentation and protein bypass supply. Moreover, it can be evidenced that the diet with *G. sepium* showed a better efficiency and use by the ruminant microorganisms, taking into account that it was the treatment with higher intake of nitrogen and less excretion of the same in the urine, which is explained by the large amount of soluble protein found in forage species, causing N to be metabolized mainly in the rumen and not in the intestinal tract, producing large amounts of ammoniacal N which meets the needs of the microorganisms of the rumen (FADIYIMU *et al.*, 2010).

Table 5. Nitrogen balance in hair lambs fed with tropical tree fodder

Variable	Treatments				SEM	P
	1	2	3	4		
N intake (gr)	9.78c	56.2b	76.58 a	68.93 a	3.03	<0.0001
N intake (gr/Kg$^{0.75}$/d)	0.96c	5.56b	7.53a	6.80a		
N Urine (gr/d)	1.26 c	1.22 c	2.83 b	5.03 a	0.34	<0.0001
N Urine gr/Kg $^{0.75}$/d)	0.13c	0.13c	0.29b	0.5a		
N Feces (gr/d)	2.44 c	4.75 a	5.1a	4.68 a	0.26	<0.0001
N Feces gr/Kg $^{0.75}$/d)	0.24c	0.47a	0.5a	0.48a		
N retained (gr/d)	6.07 c	50.24 b	68.65 a	59.24ab	2.87	<0.0001
N retained (gr/kg$^{0.75}$/d)	0.61c	4.96b	6.76a	5.83ab		
N Absorbed (gr/d)	7.33 c	51.45 b	71.49 a	64.27 a	2.93	<0.0001
N Absorbed (gr/kg$^{0.75}$/d)	0.73c	5.06b	7.04a	6.34a		
% N intake*	62.28 b	89.00 a	89.54 a	85.82 a	1.37	<0.0001

[a–d]Means within a row with different superscripts differ (P < 0.05). [1]SEM: standard error of the mean. 1Treatments: T1 = 100% *D. aristatum* hay, T2 = 50% *D. aristatum* hay, 25% *Guazuma ulmifolia* and 25% rice bran; T3 = 50% hay *D. aristatum*, 25% *Gliricidia sepium* and 25% rice bran; T4 = 50% of *D. aristatum* hay 25%; *Tithonia diversifolia* and 25% rice bran. *Efficiency in the use of nitrogen.

CONCLUSIONS

The inclusion of *Guazuma ulmifolia, Gliricidia sepium* and *Tithonia diversifolia* in hair lamb's diet improves digestibility and nutrient intake. The in vitro digestibility of *Gliricidia sepium* and *Tithonia diversifolia* is superior to *D. aristatum* hay and *Guazuma ulmifolia*. Meanwhile, nitrogen balance in lambs improved with the addition of tropical tree fodder. *Guazuma ulmifolia* has a bromatological composition

and a limited in vitro digestibility, therefore, it is recommended to carry out studies where the phenological characteristics at different ages and cutting heights and its correlation with the bromatological composition and digestibility is established. It is then concluded, that the supplementation of hair lambs with tropical tree fodder is an interesting alternative to increase the digestibility and the intake of the diets and to contribute to the improvement of the performance in sheep production in the tropical dry forest.

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