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Nutritional evaluation of *Senegalia greggii* and *Prosopis juliflora* as browse supplements for sheep

Roque G. Ramirez-Lozano[1], Humberto Gonzalez-Rodriguez*[2] and Rogelio A. Ledezma- Torres[3]

Universidad Autónoma de Nuevo León, Facultad de Ciencias Forestales,
Carretera Nacional No. 85, km 145, Linares, N.L. 67700, México.
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ABSTRACT

This study was conducted to evaluate the influence of leaves of two shrubs on digestion and nitrogen retention by sheep. Twelve rumen-fistulated castrated male sheep (Pelibuey x Rambouillet) of 42.2±1.3 kg live weight were randomly assigned to three diets (four sheep/diet): diet 1 containing 77% of *Cynodon plectostachyus* straw and 23% *Medicago sativa* hay, diet 2 containing 70.7% *C. plectostachyus* straw and 26.3% *Senegalia greggii* leaves, and diet 3 containing 76.3% *C. plectostachyu*s straw and 14.3% *Prosopis juliflora* leaves. *Medicago sativa* hay was used as control feed of good nutritional quality. The intakes of dry matter and the fiber components of sheep were not significantly different between sheep fed the diets containing the *M. sativa* hay or *S. greggii* leaves, but both were significantly higher than sheep fed the *P. juliflora* leaves. The *in vivo* digestibility coefficients of dry matter and the fiber components were not different (P>0.05) between sheep fed the all diets; however, the digestibility of CP was higher (P<0.05) for sheep fed the *M. sativa* diet compared with sheep on other diets. The N intake was similar (P>0.05) between sheep fed diets containing *M. sativa* hay or *S. greggii* leaves, but both were higher than sheep containing *P. juliflora* leaves. A similar pattern as N intake was registered in fecal and urine N excretions. The N balance was higher (P<0.05) and positive in sheep fed the *M. sativa* hay diet followed by *S. greggii* and sheep on *P. juliflora* were lowest and negative. *Senegalia greggii* leaves may have potential as an economical supplementary feed for sheep fed diets based on roughages.

Key words: *In vivo* Digestion, Nitrogen balance, *Prosopis juliflora, Senegalia greggii,* Sheep.

INTRODUCTION

Browse (leaves, flowers, fruits twigs, and pods) is an important forage resource for small ruminants in semiarid regions such as those located in northeastern Mexico (Ramirez, 1999). During drought and dry seasons, it becomes more abundant especially when the grass cover significantly deteriorations (Shelton, 2004). During these periods, not only the browse plants are in general higher in protein and in several minerals, but they also give a more constant feed resource when compared to the great yield discrepancy showed by the grass cover (Oppong *et al*., 2008). According to Mogotsi *et al*. (2011), the utilization of browse vegetation as an available source of good nutritional quality in the drought season is vital to keep seasonal and yearly permanency in ruminant production; therefore, guaranteeing sustainable pastoral management (Madzonga and Mogotsi, 2014). Thus, it is now generally acknowledged that browse vegetation is a potential low cost close by-produced protein complement for ruminants, and may precise N insufficiency in grass vegetation during the drought seasons (Van, 2006).

Shrubs and small trees are an important components of native scrub vegetation in northeast Mexico; however, the plants and density differ extensively regarding to precipitation, type of soil and climate (González-Rodríguez *et al*., 2011). Browse plants, had potentially agronomic features, which are important for ruminant foods such as: ease of establishment, competitiveness compared to wild plants, persist very prolific after browsing, to suitable the specific weather soil textures and the environment, no need fertilizer, are unaffected to native pests and diseases, satisfactory seed yield or be consistent vegetative reproduction and have a good nutritional value and appropriateness for ruminants. It has been significant attention in northern Mexico, in selection of shrubs and small tree species that meet these conditions for their possible use as feed resources (Domínguez-Gómez *et al*., 2012).

*Corresponding author's e-mail: humberto.gonzalezrd@uanl.edu.mx
[1]Universidad Autonoma de Nuevo León, Facultad de Ciencias Biológicas. Pedro de Alba y Manuel Barragán, S/N, Cd. Universitaria, San Nicolás de los Garza, N.L. 66451, México
[2]Universidad Autónoma de Nuevo León, Facultad de Ciencias Forestales, Carretera Nacional No. 85, km 145, Linares, N.L. 67700, México
[3]Universidad Autónoma de Nuevo León, Facultad de Medicina Veterinaria y Zootecnia, Campus de Ciencias Agropecuarias, Escobedo, N.L. 66450, México.

The shrub *Senegalia greggii* belongs to the family Leguminosae and the green leaves are used as fodder for wild and domestic ruminants for their high protein content; however, contains a plant secondary compound such as called prunasin (Barlow, 2000). Moreover, *Prosopis juliflora* is a shrub or small tree native to Mexico, belongs to the family Leguminosae and the dry fallen leaves are avidly consumed by range domestic (goats sheep and cattle) wild ruminants (white-tailed deer) (Ramirez, 1999). The *P. juliflora* possesses alkaloids (Pasiecznik, 2001), and its nutritive value vary greatly according to season and plant species (Guerrero *et al*., 2012). On the other hand, its nutritive value, however, does not always relate to its chemical composition due to the presence, in most species, of secondary compounds of plants such as tannins, alkaloids, cyanogenic glycosides, saponins, essential oils and oxalates, which limit nutrient utilization and reduce animal performance (Acero *et al*., 2010).

This study, therefore, was carried out to determine the nutrient intakes, digestion coefficients and N retention by sheep fed leaves from *Senegalia greggii* and *Prosopis juliflora* in combination with grass straw in comparison to *Medicago sativa* hay.

MATERIALS AND METHODS

Fodder from *Senegalia greggii* and *Prosopis juliflora* was collected in Marin, county, of the state of Nuevo León, Mexico. Marin is located at 25°43´ North latitude and 100°02´ West longitude. It has an average elevation of 363 m. The climate is semiarid with an annual mean temperature of 21°C and annual precipitation of 500 mm. Branches of each shrub were removed by hand and located in a shed. Leaf material was allowed to air dry on the branches and then removed by carefully beating the branches with wooden sticks. *Medicago sativa* hay was used as a reference forage to compare the foliage produced from shrubs to a foliage leguminous of good nutritional value. The *M. sativa* hay and *Cynodon plectostachyus* straw were obtained from a commercial store in Monterrey city, Nuevo Leon, Mexico. Forages were analyzed (AOAC, 2012) to determine dry matter (DM), ash, and crude protein (CP). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were also determined (Van Soest *et al*., 1991). Acid detergent lignin (ADL) was also measured (AOAC, 2012). Hemicellulose (NDF – ADF) and cellulose (ADF – ADL) were calculated by difference. Results of condensed tannins (butanol-HCl technique) were expressed as leucocyanidin equivalents (Makkar, 2003).

Twelve castrated rumen-fistulated permanently male sheep of the cross Pelibuey x Rambouillet which had an average live weight of about 42.2±1.3 kg were housed in metabolic cages to collect feces and urine. The diets used in this experiment were randomly assigned to sheep (four per diet). Feeds were given to sheep twice a day: at 08:00 and 16:00. Diets offered were: diet 1 containing 77% of *Cynodon plectostachyus* straw and 23% *Medicago sativa* hay, diet 2 containing 70.7% *C. plectostachyus* straw and 26.3% *Senegalia greggii* leaves, and diet 3 containing 76.3% *C. plectostachyus* straw and 14.3% *Prosopis juliflora* leaves. In all diets were added 0.5% of a mineral premix and 5.0% molasses. All diets were adjusted to a ratio to contain about 12% of CP.

Sheep were adjusted to diets for 15 days, and then total feces and urine were collected for 7 days. Subsamples (10%) of urine and feces were taken twice daily and frozen until analysed. Ten millilitres of a 50% (v/v) HCl solution was added to urine collection buckets daily to prevent ammonia loss. Feed offered and refusals were sampled (5%) daily with subsamples bulked over collection period for subsequent analysis.

Samples of feed offered and refused were ground in a Wiley mill to pass a 2 mm screen. Feces were thawed at room temperature and partial DM determined by oven drying (55°C) for 76 h. Dry matter (105°C), ash (550°C) and N were analyzed on separate samples (AOAC, 2012). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were also determined (Van Soest *et al*., 1991). Acid detergent lignin (ADL) was also determined (AOAC, 2012). Hemicellulose (NDF – ADF) and hemicellulose (ADF – ADL) were estimated by difference. Nitrogen in urine samples was determined by the Kjeldhal method (AOAC, 2012).

The significance of diet effects on nutrients intakes, digestion coefficients of DM, CP, NDF, ADF, cellulose and hemicellulose, and N retention by sheep was determined by one-way analysis of variance using the GLM procedure (SAS, 2000). Means were separated by the least square means technique ($P<0.05$).

RESULTS AND DISCUSSION

Data from chemical composition of plants and diets are shown in Table 1. *Prosopis juliflora* had higher CP content, followed by *Medicago sativa* hay and very similar to *Senegalia greggii*; while, the ash content was lower for *P. juliflora* compared with *S. greggii* and *M. sativa* hay. The NDF in *S. greggii* was the highest over *P. juliflora* or *M. sativa* hay. Likewise, the ADF in *S. greggii* was higher than *P. juliflora* or *M. sativa* hay. The percentages of cellulose, hemicellulose were higher for *P. juliflora*, and followed by *S. greggii* and *M. sativa* hay. The ADL was higher in *S. greggii* than *P. juliflora* or *M. sativa* hay. The concentration of CT was low in the three forages. The nutrient content of the diets followed a similar pattern as the plant materials (Table. 1).

The DM, CP, NDF, ADF, cellulose and hemicellulose intakes were not significantly different between sheep fed with *M. sativa* hay or *S. greggii* leaves

Table 1: Chemical composition of *Medicago sativa* hay, *Cynodon plectostachyus* straw and leaves of the shrubs *Senegalia greggii* and *Prosopis juliflora* and diets offered to sheep.

Concept[1]	*Medicago sativa*	*Senegalia greggii*	*Prosopis juliflora*	*Cynodon plectostachyus*
Forages, %				
Crude protein	15.9	15.4	19.5	10.5
Ash	10.7	9.4	7.3	11.4
Neutral detergent fiber	31.9	41.9	39.9	73.2
Acid detergent fiber	26.5	32.0	29.8	40.4
Cellulose	22.3	22.3	25.5	30.3
Hemicellulose	1.9	8.6	9.8	27.5
Acid detergent lignin	4.1	6.1	4.1	6.0
Condensed tannins	0.0	0.9	0.2	0.0
Diets, %[2]				
Crude protein	12.7	12.4	12.4	
Ash	12.2	12.1	10.7	
Neutral detergent fiber	62.5	59.1	66.4	
Acid detergent fiber	18.4	16.3	20.4	
Acid detergent lignin	38.0	38.0	39.7	
Cellulose	28.9	27.7	30.0	
Hemicellulose	5.5	7.6	6.5	
Condensed tannins	0.0	0.7	0.0	

[1]Dry matter basis.

[2]Each diet contained 0.5% of a premix (8.0% of P; 7.0% of Ca; 0.8% of Mg; 400 ppm of Fe; 2800 ppm of Mn; 2400 ppm of Zn; 1450 ppm of I_2; 8 ppm of Co and 6500 IU of vitamin A and 5% of liquid molasses.

significantly higher than sheep fed *P. juliflora* leaves (Table 2). The *in vivo* digestibility of DM, NDF, ADF, cellulose and hemicellulose of sheep were not different (P>0.05) among all diets. However, the digestibility of CP was higher (P<0.05) for sheep fed with *M. sativa* hay compared with sheep on other diets (Table 2). It seems that the alkaloids contained in *P. juliflora* leaves (Pasiecznik, 2001) may interfere with microbial activity in the rumen of sheep, which could have affected the nutrient intakes and CP digestibility. Moreover, intoxication with the *P. juliflora* leaves has been

Table 2: Body weight, nutrient intakes and digestion coefficients of sheep fed diet containing different levels of *Medicago sativa* hay or *Senegalia greggii* or *Prosopis juliflora* leaves.

Concept[1]	Diets			SEM[2]
	Medicago sativa	*Senegalia greggii*	*Prosopis juliflora*	
Live body weight, kg	46.0	39.1	41.7	1.3
Intakes, g/day				
Dry matter intake	961.8^{a}	816.6^{a}	388.5^{b}	96.1
Crude protein	131.5^{a}	101.6^{a}	48.0^{b}	12.2
Neutral detergent fiber	542.4^{a}	443.4^{a}	233.5^{b}b	54.2
Acid detergent fiber	365.5^{a}	310.6^{a}	154.2^{b}	37.0
Cellulose	274.4^{a}	231.1^{a}	116.6^{b}	28.6
Hemicellulose	176.8^{a}	132.8^{ab}	79.2^{b}	17.3
Digestion coefficients, %				
Dry matter	49.3	47.8	45.1	1.3
Crude protein	67.8^{a}	60.4^{b}	57.4^{c}	1.0
Neutral detergent fiber	40.9	40.6	38.6	1.9
Acid detergent fiber	40.7	39.7	36.8	2.4
Cellulose	56.9	61.0	58.0	2.5
Hemicellulose	41.6	42.9	42.0	2.2
Nitrogen balance, g/day				
Nitrogen intake	21.1^{a}	16.2^{a}	7.7^{b}	2.0
Fecal nitrogen	6.7^{a}	6.3^{a}	3.1^{b}	0.7
Urinary nitrogen	9.1^{a}	7.3^{ab}	5.4^{b}	0.7
Nitrogen balance	5.3^{a}	2.3^{b}	-0.9^{c}	0.6
Percent of nitrogen intake	24.6^{a}	16.2^{a}	-18.2^{b}	4.1

[1]Dry matter basis; [2]SEM = standard error of the mean.

[abc]Means in a row with different letter superscripts are different (P<0.05).

reported and is characterized by neuromuscular alterations and gliosis (Nakano *et al*., 2004). In addition, total alkaloid extract and fractionated alkaloids from *P. juliflora* act directly on glial cells, inducing activation and/or cytotoxicity, and may have an impact on neuronal damages observed on intoxicated animals (Hughes *et al*., 2005).

It seems that the use of native shrubs in the diet of ruminants can cause beneficial effects for the animals that consume them (Ramirez, 1996), although some shrubs may contain compounds antagonistic to the proper microbial growth in the rumen (Ramirez-Lozano and Garcia-Castillo, 1996; Kushwaha *et al*., 2011; Brown *et al*., 2016). *In vivo* digestibility studies conducted in sheep fed diets mixed with different levels of native shrubs originated from different parts of the world (Reed and Woodward, 1990; Rafique *et al*., 1992; Datt *et al*., 2008) showed that the overall dry matter digestibility in sheep was not altered by the inclusion of shrubs fed diets based on grass straw; CP digestibility in some cases was diminished in those sheep fed native shrubs, although nitrogen balance did not decrease significantly (Patra, 2009).

In this study, N intake was similar (P>0.05) between sheep fed diets containing *M. sativa* hay or *S. greggii* leaves, but both were higher than sheep on *P. juliflora* diet. A similar pattern as N intake was registered in fecal and urine N excretions. The N balance was higher (P<0.05) and positive in sheep fed with *M. sativa* hay diet followed by *S. greggii* and sheep fed with *P. juliflora* were lowest and negative. Negative N balance was also reported in other studies conducted with sheep fed with different levels of shrubs in diets based on grass straw (Patra, 2009; 2010).

CONCLUSION

It is concluded that even though the leaves of the legume *S. greggii* contained plant secondary compounds such as cyanogenic glycoside, it may be essential in sheep feed programs because it is very similar supplementary feed than *M. sativa* hay. Conversely, alkaloids in *P. juliflora* leaves may interfered with microbial activity in the rumen of sheep that affected their intake and CP digestibility.

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REFERENCES

Acero, A., Muir, J.P. and Wolfe, R.M. (2010). Nutritional composition and condensed tannin concentration changes as browse leaves become litter. *J. Science Food Agr*., **90**: 2582-2595.

AOAC (2012). Official Methods of Analysis. Association of Official Analytical Chemists, (Gaithersburg, Maryland, USA).

Barlow, C. (2000). The Ghosts of Evolution: Nonsensical fruit, missing partners and other ecological anachronisms. Basic Books: N.Y., USA.

Brown, D., Ng'ambi, J.W. and Norris, D. (2016). Voluntary intake and palatability indices of pedi goats fed different levels of *Acacia karroo* leaf meal by cafeteria method. *Ind. J. Anim. Res*., **50**: 41-47.

Datt, Ch., Datta, M. and Singh, N.P. (2008). Assessment of fodder quality of leaves of multipurpose trees in subtropical humid climate of India. *J. For. Res*., **19**: 209-214.

Domínguez-Gómez, T.G., Ramírez Lozano, R.G., Estrada Castillón, A.E., Scott Morales, L.M., González Rodríguez, H. and Alvarado, M. Del S. (2012). Importancia nutrimental en plantas forrajeras del matorral espinoso tamaulipeco. *CIENCIA UANL*, **15**: 77-93.

Guerrero, M., Cerrillo, S.M.A., Ramírez, R.G., Salem, A.Z.M., González, H. and Juárez, R.A.S. (2012). Influence of polyethylene glycol on *in vitro* gas production profiles and microbial protein synthesis of some shrub species. *Anim. Feed Sci. Tech*., **176**: 32-39.

González-Rodríguez, H., Domínguez-Gómez, T.G., Cantú-Silva, I., Gómez-Meza, M.V., Ramírez-Lozano, R.G., Pando-Moreno, M. and Fernández, C.J. (2011). Litterfall deposition and leaf litter nutrient return in different locations at Northeastern Mexico. *Plant Ecol*., **212**: 1747-1757.

Hughes, J.B., Sousa, J.S., Barreto, R.A., Silva, A.R., Souza, C.S., Silva, V.D.A., Silva, B.M.P., Freitas, S.R.V.B., Costa, M.F.D., El-Bacha, R.S., Batatinha, M.J.M., Tardy, M., Velozo, E.S. and Costa, S.L. (2005). Cytotoxic effects of an extract containing alkaloids obtained from *Prosopis juliflora* Sw. D.C. (Algaroba) pods on glioblastoma cells. *Rev. Bras. Sau. de Prod. Ann*., **6**: 31-41.

Kushwaha, R., Rai, S.N., Singh, A.K., Chandra, G., Vaidya, M.M., Sharma, V.K., Pathan, M.M. and Kumar, S. (2011). Tanniniferous feed resources in dairy animals: A review. *Agri. Reviews*, **32**: 267-275.

Madzonga, Z. and Mogotsi, K. (2014). Production, harvest and conservation of *Lablab purpureus* (L) sweet forage in semi arid livestock regions: The case of east central Botswana. *J. Anim. Plant Sci*., **24**: 1085-1090.

Makkar, H.P.S. (2003). Quantification of tannins in tree and shrub foliage. A Laboratory Manual. Kluwer Academic Publishers. Alphen and den Rijn. The Netherlands, pp. 59-60.

Mogotsi, K., Nyangito, M.M. and Nyariki, D.M. (2011). The perfect drought? Constraints limiting Kalahari agro-pastoral communities from coping and adapting. *Afr. J. Environ. Sci. Technol*., **5**: 168-177.

Nakano, H., Nakajima, E., Hiradate, S., Fujii, Y., Yamada, K., Shigemori, H. and Hasegawa, K. (2004). Structure-activity relationships of alkaloids from mesquite (*Prosopis juliflora* (Sw.) DC.). *Plant Growth Regul*., **44**: 207-210.

Oppong, S.K., Kemp, P.D. and Douglas, G.B. (2008). Browse shrubs and trees as fodder for ruminants: A review on management and quality. *J. Sci. Technol*., **28**: 65-75.

Pasiecznik, M.N. (2001). The *Prosopis juliflora-Prosopis pallida* Complex: A Monograph, HIDRA Coventry UK. p.120.

Patra, A.K. (2009). Meta-analysis on effects of supplementing low-quality roughages with foliages from browses and tree fodders on intake and growth in sheep. *Livest. Sci*., **121**: 239-249.

Patra, A.K. (2010). Effects of supplementing low-quality roughages with tree foliages on digestibility, nitrogen utilization and rumen characteristics in sheep: a meta-analysis. *J. Anim. Physiol. Anim. Nut*., **94**: 338-353.

Rafique, S., Wallace, J.D., Holechek, J.L., Galyan, M.L. and Arthun, D.P. (1992). Effects of forb and shrub diets on ruminant nitrogen balance. I. Sheep Studies. *Small Rumi. Res*., **45**: 113-122.

Ramirez-Lozano, R.G. and Garcia-Castillo, C.G. (1996). Nutrient profile and *in situ* digestion of forage from *Leucaena leucocephala* and *Acacia berlandieri*. *Forest, Farm, and Community Tree Network*, **1**: 27-31.

Ramirez, R.G. (1996). Feed value of browse. VI International Conference on Goats. Vol. 2. International Academic Publishers. pp. 510-528. Beijing, China.

Ramirez, R.G. (1999). Feed resources and feeding techniques of small ruminants under extensive management conditions. *Small Rumin. Res*., **34**: 215-230.

Reed, J.D. and Woodward, A. (1990). Fodder tree and straw diets for sheep intake, growth, digestibility and the effects of phenolics on nitrogen utilization. *Anim. Feed Sci. Technol*., **30**: 39-50.

SAS (2000). SAS/STAT® User's Guide (8.1Edition). SAS Inst. Inc., Cary, NC, USA.

Shelton, H.M. (2004). Importance of tree resources for dry season feeding and the impact on productivity of livestock farms. In: 't Mannetje L, Ramirez L, Ibrahim M, Sandoval C, Ojeda N, Ku J (eds). The importance of silvopastoral systems in rural livelihoods to provide ecosystem services. Proceedings of 2nd International Symposium on Silvopastoral Systems, Universidad Autónoma de Yucatán, Mérida, Yucatán, México.

Van, D.T.T. (2006). Some animal and feed factors affecting feed intake, behavior and performance of small ruminants. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsala.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary, neutral detergent fiber, and nonstartch polysaccharides in relation to animal nutrition. Symposium: carbohydrate methodology, metabolism, and nutritional implications in dairy cattle. *J. Dairy Sci*., **74**: 3583-3597.