Productive Response and Apparent Digestibility of Sheep Fed on Nutritional Blocks with Fruits of *Acacia farnesiana* and *Acacia cochliacantha*

Rojas Hernandez S[1], Quiroz Cardoso F[3], Camacho Diaz LM[1], Cipriano Salazar M[1], Avila Morales B[1], Cruz Lagunas B[2], Jimenez Guillen R[4], Villa Mancera A[5], Abdelfattah Z.M. Salem[6], Olivares Pérez J[1]*

[1]Unidad Académica de Medicina Veterinaria y Zootecnia-Universidad Autónoma de Guerrero, Carretera Cd. Altamirano-Iguala km 3.5 Col. Las Querenditas, Cd. Altamirano, Gro. CP 40660 Tel-Fax 7676723494. México.
[2]Unidad Académica de Ciencias Agropecuarias y Ambientales- Universidad Autónoma de Guerrero, México
[3]Maestria en Sistemas de Producción Agropecuaria- Universidad Autónoma de Guerrero, México
[4] INIFAP-Campus Iguala de la Independencia, Guerrero, México
[5] Facultad de Medicina Veterinaria- Benemérita Universidad Autónoma de Puebla, México
[5]Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México, Estado de México, México
Corresponding author: olivaares@hotmail.com

Abstract: The objective was to evaluate the use of *Acacia cochliacantha* and *Acacia farnesiana* fruits in nutritional blocks (NB) for sheep and evaluate the productive response and apparent digestibility of diets. Eighteen sheep F1 (Pelibuey × Dorper) with live weight of 20.4 ± 1.8 kg were randomized into three groups of 6 animals each. Treatments were basal diet with nutritional blocks without fruit (T0 = control), with 30% of fruits of *A. farnesiana* (T2) or with 30% fruits of *A. cochliacantha* (T3) on a dry matter basis. Dry matter intakes of nutritional blocks (NB), corn stover (CS), concentrate and total consumption were measured. Moreover, the daily weight gain (DWG), feed conversion (FC), apparent digestibility of nutrients as the organic matter (OM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (FDA) were also measured. Intake of NB were higher ($p > 0.001$) in sheep of treatments T1 and T2; however, CS intake and total dry matter intake was higher ($p < 0.001$) in animals of T2. Consumption of concentrate, OM, CP, NDF, the DWG and FC were similar ($p > 0.05$) between treated animals. The intake of ADF was higher ($p < 0.001$) for animals of T2. The apparent nutrient digestibility of diets was similar ($p > 0.05$). It is concluded that the use of the fruits of acacias in NB as a feed supplement in the diet of sheep, increased consumption of total dry matter, without affecting the digestibility of the diet and weight gain of the animals in the tropics of Mexico.

[Rojas Hernandez S, Quiroz Cardoso F, Camacho Diaz LM, Cipriano Salazar M, Avila Morales B, Cruz Lagunas B, Jimenez Guillen R, Villa Mancera A, Abdelfattah Z.M. Salem, Olivares Pérez J. **Productive Response and Apparent Digestibility of Sheep Fed on Nutritional Blocks with Fruits of *Acacia farnesiana* and *Acacia cochliacantha*.** *Life Sci J* 2015;12(2s):81-86]. (ISSN:1097-8135). http://www.lifesciencesite.com. 12

Keywords: fruits; tree; apparent digestibility; sheep

1. Introduction

In the tropics, ruminant feed is traditionally based on seasonal forage resources (Mellado *et al*., 2006). In pastoral areas there are leguminous trees and shrubs that produce fruit in the dry season (Smith *et al*., 2005; Yaynesheta *et al*., 2008; Salem *et al*., 2012). The fruits of the trees can be used as a source of protein for small ruminants (Mlambo *et al*., 2008; Ben-Salem *et al*., 2008). Studies have shown that fruits can contribute to maintain or improve production efficiency in ruminants (Garcia *et al*., 2009). There are various forms of tree biomass using in animal feed such as mixing fruits with other feeds in the concentrate or nutritional blocks, which cause improving digestibility and digestion products (Salem, 2005; Briceño *et al*., 2012).

The *Acacia farnesiana* and *Acacia cochliacantha* trees grow wild in the dry tropics, with fruit production in the dry season and serve as feed for sheep and goats (Olivares *et al*., 2013; Garcia *et al*., 2009). The elaboration of nutritional blocks is a technology for feeding ruminants, to take advantage of local resources (Tendonkeng *et al*., 2014). It has also been demonstrated the success of nutritional blocks in ruminant feed (Kawas *et al*., 2010) by allow the alternative use of feed as tree fruits and agro-industrial by-products for elaboration (Thi *et al*., 2008; Cuchillo *et al*., 2010). The aim of the study was to evaluate the included 30% of acacia fruits in nutritional blocks, on dry matter intake and dietary nutrients apparent digestibility in growing sheep males.

2. Materials and methods

2.1. Study site

The study was conducted in the community of Limones, in the Municipality of Pungarabato, Guerrero Mexico, located in the region of Tierra

Caliente (18° 20' 30" north latitude and 100° 39' 18" west longitude). The climate is Aw0 the driest of the sub humid tropics. The minimum and maximum annual temperature of 28° C to 46° C, 250 meters above sea level and annual rainfall of 750 mm (Fragoso, 1990).

2.2. Harvesting of the acacias fruits

Dried fruits were collected manually from the trees during the months of February and March 2013. After, fruits were ground in a hammer mill with screen of the number two to get the flour, and then integrated into the nutritional blocks.

2.3. Elaboration of nutritional blocks (NB) and treatments design

The NB of each treatment were balanced according to the nutritional requirements of sheep (NRC, 2001) and manually prepared in three treatments (Table 1). The NB supplement to the basal diet composed of ground corn stover ad libitum and concentrates supplement (200 g DM animal^{-1} d^{-1}) (Table 1).

Table 1. Ingredients of nutritional blocks and concentrates supplement (kg dry matter) that constituted the diet of sheep (T1, NB without fruits + basal diet; T2, NB with 30 % of *A. farnesiana* fruits + basal diet; T3, NB with 30 % of *A. cochliacantha* fruits + basal diet)

Ingredients	Nutritional blocks (NB)[1]			Concentrate
	T0	T1	T2	
Molasses	38.0	38.0	38.0	-
Urea	6.0	6.0	6.0	-
Cement	10.0	10,0	10.0	-
A. farnesiana fruits	-	30.0	-	-
A. cochliacantha fruits	-	-	30.0	-
Ground corn cobs	38.3	14.0	14.0	58.0
Soybean meal	5.7	-	-	13.0
Coconut paste	-	-	-	15.0
Sorghum grain	-	-	-	14.0
Minerals	2.0	2.0	2.0	-
Total (kg of DM)	100.0	100.0	100.0	100.0

2.4. Chemical composition of diets

Three samples selected randomly from the NB and diets (200 g) were collected. Samples were dried at 70 °C in a forced air oven and ground in Willey mill with 1 mm diameter screen and analyzed for ash content, organic matter (OM), ether extract (EE) and N with the method of kjeldahl (AOAC, 2000). The content of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to Van Soest *et al.* (1991). For the NB, the total phenolic content (FT) and condensed tannins (CT) (butanol-HCl) were also determined by the method described by Waterman and Mole (1994).

2.5. Management and productive response in sheep

Eighteen male sheep F1 (Dorper × Pelibuey) with live weight of 20.4 ± 1.8 kg were used. Sheep were dewormed with albendazole sulfoxide at a dose of 4.5 mg / kg corporal weight orally, and were administered vitamin complex ADE (Vigandol ADE; 1.5 mL per animal) at the start of the adaptation period to confinement and treatment diets. Sheep were housed in individual in pens of 1 × 1.5 m with concrete floor and shade. Sheep were fed on the NB, ground corn stover and concentrate supplement (200 g DM animal^{-1} d^{-1}) individually with free access to water.

Live weight changes (g day^{-1}) were measured at 0, 15, 30 and 45 days of the experiment after fasting for 12 h, with an electronic scale (TOR REY Mod. CRS 500/1000) were registered. The average daily gain was measured as the difference between the final weights minus initial weight divided by the days of the assessment. Dry matter intake (g day^{-1}) of NB, basal diet and total dry matter were measured as the difference between the dry matter offered and rejected daily. Feed conversion (FC) was calculated by dividing the total feed consumption between total weight gains of the animals.

2.6. Nutrients apparent digestibility

Apparent digestibility of nutrients was determined by the method of total stool collection for 14 days from three sheep of each treatment. The feces were dried in a forced air oven at 65 °C for 72 hours for dry matter determination. Subsequently, the feces were ground in a Willey mill with 1 mm diameter screen and were analyzed for ash content, organic matter, ether extract (EE) and crude protein (CP; N× 6.25) with the Kjeldahl method (AOAC, 2000). The contents of NDF and ADF were determined according to the method of Van Soest *et al.* (1991) in triplicate samples.

The apparent digestibility was calculated using the equation described by Ramirez (2008):

$$\text{Nutrient digestibility (\%)} = \frac{\text{TIN} - \text{TEN}}{\text{TIN}} x100$$

Where: TIN = Total of intake nutrient

TEN = Total of excreted nutrient

2.7. Data analysis

Data were analyzed using the general linear model procedures of SAS (2002). The Tukey's multiple range tests were used for data of the experiment to test the significance among means.

The chemical composition of NB, nutrients intake, nutrients apparent digestibility and animal response were analyzed in a completely randomized statistical design using the following model: $Yij = \mu + Ti + \xi ij$, where Yij = response to the *i*th treatment in the *j*th measurement; μ = overall mean; Ti = the effect of *i*th treatment; ξij = the random error and a mean of zero and variance σ^2 are assumed.

3. Results and discussion

3.1. Chemical composition of nutritional blocks

Table 2 shows the chemical composition of NB. The contents of DM, OM, CP, and NDF were similar ($p > 0.05$), with mean values of 909.3, 835.2, 266.5 and 471.9 g kg^{-1} DM, respectively. The content of EE was higher ($p < 0.004$) in the NB without fruits with 20.2 g kg^{-1} DM (T0), compared to NB with fruits of acacias (T1 and T2) (Table 2). The ADF content was higher ($p < 0.001$) in the NB with fruit of *A. cochliacantha* (T2) with 449.5 g kg^{-1} DM. The contents of total phenolics and condensed tannins were higher ($p < 0.001$) in the NB with fruit of *A. farnesiana* (T1) with 5.37 and 1.77 g kg^{-1} DM, respectively, compared to NB with fruit of *A. cochliacantha* (T2) (Table 2). Differences in EE content could be because the NB T0 was prepared with soybean, ingredient with higher ether extract content (NRC, 2001). The highest content of ADF in the NB of T2 indicates higher concentrations of cellulose and lignin, as described by Gidenne *et al.* (2010). In the contribution of secondary compounds, there is evidence that the fruits of *A. farnesiana* contain and provide more total phenols (TP) and condensed Tannins (CT) from the fruits of *A. cochliacantha* to the diet of animals (Garcia *et al.*, 2009; Olivares *et al.*, 2013).

The CP content of NB (Table 2) is similar to those obtained by Martinez-Mertinez *et al.*, (2012) and Aye and Adegun (2010) with biomass of *Acacia cochliacantha*, *Brosimum alicastrum*, *Guazuma ulmifolia* and *Leucaena lanceolata*. The contents of NDF and ADF of the NB (Table 2) were comparable to those reported by Vázquez *et al.* (2012); Raghuvansi *et al.* (2007) and Tendonkeng *et al.* (2014) for nutritional block with tree biomass.

The differences in the contribution and content of secondary compounds (TP and CT) in NB of T1 and T2 did not affect the consumption of block (Table 3); this is attributed to low TP between 3.23 and 5.37 g kg^{-1} DM and CT between 1.35 and 1.77 g kg^{-1} DM (Table 2). Reports indicated that low concentrations (<7.0 g kg^{-1} DM) in feeds, can exert beneficial effects on protein digestion in ruminants, decreasing degradation of dietary protein in rumen and promote digestion in the small intestine with the amino acid absorption (Ben-Salem, 2010; Patra and Saxena, 2010).

3.2. Productive response of sheep

Differences ($p > 0.001$) in NB consumption among treatments (Table 3) were observed. The intake of block was higher in animals received T1 and T2 with 304.7 and 307.9 g $animal^{-1}$ d^{-1}, respectively, compared to sheep of T0 (Table 3). This is attributed to that fruits of the trees added to NB of the treatments T1 and T2 gave greater palatability to the diet of the sheep; similar to that reported by Olivares *et al.* (2013) and Garcia *et al.* (2009).

The consumption of corn stover (CS) increased ($p < 0.001$) with animals of the T2 (493.4 g) (Table 3). The supplement intake was not different between animals ($p > 0.05$); on average was 198.9 g $animal^{-1}$ d^{-1} (Table 3). Total DM intake of sheep in the T2 was higher ($p < 0.001$) with 1002.2 g $animal^{-1}$ d^{-1}, which was directly related to increased consumption of NB and CS. No statistical differences ($p > 0.05$) in daily weight gain (DWG) and feed conversion (FC), with means of 94.8 g $animal^{-1}$ d^{-1} and 9.63 kg DM, respectively (Table 3) were found. It can be observed that the addition of fruits to the NB as part of the animals diet, did not affect feed intake or weight gain and feed conversion; similar results have been published with the use of biomass of trees for feeding small ruminants (Rojas *et al.*, 2013; Olivares-Perez *et al.*, 2013).

The response of the animals to the consumption of nutritional blocks was similar to that reported by Vazquez *et al.* (2012) and Martinez-Mertinez *et al.* (2012) and coincide that small ruminants prefer to consume NB added with tree biomass.

Table 2. Chemical composition (g kg^{-1} DM) of nutritional blocks with fruits of the Acacias, corn stover and concentrate supplement (T0, Control without fruits; T1, 30% of *A. farnesiana* fruits; T2, 30% of *A. cochliacantha* fruits; SEM, Stander error of the means; Pr>F, significance; ^{a,b} Means with a different letter in the same row are different, Tukey test ($p < 0.05$))

Chemical composition	Nutritional blocks (NB)					Basal diet	
	T0	T1	T2	SEM	Pr>F	Corn stover	Concentrate
Dry matter	908.0	911.8	908.2	1.50	0.935	921.0	901.0
Organic matter	835.3	841.2	829.1	1.61	0.661	966.1	972.3
Crude protein	273.0	268.7	257.9	0.91	0.168	54.0	151.8
Ether extract	20.2^a	11.2^b	13.0^b	0.23	0.004	9.7	48.5
Neutral detergent fiber	482.6	459.4	473.7	1.30	0.151	741.1	587.5
Acid detergent fiber	350.9^b	392.9^b	449.5^a	1.33	<0.001	571.8	442.3
Total phenols	-	5.37^a	3.23^b	0.60	<0.001	-	-
Condensed tannins	-	1.77^a	1.35^b	0.11	<0.001	-	-

Table 3. Productive response of male sheep fed with nutritional blocks elaborated with fruits acacia (T0, NB control without fruits; T1, NB with 30 % of *A. farnesiana* fruits; T2, NB with 30 % of *A. cochliacantha* fruits; *Pr>F, significance; SEM, stander error of the means; [a,b] Means with a different letter in the same row are different, Tukey test ($p < 0.05$))

Variables	T0	T1	T2	SEM	Pr>F*
Diet intake (g amimal^{-1} d^{-1})					
Nutritional blocks	224.0^{b}	304.6^{a}	307.9^{a}	24.85	<0.001
Corn stover	439.3^{b}	368.2^{c}	493.4^{a}	29.37	<0.001
Concentrate supplement	197.7	199.7	199.3	1.73	0.156
Total dry matter	861.0^{b}	872.5^{b}	1000.6^{a}	45.99	<0.001
Response variables					
Initial weight (kg)	20.4	20.2	20.6	-	-
Final weight (kg)	24.2	24.5	25.3	-	-
Daily weight gain (g amimal^{-1} d^{-1})	85.2	94.8	104.5	34.28	0.632
Fed conversion (kg DM intake / kg of corporal weight)	10.11	9.20	9.58	3.97	0.702

3.3. Nutrients intake

It was observed that the NDF ($p < 0.049$) and ADF ($p < 0.013$) intakes were higher in animals receiving NB (T2) supplemented with the fruits of *A. cochliacantha* with 628.6 and 508.6 g animal^{-1} d^{-1} (Table 4). This is attributed to increased consumption of dry matter of NB and CS with these animals (Table 3); besides reports indicates that the fruit of *A. cochliacantha* has important contributions of ADF and NDF as feed for small ruminants (Olivares *et al*., 2013).

The consumption of TP ($p < 0.003$) and CT ($p = 0.050$) were higher in male sheep receiving NB (T1) supplemented with fruits *A. farnesiana*, with 1.64 and 0.54 g animal^{-1} d^{-1}, respectively (Table 4). Report indicates that the fruit of *A. farnesiana* has important contributions of secondary compounds (Garcia *et al*., 2009) compared to the fruit of *A. cochliacantha* (Olivares *et al*., 2013).

The consumption of CP was not differed ($p > 0.146$) (Table 4), but the sheep showed consumption of protein (T0: 114.9 g; T1: 132.0 g T2: 136.3 g animal^{-1} d^{-1}, respectively) sufficient to the required by animals for increased live weight of 100 g animal^{-1} d^{-1} (NRC, 2001); which are similar to those reported in this study.

Table 4. Nutrient intake in sheep fed with nutritional block supplemented with fruits of acacias (g animal^{-1} d^{-1}) (T0, NB control without fruits; T1, NB with 30 % of *A. farnesiana* fruits; T2, NB with 30 % of *A. cochliacantha* fruits; SEM, stander error of the means; Pr>F, significance; [a,b] Means with a different letter in the same row are different, Tukey test ($p < 0.05$))

Nutrient intake	T0	T1	T2	SEM	Pr>F
Organic matter	803.8	806.1	925.7	96.30	0.072
Crude protein	114.9	132.0	136.3	18.78	0.146
Neutral detergent fiber	549.8^{b}	530.1^{b}	628.6^{a}	66.38	0.049
Acid detergent fiber	417.2^{b}	418.5^{b}	508.6^{a}	53.43	0.013
Total phenol		1.64^{a}	0.99^{b}	2.80	0.003
Condensed tannins		0.54^{a}	0.42^{b}	9.90	0.050

3.4. Apparent digestibility

The apparent nutrient digestibility of diets did not differed ($p > 0.05$) in the treated animals (Table 5); meaning that the fruits of the two acacias not decrease the digestibility of dietary nutrients by the contribution of fiber and / or secondary compounds such as TP and CT (Table 4). Although the contents of TP and CT was different between the NB with fruits of *A. farnesana* (T1) and with fruit *A. cochliacantha* (T2) in none of the cases contributed more than 80 g daily in the diet of animals to observe negative effect in the digestibility (Waghorn, 2008; Patra and Saxena, 2010). Bakshi and Wadhwa (2007) mentioned that the content of detergent fiber is indicative of the nutritive value of feed in addition relates to the voluntary intake and digestibility of DM.

Moreover it is important to note that digestibility observed for each component of the diet, in this study, are higher than those reported by other researchers when they evaluated the use of biomass of trees in NB for supplement in ruminants (Raghuvansi *et al*., 2007).

Table 5. Apparent nutrients digestibility of diet (%) of male sheep fed with nutritional blocks containing acacia fruits (T0, NB control without fruits; T1, NB with 30 % of *A. farnesiana* fruits***;*** T2, NB with 30 % of *A. cochliacantha* fruits; SEM, stander error of the means; Pr>F, significance)

Nutrient	T0	T1	T2	SEM	Pr>F
Dry matter	66.0	64.2	62.4	7.21	0.834
Organic matter	69.2	65.9	65.8	5.30	0.689
Crude protein	73.0	70.0	78.4	6.42	0.341
Neutral detergent fiber	61.0	60.4	61.0	8.30	0.762
Acid detergent fiber	50.9	50.6	46.6	10.23	0.851

4. Conclusions

The fruit of *A. cochliacantha* added to NB increase palatability and consumption of total dry matter in male sheep, but not increased daily weight gain, feed conversion and the apparent digestibility of dietary nutrients. Likewise, the contribution of total phenolics, condensed tannins and fruit fiber to the diet of animals was not representative to adversely affect health and animal response.

The results placed the fruit used in the study as an option for the supply of feed and nutrients to the diet of sheep and replacing high-value ingredients for feeding humans as corn (ground cob) in the Mexican tropics.

References

1. Association of Official Analytical Chemist, AOAC. Official methods of analisis.17th ed. Arlington, VA. USA. 2000.
2. Aye PA, Adegun MK. Digestibility and growth in West African dwarf sheep fed gliricidia – based multinutrient block supplements. Agriculture and Biology Journal of North America 2010; 1(6): 1133-1139.
3. Bakshi MPS, Wadhwa M. Tree leaves as complete feed for goat bucks. Small Ruminant Research 2007; 69:74-78.
4. Ben Salem H, Priolo A, Morand FP. Shrubby vegetation and agro-industrial by-products as alternative feed resources for sheep and goats: Effects on digestion, performance and product quality. Animal Feed Science and Technology 2008; 147(1-3): 1-2.
5. Ben-Salem H. Nutritional management to improve sheep and goat performances in semiarid regions. Revista Brasileira de Zootecnia 2010; 39: 337-347.
6. Briceño PEG, Ruiz GA, Chay CAJ, Ayala BAJ, Aguilar PCF, Solorio SFJ, Ku VJC. Voluntary intake, apparent digestibility and prediction of methane production by rumen stoichiometry in sheep fed pods of tropical legumes. Animal Feed Science and Technology 2012; 176(1–4): 117-122.
7. Cuchillo HM, Delgadillo PC, Wrage N, Pérez GRF. Feeding goats on scrubby Mexican rangeland and pasteurization: influences on milk and artisan cheese quality. Tropical Animal Health and Production 2010; 42: 1127-1134.
8. Fragoso LC. Monografía del Estado de Guerrero, sur amate de mar y montaña. SEP, México, D.F. 1990; 237.
9. García WLR, Goñi CS, Olguín LPA, Díaz SG, Arriaga JCM. Huizache (*Acacia farnesiana*) whole pods (flesh and seeds) as an alternative feed for sheep in Mexico. Tropical Animal Health and Production 2009; 41: 1615-1621.
10. Gidenne T, Caraba R, Garcia J, Deblas C. Fibre digestion. Nutrition of the rabbits. 2nd Edition CABI North American office 2010: 66-82.
11. Kawas JR, Andrade-Montemayor H, Lu CD. Strategic nutrient supplementation of free-ranging goats. Small Ruminant Research 2010; 89(2-3): 234-243.
12. Martinez-Martinez R, Lopez-Ortiz S, Ortega-Cerrilla ME, Soriano-Robles R, Herrera-Haro GJ, Lopez-Collado J, Ortega-Jimenez E. Preference, consumption and weight gain of sheep supplemented with multinutritional blocks made with fodder tree leaves. Livestock Science 2012; 149: 185–189.
13. Mellado M, Estrada R, Olivares L, Pastor F, Mellado J. Diet selection among goats of different milk production potential on rangeland. Journal of Arid Environments 2006; 66: 127-134.
14. Mlambo V, Mould FL, Sikosana JLN, Smith T, Owen E, Mueller HI. Chemical composition and in vitro fermentation of tannin-rich tree fruits, Animal Feed Science and Technology 2008; 140: 402-417.
15. National Research Council. NRC. Nutrient requirement of small ruminants. 7 th Edition National Academic Press, Washington, D.C, U.S.A. 2001; 381.
16. Olivares PJ, Avilés NF, Albarrán PB, Castelán OOA, Rojas HS. Nutritional quality *of Pithecellobium dulce* and *Acacia cochliacantha*

fruits, and its evaluation in goats. Livestock Science 2013; 154: 74-81.
17. Olivares-Perez J, Aviles-Nova F, Albarran-Portillo B, Castelan-Ortega OA, Rojas-Hernández S. Use of three fodder trees in the feeding of goats in the subhumid tropics in Mexico. Tropical Animal Health and Production 2013; 45: 821–828.
18. Patra AK, Saxena J. A new perspective on the use of plant secondary metabolites to inhibit methanogenesis in rumen. Phytochemistry 2010; 71: 1198-1222.
19. Raghuvansi SKS, Tripathi MK, Mishra AS, Chaturvedi OH, Prasad R, Saraswat BL, Jakhmola RC. Feed digestion, rumen fermentation and blood biochemical constituents in Malpura rams fed a complete feed-block diet with the inclusion of tree leaves. Small Ruminant Research 2007; 71: 21-30.
20. Ramírez LRG. Nutrición de caprinos: en pastoreo. 1° Edición, Editorial Trillas. México, D. F. 2008; 208.
21. Rojas HS, Olivares PJ, Gutiérrez SI, Jiménez GR, León LF, Córdova IA. Use of *crescentia alata* and *Guazuma ulmifolia* fruits in lamb feeding in subtropical region of Guerrero, Mexico. Revista Científica FCV-LUZ 2013; XXIII (2): 157-162.
22. Salem AZM, Szumacher-Strabel M, Lopez S, Khalil MS, Mendoza GD, Ammar H. In situ degradability of soyabean meal treated with Acacia saligna and Atriplex halimus extracts in sheep. Journal of Animal and Feed Sciences 2012; 21 (3): 447-457.
23. Salem AZM. Impact of season of harvest on in vitro gas production and dry matter degradability of Acacia saligna leaves with inoculum from three ruminant species. Animal Feed Science and Technology 2005; 123-124P1, 67-79.
24. Smith T, Mlambo V, Sikosana JLN, Maphosa M, Mueller HI, Owen E. *Dichrostachys cinerea* and *Acacia nilotica* fruits as dry season feed supplements for goats in a semi-arid environment: Summary of a DFID funded project in Zimbabwe. Animal Feed Science and Technology 2005; 122(1-2): 149-157.
25. Statistical Analysis System SAS. SAS/StAt User's Guide. Version 8.2. SAS Institute Inc, Cary NC, USA. 2002.
26. Tendonkeng F, Fogang ZB, Sawa C, Boukila B, Tedonkeng PE. Inclusion of Tithonia diversifolia in multinutrient blocks for West African dwarf goats fed Brachiaria straw. Tropical Animal Health and Production 2014; 46(6): 981-986.
27. Thi HK, Thi TVD, Ledin I. Effect of supplementing urea treated rice straw and molasses with different forage species on the performance of lambs. Small Ruminant Research 2008; 78: 134-143.
28. Van Soest PJ, Robertson JB, Lewis BA. Symposium: Carbohydrate methodology, metabolism, and nutritional implications in dairy cattle methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. Journal Dairy Science 1991; 74: 3583-3597.
29. Vázquez MP, Castelán OOA, García MA, Avilés NF. Uso de bloques nutricionales como complemento para ovinos en el trópico seco del altiplano central de México. Tropical and Subtropical Agroecosystems 2012; 15: 87-96.
30. Waghorn G. Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production - Progress and challenges. Animal Feed Science and Technology 2008; 147: 116-139.
31. Waterman PG, Mole S. Analysis of phenolic plant metabolites. Blackwell Scientific Publications, London. 1994.
32. Yaynesheta T, Eik LO, Moe RS. Feeding *Acacia etbaica* and *Dichrostachys cinerea* fruits to smallholder goats in northern Ethiopia improves their performance during the dry season. Livestock Science 2008; 119(1-3): 31-41.

2/11/2015