Journal of Animal and Veterinary Advances 6 (9): 1042-1046, 2007
ISSN: 1680-5593
© Medwell Journals, 2007

Effect of Supplementing Tree Foliage to Grazing Dual-Purpose Cows on Milk Composition and Yield

[1]A.R. Bobadilla-Hernández, [2]L. Ramírez-Avilés and [2]C.A. Sandoval-Castro
[1]Faculty of Veterinary Medicine and Animal Science, Universidad Autónoma de México
[2]Faculty of Veterinary Medicine and Animal Science, Universidad Autónoma de Yucatán, Km 15.5 carr. Xmatkuil, Apdo. 4-116 Itzimná, Mérida, Yucatán, 97100, México

Abstract: Fourteen lactating Holstein×Zebu cows (450±28 kg) were used to evaluate the effect of supplementing forage tree foliage on Foliage Dry Matter Intake (FDMI), milk yield and milk composition. Cows were milked once daily and calves suckled twice a day. Animals grazed guinea grass and received 2 kg sun-cured foliage. Supplements were: BA (100% *Brosimun calicastrum*), LL (100% *Leucaena leucocephala*), LB (50% *L. leucocehpala*+50% *B. alicastrum*), LP (50% *L. leucocehpala*+50% *Piscida piscipula*), LG (50% *L. leucocehpala*+50% *Guazuma ulmifolia*), LPG (33.3% *L. leucocehpala*+33.3% *P. piscipula*+33.3% *G. ulmifolia*) and BPG (33.3% *B. alicastrum*+ 33.3% *P. piscipula*+33.3% *G. ulmifolia*). Mixtures were prepared simulating the likely intake of these species in the area. There were differences in FDMI ($p<0.05$), with higher intakes for LB (1648 g DM day^{-1}) and lower intakes for LP (1112.8 g DM day^{-1}). There were no differences in saleable milk yield ($p>0.05$). Higher milk intake by the calf (MIC) was found in LL (2.6 kg day^{-1}) ($p<0.05$) than in LB or LP (1.9 kg day^{-1}). The highest total milk yield was for LL (6.1 kg day^{-1}) and the lowest, for LPG (5.1 kg day^{-1}) ($p<0.05$). No effect was found in milk composition (total solids, protein and fat). Milk urea levels were similar amongst treatments. It can be concluded that the use of tree foliage as a supplement in Holstein×Zebu cows, does not affect milk composition, but MY improvements might be limited by energy supply.

Key words: Milk yield, tree foliage, tree foliage mixtures, dual purpose cows

INTRODUCTION

Countries with large tropical areas, like Mexico, have forage resources (either native or introduced) that could be used to feed animals. Therefore, new methodologies that introduce these resources into animal production systems, without harming the environment, are sought. Grazing within an agropastoral system has become such an alternative because it combines these two aspects (Solorio Sánchez and Solorio Sánchez, 2002). This technique uses the knowledge of alternative forage resources, like tree foliage, to generate coherent animal feeding strategies in the tropics, where climate determines in great part the availability of those resources (Shelton, 2000). This study evaluated the effect of foliage from native trees from Yucatán, Mexico, given alone or in combination to double-purpose grazing cows, on foliage intake, saleable milk, quantity of milk ingested by the calf, total milk yield and milk composition during the dry season.

MATERIALS AND METHODS

Study area: The field work was carried out at the experimental station of "Hobonil" (FMVZ-UADY) during the months of February and March. The station is located at 19° 59' north latitude, 89° 02' west longitude and at 10 m above sea level. The climate is warm, with rains during the summer (Aw_0); the mean annual temperature ranges from 25.4-27.2°C, with mean rainfall of 1,000-1,200 mm (García, 1988). The laboratory work was performed at the Animal Nutrition Department (FMVZ-UADY), located in the Mérida-Xmatkuil road, Km 15.5, Yucatán, Mexico.

Animals and experimental diets: Fourteen Holstein×Zebu cows (450±28 kg) were used. Animals were in their third or fourth lactation and their calves were kept with them. Cows were dipped in amitraz (0.02%) before the study began (ticks control). They were milked once daily and suckled their calves twice a day (8:00 and 14:30 h). Animals grazed guinea grass (*Panicum maximum*) and

Corresponding Author: C.A. Sandoval-Castro, Faculty of Veterinary Medicine and Animal Science, Universidad Autónoma de Yucatán, Km 15.5 carr. Xmatkuil, Apdo. 4-116 Itzimná, Mérida, Yucatán, 97100, México

Table 1: Chemical composition and *in vitro* dry matter and organic matter digestibility (%) of experimental supplements offered to lactating double-purpose cows grazing in a sub-humid tropical region in Mexico

Supplement	DM	OM	CP	NDF	ADF	Lignin	CT	IVDMD	IVOMD
BA	90.4	74.9	16.3	40.0	30.1	7.9	<2.0	64.5	74.4
LL	91.1	82.8	26.3	38.2	25.5	13.3	2.6	47.6	51.9
LB	90.5	78.6	21.7	40.3	31.6	10.5	<2.0	56.3	63.1
LP	91.0	79.0	21.1	41.7	28.6	13.4	3.7	44.2	51.7
LG	92.4	83.1	20.9	41.1	26.2	12.4	3.0	46.9	52.2
LPG	90.7	77.2	19.3	41.2	29.4	14.3	5.6	43.3	52.1
BPG	92.2	78.6	15.1	42.4	31.4	12.2	3.7	50.7	59.9

DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; CT = condensed tannins; IVDMD = *in vitro* dry matter digestibility; IVOMD = *in vitro* organic matter digestibility; BA: *B. alicastrum*; LL = *L. leucocephala*; LB = *L. leucocephala*+*B. alicastrum*; LP = *L. leucocephala*+*P. piscipula*; LG = *L. leucocephala*+*G. ulmifolia*; LPG = *L. leucocephala*+*P. piscipula*+*G. ulmifolia*; BPG = *B. alicastrum*+*P. piscipula*+*G. ulmifolia*

received 2 kg of a supplement based on sun-cured foliage from four native tree species given in different proportions. Table 1 shows the nutritional composition of each supplement. Treatments were: BA (100% *Brosimun alicastrum*), LL (100% *Leucaena leucocephala*), LB (50% *L. leucocehpala*+50% *B. alicastrum*), LP (50% *L. leucocehpala*+50% *Piscida piscipula*), LG (50% *L. leucocehpala*+50% *Guazuma ulmifolia*), LPG (33.3% *L. leucocehpala*+33.3% *P. piscipula*+33.3% *G. ulmifolia*) and BPG (33.3% *B. alicastrum*+ 33.3% *P. piscipula*+33.3% *G. ulmifolia*). Mixtures were prepared simulating the likely intake of these species when the cows graze the secondary vegetation in the area. Supplements were offered twice a day, 0.75 kg DM/animal in the morning, during milking and 1.25 kg DM/animal in the afternoon, before the second suckling. In order to guarantee their consumption, 100 g of cane molasses kg^{-1} of supplement were poured over the foliage.

Foliage quality was assessed via *in vitro* digestibility and gas production production technique (Theodorou *et al*., 1994). The elaboration of the *in vitro* medium was carried out as for Menke and Staingass (1988). Rumen content was collected from two canulated heifers, which were fed with about 16 kg FM of chopped *Pennisetum purpureum* grass and supplemented with 3 kg of a commercial concentrate (16% of CP). Each sample was placed in a 100 mL bottle and added 6 mL of inoculate and 54 mL of *in vitro* medium. All treatment mixtures have a total weigh of 0.5 g of DM. The gas volume and pressure were recorded at 0, 3, 6, 9, 12, 15, 18, 21, 24, 30, 36, 48, 60, 72 and 96 h post-incubation. After this period, samples were filtered and residual DM was determined, next samples were ashed at 450°C and residual OM estimated by difference. Digestibility (DM and OM) was estimated from the difference between the incubated and the residual fraction after blank correction.

Cows had an initial adaptation period of 11 days to the milking, double suckling and first supplement intake, after which measurements were taken over the following three days. Once this first period was over, animals had an adaptation period of four days to their next treatment and measurements were taken again over the following three days. Milk yields and Foliage Dry Matter Intake (FDMI) were measured in each period. Cows and calves live weight was recorded at the beginning of the adaptation, beginning of the experimental period and at the end of the experimental period to assess live weight changes.

Saleable Milk Yield (SMY) was measured during milking. The quantity of Milk Ingested by the Calf (MIC) was obtained by difference, weighing the calf before and after suckling and adding up the results from the morning and afternoon suckling periods. Total Milk Yield (TMY) was the result of adding up SMY+MIC. FDMI was calculated substracting orts, collected immediately after the allotted time for foliage consumption, from the amount of foliage offered. Dry matter was obtained both for the foliage and for the orts.

Milk samples were analyzed for total solids (Pereira, 1988), protein (A.O.A.C., 1980), fat (O`Mahony, 1980) and milk urea (Merck, 1998). Feed samples were analyzed for dry matter, ash, crude protein (A.O.A.C., 1980) NDF, ADF and lignin (Van Soest *et al*., 1991) and condensed tannins (Price and Buttler, 1977).

Statistical analysis: The experimental design was a latin rectangle (Mead, 1990), 14 animals ×7 periods. The GLM procedure from SAS was used (SAS, 1995). Means were compared using Tukey's procedure.

RESULTS AND DISCUSSION

Intake of experimental supplements: The reason for including tree foliage in the diet of ruminants is that they are an important source of Protein (CP). Their potential to supply of CP and digestible material is shown in Table 1 and 2 which present their chemical composition, IVDMD, IVOMD and gas production of the foliages evaluated.

Intake and milk yield is presented in Table 3. A higher FDMI was observed for the BA and LB treatments (1637 g DM day^{-1}), average intakes for the LL and LG supplements (1483 g DM day^{-1}) and lowest intakes for

Table 2: *In vitro* gas production (mL g^{-1} DM±standard error) of four tropical foliages used as supplements for dual purpose cows

Supplement	a	B	c	R^2	rsd
BA	-18.5±2.64	212.4±5.23	0.022±0.0015	0.98	6.4
LL	-5.6±2.05	122.2±5.32	0.019±0.0021	0.97	5.1
PP	-1.3±1.63	93.3±5.07	0.017±0.0023	0.96	4.1
GU	-6.9±1.49	168.6±7.94	0.013±0.0013	0.98	3.9

BA = B. alicastrum; LL = *L. leucocephala;* GU = *G. ulmifolia;* PP = *P. piscipula, a, b, c* = parameters according to the equation: gas (mL g^{-1} DM) = a+b (1- $\exp^{-ct}$)

Table 3: Foliage dry matter intake (g d^{-1}), milk yield (kg d^{-1}) and milk composition (g kg^{-1}, except where indicated) of dual purpose cow supplemented with forage tree mixtures

Supplement	FDMI	SMY	MIC	TMY	Total solids	Fat	Protein	Urea (mg 100 mL^{-1})
BA	1626.3[a]	3.1a	2.2ab	5.5ab	94.8	12	27.78	27.0
LL	1495.2ab	3.5a	2.6a	6.1a	92.2	13	27.51	26.6
LB	1648.2[a]	3.6a	1.9b	5.5ab	93.1	13	26.86	27.8
LP	1112.8c	3.3a	1.9b	5.3ab	94.9	14	27.50	26.5
LG	1470.3ab	3.3a	2.4ab	5.9ab	96.2	13	29.07	27.8
LPG	1157.3c	3.0a	2.1ab	5.1b	94.9	12	28.10	26.1
BPG	1201.2bc	3.4a	2.2ab	5.6ab	97.4	13	28.56	26.9
EE	72.06	0.1384	0.1489	0.2196	2.06	0.088	0.364	0.48

FDMI = Foliage dry matter intake; SMY = Saleable milk yield; MIC = Quantity of milk ingested by the calf; TMY = Total milk yield; BA: *B. alicastrum*; LL = *L. leucocephala*; LB = *L. leucocephala+B. alicastrum*; LP = *L. leucocephala+P. piscipula*; LG = *L. leucocephala+G. ulmifolia*; LPG = *L. leucocephala+P. piscipula+G. ulmifolia*; BPG = *B. alicastrum+P. piscipula+G. ulmifolia*, Different literals in the same column indicate statistical difference ($p<0.05$)

the other three treatments, BPG, LP and LPG (1157 g DM day^{-1}) (Table 3). The inclusion of more CP in the diet has been associated with higher DM intakes (Folman *et al.*, 1981). However, in this case, the LB supplement, which showed one of the highest intakes, had 5% less CP than the LL supplement, of average intake, although not statistically different from LB. Furthermore, intake of the BPG supplement, which had the lowest CP concentration (15.1%), was not statistically different from intakes of LPG or LP, which approximately contained 6% more CP. These results are similar to those of Mayne and Gordon (1984), who found differences in production performance but not in DM intake of lactating cows offered supplements with 24% CP. Therefore, if supplements with similar CP, neutral detergent fiber and acid detergent fiber concentrations, like LB, LG and LPG (Table 1), showed different FDMI it is likely that other factors were at play. The concentration of Condensed Tannins (CT), which was different between these supplements, could be one explanation. Minson *et al.* (1993) found that CT decreased in DM intake from 40-50%. CT also reduced the activity of certain fiber-degrading enzymes (Mupangwa *et al.*, 2000), increasing the amount of time the feed stays in the rumen and, thus, decreasing DM intake (Faverdin *et al.*, 1999). However, it is likely that the main constraint was not CT content of foliage. Trade-off between quality and quantity of available herbage may lead to herbivores to select diets of intermediate quality in order to maximize their overall rate of nutrient assimilation (Duncan and Gordon, 1999). Also, it seems that ruminants make dietary choices in order to meet their rumen degradable protein requirement (Kyriazakis *et al.*, 1999) but also, giving the opportunity to choose amongst several feeds, ruminants will avoid

Table 4: Live Weigth (LW) and the end of the trial and cumulative LW Change (CLWC) in grazing cows and its calves when cows were supplemented with forage trees

	Calves		Cows	
Supplement	Final LW kg	CLWC kg	Final LW kg	CLWC kg
BA	62.2	10.1	420.8	-13.5
LL	62.1	10.1	423.6	-10.8
LB	61.5	9.5	422.9	-11.4
LP	61.4	9.4	420.2	-14.2
LG	61.6	9.5	424.4	-9.9
LPG	61.9	9.9	424.4	-9.9
BPG	61.9	9.9	424.4	-9.9
EE	0.45	0.45	1.14	1.14

BA: *B. alicastrum*; LL = *L. leucocephala*; LB = *L. leucocephala+B. alicastrum*; LP = *L. leucocephala+P. piscipula*; LG = *L. leucocephala+G. ulmifolia*; LPG = *L. leucocephala+P. piscipula+G. ulmifolia*; BPG = *B. alicastrum+P. piscipula+G. ulmifolia*

eating in excess (Tolkamp *et al.*, 1998). BA is a highly and rapidly degradable DM and N at ruminal level (Sandoval-Castro, 1996). Cows supplemented with BA alone might not be maximizing nutrient assimilation (i.e., MP). On the other hand, providing a mixture of plants which includes those containing tannins might lead to more efficient nutrient utilization (i.e., N). Thus, it can be explained that cows eating foliage mixtures have lower FDMI but it did not resulted in lower TMY, higher milk urea or higher weight loss (Table 3 and 4). We could hypothesize that the higher FDMI observed with BA, LL or LB mixture led to lower N capture efficiency probably due to energy supply being limited in the supplement.

Milk yield and composition: There were no differences ($p>0.05$) in SMY among supplements (Table 3). Calves in LL treatment ingested more milk (2.6 kg milk day^{-1}) than calves in either LB or LP treatments (1.9 kg milk day^{-1})

(Table 3). Sandoval *et al.* (1997) suggests that if the diet of the Holstein×Zebu cow in the tropics was improved in its nutritional content and no increase is observed in the SMY, then the calf would be ingesting the amount of milk produced in excess. The results of MIC agree with those reported by Alvarez *et al.* (1980), who indicated an intake of 2 L day^{-1}. For TMY, the supplement with the best yield was L (6.1 kg day^{-1}), which is in accordance with previous reports with supplemented dual purpose cows (Combellas, 1998, Hernández *et al*., 1999). It is worth noting that when the foliage of trees with higher CT concentration was used in the mixtures, as was the case in the LP and LPG supplements, there was a tendency for both FDMI and hence TMY to decrease. As grass intake was not measured it is not clear if total DMI was also reduced or it was compensated. Juma *et al.* (2006) observed no difference between legume supplementation treatments but supplemented cows had higher milk production than unsupplemented cows. However, Bustamente *et al*. (2003) found lower DMI when *L. leucocephala* was used as supplement than when only a commercial concentrate was offered. In the present experiment there were no negative control and the exact effect of foliage supplementation can not be fully explained. Further research is need in this area.

Milk composition was not affected by any of the treatments (Table 3) suggesting similar nutrient supply from the supplements. This is supported by the milk urea level which was similar amongst treatments. Supplement with higher CP content had lower FDMI, with a net effect of providing a similar nutrient supply to the animal. Moreover, Ferguson (2000) points out that only 0.02 change was expected in milk protein content for every 1% change in dietary CP. Thus relatively minor changes were expected from the diet composition values. Furthermore, observed LW changes (Table 4) suggest that cows were mobilizing body reserves in a similar magnitude, the fact that tree foliage were providing mainly protein, thus energy might have limited the performance of the cows and no energy source was included in the supplements provided. Similarly, Bustamente *et al.* (2003) found greater LW mobilization in *L. leucocephala* supplemented cows as compared with concentrate supplemented cows. In the present experiment, it is likely that a higher proportion of N was not captured at ruminal level due to energy supply constraints and was loss (in urine and milk), as suggested by the milk urea level, which is higher than values normally found in dairy animals (Melendez, 2000).

CONCLUSION

When forage tree foliages are used as supplement either alone or combining a mixture of different foliages, there is a limited response in TMY probably due to energy supply constraints.

ACKNOWLEDGEMENT

A.R. Bobadilla, received a scholarship from CONACYT-México to undergo MSc. Studies. Research supported by CONACYT grant 31661-B.

REFERENCES

AOAC, 1980. Oficial Methods of analysis, (13th Edn.), Washington, DC, USA.

Alvarez, F.J., G. Saucedo, A. Arriaga and T.R. Preston, 1980. Efecto sobre la producción de leche y el comportamiento de los becerros al ordeñar vacas cebú/europeo con o sin apoyo del becerro y amamantamiento restringido. Prod. Anim. Trop., 5: 27-39.

Bustamante, J.J., J.F. Villanueva, A. Bonilla and B. Vidal, 2003. Milk yield by brown swiss cows at grazing and supplemented with leucaena (*Leucaena leucocephala*) in compact areas. Trop. Subtrop. Agrecosyst., 3: 67-71.

Combellas, I.J., 1998. Alimentación de la vaca de doble propósito y de sus crías. Fundación Inlaca. Venezuela.

Duncan, A.J. and I.J. Gordon, 1999. Habitat selection according to the ability of animals to eat, digest and detoxify foods. Proc. Nutr. Soc., 58: 799-805.

Faverdin, P., N. Bareille and R. Verite, 1999. Effects of rumen energy timing on feed intake control in lactating dairy cows. J. Dairy Sci., 82: 2443-2454.

Ferguson, D.J., 2000. Milk protein. Center for animal health and productivity. School of veterinary medicine, university of Pennsylvania. http://cashpwww.nbc.upenn.edu/mun/milk_protein.html

Folman, I., H. Neumark, M. Kaim and W. Kaufmann, 1981. Performance, rumen and blood metabolites in high-yielding cows fed varying protein percents and protected soybean. J. Dairy Sci., 64: 759-768.

Juma, H.K., S.A. Abdulrazak, R.W. Muinga and M.K. Ambula, 2006. Effects of supplementing maize stover with clitoria, gliricidia and mucuna on performance of lactating jersey cows in coastal lowland kenya. Trop. Subtrop. Agroecosyst., 6: 1-7.

Kyriazakis, I., B.J. Tolkamp and G. Emmans, 1999. Diet selection and animal state: An integrative framework. Proc. Nutr. Soc., 58: 765-772.

García, M.E., 1988. Modificaciones al sistema de clasificación climática de Köppen. Instituto de Geografía. UNAM. México, D.F.

Hernández, I., M.M.G. Milera, J. Iglesias and L. Simón, 1999. Sistemas silvopastoriles en Cuba. Memorias de los simposios de la XXXV Reunión Nacional de Investigación Pecuaria, Yucatán 1999. Mérida, Yucatán, México, pp: 1-15.

Mayne, C.S. and F.J. Gordon, 1984. The effect of type of concentrate and level of concentrate feeding on milk production. Anim. Prod., 39: 65-76.

Mead, R., 1990. The desing of experiments: Stadistical principles for practical applications. Cambridge University Press. England, pp: 176-213.

Meléndez, P., A. Donovan and H. Hernandez, 2000. Milk urea nitrogen and fertility in Florida Holstein cows. J. Dairy Sci., 83: 459-463.

Menke, K.H. and H. Steingass, 1988. Estimation of the energetic feed value obtained from chemical analysis and *in vitro* gas production using rumen fluid. Anim. Res. Dev., 28: 7-55

Merck, 1998. Urea in milk. Photometric determination with diacetyl monxime in the sample clarified with trichloroacetic acid. http://www.merck.de/english/services/labor/l_uba/applic/applic2/ureamilk2.html

Minson, D.J., T. Cowan and E. Havulah, 1993. Nothern dairy feedbase 2001. Summer pasture and crops. Trop. Grassl., 27: 131-149.

Mupangwa, J.F., T. Acamovic, J.H. Topps, N.T. Ngangoni and H. Hamudikuwanda, 2000. Content of soluble and bound condensed tannins of three tropical herbaceus forage legumes. Anim. Feed Sci. Tech., 83: 139-144.

O`Mahony, F., 1988. Butterfat determination. Rural dairy technology. Experiences in Ethiopia. ILCA Manual, 4: 55-56.

Pereira, P.F., 1988. Alimentos. Manual de análisis fisicoquímicos. Universidad Autónoma de Yucatán. México, pp: 40-41.

Price, L.M. and G.L. Buttler, 1977. Rapid visual estimation and spectrophotometric determination on tannin contents of sorghum grain. J. Agric. Food Chem., 25: 1268-1273.

Sandoval Castro, C.A., 1996. The effect of restricted suckling, milking and nutricional management on milk production and calf performance in dual purpose cattle. PhD. Thesis. Wye College, University of London.

Sandoval Castro, C.A., J.D. Leaver and S. Anderson, 1997. Manejo de la Nutrición de la Vaca y la Relación Vaca-Ternero. In: Lascano, C.E. and F. Holmann (Eds.), Conceptos y metodologías de investigación en fincas con sistemas de producción animal de doble propósito. Centro internacional de agricultura tropical: Consorcio tropileche. Cali. Colombia, pp: 15-25.

S.A.S., 1995. SAS software release 6.11 TS020. Institute Inc., Cary, NC. USA. 1989-1995.

Shelton, H.M., 2000. Potential and limitations of *Leucaena* sp. for silvopastoral systems. Memorias del Simposio internacional. "Sistemas agroforestais pecuarios na América do Sul. Ministerio da agricultura e do abastecimento. Red de agroforestería pecuaria. Embrapa, Dairy Cattle-FAO. de setembro de Juiz de Fora-MG-Brasil, pp: 18-20.

Simpson, J.R. and J.H. Conrad, 1993. Intensification of cattle production systems: Why and When. J. Dairy Sci., 76: 1744-1752.

Solorio Sánchez, F.J. and B. Solorio Sánchez, 2002. Integrating fodder tress into animal production systems in the tropics. Trop. Subtrop. Agroecosyst., 1: 1-11.

Theodorou, M.K., B.A. Williams, M.S. Dhanoa, A.B. McAllan and J. France, 1994. A simple gas production method using a pressure transducer to determine the fermentation kinetics of ruminant feeds. Anim. Feed Sci. Tech., 48: 185-197.

Tolkamp, B.J., I. Kyriazakis, J.D. Oldham, M. Lewis, R.J. Dewhurst and J.R. Newbold, 1998. Diet choice in dairy cows. II. Selection for metabolizable or for ruminally degradable protein?. J. Dairy Sci., 81: 2670-2680.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary neutral detergent fiber and nonstarch polysacacharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.