

Supplementation of Grazing Dairy Cattle with Mulberry in the High Part of the Central Valley of Costa Rica

**J. Benavides, I. Hernández, J. Ésquivel,
J. Vasconcelos, J. González and E. Espinosa**

CATIE, Turrialba, Costa Rica

Introduction

In Costa Rica, and in other tropical countries, there are many species of trees and shrubs with good forage characteristics thanks to the high nutrient of their forage and to their capacity of producing large amounts of biomass per unit area (Benavides, 1991; Reed, 1991). Due to these features, the use of their forage contributes to reduce the dependency on imported inputs to feed livestock (Romero *et al.*, 1991).

Among woody forages, mulberry (*Morus spp.*) stands out, since its leaves have more than 20% crude protein (CP) and *in vitro* dry matter digestibility (IVDMD) between 70-80% (Benavides, 1994). Jegou *et al.* (1991) reported *in vivo* digestibility of 79% for DM and 89% for crude protein (CP). Under humid tropical conditions, with 4 harvests per year, 30 tons of DM per year, with 60% edible material, have been obtained. (Benavides *et al.*, 1994). Oviedo (1995) stated that in association with Poró (*Erythrina poeppigiana*), mulberry can produce up to 7.2 tons of edible DM/ha just applying Poró's foliage as green manure.

Supplementing only with mulberry grazing dairy cows in the humid tropics, milk production did not differ significantly to that obtained with commercial concentrate supplementation (Oviedo, 1995). The objective of this experiment was to test the effect of

different levels of concentrate substitution by mulberry on milk production with genetically superior cows.

Materials and Methods

The trial was conducted in a dairy farm at Coronado (San José, Costa Rica) at 1,471m above sea level, with annual mean temperature of 16.7°C and rainfall of 2,892mm (Chinchilla, 1987). Six Holstein cows with 2 or more calvings, an initial production of 18 kg of milk per day and 485kg of body weight were used. On a DM basis, the supplementation treatments were: commercial concentrate (T1); 35% mulberry and 65% concentrate (T2); and 65% mulberry and 35% concentrate (T3).

A Latin square, simple changeover, 3 x 3 design (Lucas, 1957) with 2 repetitions, was utilised. Each period lasted 21d (16 for adaptation and 5 for measurements). Supplementation was at the level of 1.3% of body weight on a DM basis at the beginning of each period.

Experimental animal grazed together with the rest of the milking cows on Kikuyo grass (*Pennisetum clandestinum*) which had patches of African Star grass (*Cynodon nlemfuensis*). Supplements offered and refused were measured individually and sampled for DM CP and *in vitro* DM digestibility determinations. Chromic oxide was used as marker for grazing intake estimations (Lascano, 1990). In addition to milk yield, intakes of DM and CP were measured and digestible energy (DE) calculated. Milk samples were analysed for fat, protein and total solids.

Results and Discussion

Mulberry used in this experiment had less CP compared to previous reports (Benavides, 1994; Benavides et al., 1994), who reported values over 20%. IVDMD and DE were high and

comparable to reports from the same authors, 85.0 % y 3,75 Mcal/kg MS, respectively (Table 1).

Table 1. Dry matter, crude protein, digestible energy and *in vitro* dry matter digestibility of feeds utilised for dairy cows.

Feed	DM (%)	CP (%)	IVDMD (%)	DE¹ (Mcal/kg DM)
Kikuyo grass	23.0	8.0	65.0	2.9
Mulberry	25.4	16.1	80.0	3.5
Concentrate	91.5	17.7	85.0	3.7

¹ DE = (IVDMD x 4,409)/100

The nutritional value of mulberry was better than Kikuyo grass and slightly better than the concentrate. It was also superior to other supplements traditionally used in dairies, such as sugar cane (4.9% CP; 2.9 Mcal DE/kg DM), bananas (4.8% CP; 3.1 Mcal DE/kg DM) and poultry manure (19.2% CP; 1.4 Mcal DE/kg DM) (Vargas, 1984).

Intakes of DM were adequate to animal type and production level. Although there were no significant differences among treatments, total intake declined with increasing levels of mulberry (Table 2), possible due to greater rumen fill of the bulky fresh mulberry. The intake was smaller than that reported by Oviedo (1995), of 3.8% of liveweight on DM basis when supplementing dairy cows under humid tropical conditions. Similar intakes of CP (1.9; 1.8 and 1.7 kg/d, for each substitution level, respectively) and DE (50.6; 48.0 and 44.3 Mcal/d, respectively) were observed.

Table 2. Effect of mulberry supplementation on dry matter intake of grazing dairy cows.

Feed	Ratio Concentrate/Mulberry		
	100/0	60/40	25/75
	DM, kg/animal/day		
Concentrate	6.4	4.2	1.9
Mulberry	0	2.8	5.5
Kikuyo grass	9.3 ^a	7.8 ^{ab}	6.2 ^b
Total	15.7	14.8	13.6
	DM, % body weight		
Concentrate	1.3	0.8	0.4
Mulberry	0	0.5	1.1
Kikuyo grass	1.7 ^a	1.6 ^{ab}	1.2 ^b
Total	3.0	2.9	2.7

Despite slight decrease on intake, there were no significant differences ($p < 0.05$) on milk quality and yield due to supplement substitution (Table 3). Oviedo (1995) did not find significant differences on milk production and on composition when concentrate was replaced by mulberry (1.03% body weight on DM basis) in dairy cows in the humid tropics. There was no difference among treatments ($p < 0.05$), with Duncan test.

Table 3. Milk yield and quality of dairy cows with different proportions of concentrate and mulberry.

Parameter	Ratio Concentrate/Mulberry		
	100/0	63/35	35/65
Milk, kg/animal/d	14.2	13.2	13.8
Milk protein, %	3.0	3.0	2.9
Milk fat, %	3.6	3.6	3.5
Total solids, %	12.7	12.6	12.5

Partial analysis of income and costs, considering only feeding costs, indicates a higher net income and better benefit/cost ratio per animal when mulberry replaced concentrates (Table 4).

Table 4. Partial benefit/cost ratio per animal when supplementing with concentrate and/or mulberry on grazing dairy cows (In Costa Rican currency, colones²).

Item	Ratio Concentrate/Mulberry ¹	
	100/0	35/65
Concentrate	135,983	40,561
Cut & carry mulberry		54,626
Manure spreading		6,400
Depreciación ³		6,010
Total costs	135,983	107,560
Total income	307,343	298,694
Net income	171,361	191,096
Profitability, %	56	64

¹ Considering only feed costs.

² December 1995.

³ Depreciation in 10 years the establishment cost for mulberry (Adapted from Ramos, 1996).

Conclusions and Recommendations

Substituting concentrates for mulberry in supplements for grazing dairy cows did not affect milk yield nor quality. At the same time, the use of mulberry can decrease feeding costs and the use of concentrates. It is advisable to carry out longer-term studies to establish the real potential for mulberry in complete lactations and to evaluate its effect on reproductive parameters.

References

- Benavides, J. E. 1991. Integración de árboles y arbustos en sistemas de alimentación para cabras en América Central: un enfoque agroforestal. El Chasqui (C.R.) No. 25: 6-36.
- Benavides, J. E.; Lachaux, M. y Fuentes, M. 1994. Efecto de la aplicación de estiércol de cabra en el suelo sobre la calidad y producción de biomasa de Morera (*Morus sp.*) In: Benavides, J.E. (ed.) Árboles y arbustos forrajeros en América Central. Turrialba, C.R.: CATIE. V 2. 495-514 (Serie técnica. Informe técnico/CATIE; No. 236).
- Chinchilla, E. 1987. Atlas Cantonal de Costa Rica. V.1. San José C P IFAM. 396 p.
- Jegou, O.; Nicolas J.; Waelput, J.J.; y Brunschwig, G. 1991. Consumo, digestibilidad y ciclo del nitrógeno del follaje de Morera (*Morus sp.*) y Amapola (*Ma/vaviscus arboreus*) con cabras lactantes. In: Seminario Internacional de Investigación en Cabras (1., 1991, El Zamorano, Hond.). Memorias. SRN. p. irr.
- Lucas, H.L.1957. Extra-period latin-square change over designs. Journal of Dairy Science 40:225-239.
- Mora, J.A. 1996. Indicadores de impacto ambiental: Plan de mejoramiento ambiental de la Cuenca del río Virilla, Costa Rica. Tesis Mag. Sc., Turrialba, C.R., CATIE. 173 p.
- Oviedo, F. 1995. Morera (*Morus sp.*) en asocio con poró (*Erythrina poeppigiana*) y como suplemento para vacas lecheras en pastoreo. Tesis Mag. Sc, Turrialba C.R., CATIE. 87p.
- Oviedo, F.J.; Benavides, J.E. y Vallejo, M. 1994. Evaluación bioeconómica de un módulo agroforestal con cabras en el trópico húmedo. In: Benavides, J. E. (ed). Árboles y arbustos forrajeros en América Central. Turrialba, C.R.,CATIE. 2:495-514 (Serie técnica. Informe técnico/CATIE; No. 236).
- Ramos, J.A. 1996. Indicadores de impacto ambiental. Plan de mejoramiento ambiental de la Cuenca del río Virilla, Costa Rica Tesis Mag. 90.1 Turrialba, CR, CATIE 176p.

Reed, J. 1991. Características de las plantas tropicales que determinan el valor nutritivo. *In: Ganadería y recursos naturales en América Central: estrategias para la sostenibilidad.* (1991, San José, C.R.). 1994. [Memorias]. Homan, E.J. (ed). CATIE, Turrialba. p. 195-206.

Romero, F.; Benavides J.; Kass, M. y Pezo, M. 1991. Utilización de Arboles y arbustos en sistemas de producción de rumiantes. *In: Ganadería y recursos naturales en América Central: estrategias para la sostenibilidad* (1991 San José, C.R.). 1994. [Memorias]. Homan, E.J. (de). CATIE, Turrialba. p. 207-220.

Vargas, L. 1984. Tabla de composición de alimentos para animales de Costa Rica. Editorial UCR, San José, C.R. 90 p.