Tithonia (*Tithonia diversifolia*) foliage meal in integral diets for lactating calf feeding: preliminary economical results

Delia María Cino, T.E. Ruíz, Y. Martínez, Berta Chongo and H. Díaz
Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, Mayabeque, Cuba
Email: dcino@ica.co.cu

The economical possibilities of using *Tithonia diversifolia* as forage meal in integral diets for lactating calves were evaluated from experimental data of the Institute of Animal Science (Ruiz *et al*. 2008 and Martínez 2009). Elements involving sowing and establishment as forage species and for grazing were collected. Cost data cards were organized indicating preparation, sowing and forage cut expenses to estimate the cost per ton of forage and as foliage meal. The inclusion of different meal levels were evaluated economically in diets for crossbred dairy calves of 40 kg (30 to 120 days of age) with ground hay of Cynodon nlemfuensis in 4 treatments: T1 ID (integral diet) + 20% hay, T2 ID+ 5% hay + 5% Tithonia meal, T3 ID + 10% hay + 10% Tithonia meal and T4 ID + 15% hay + 15% Tithonia meal. In all treatments 4 liters of milk were supplied from 30 to 60 days of age. Cost data cards were estimated per treatment and the indicators: production value, cost/animal/day per kg live weight, Benefit/cost ratio, variable expenses/incomes, gross margin/animal and economical profitability. The Northamerican dollar (USD) was used as money standard. The cost per t of forage was of 4.26 and 128.40 the t of meal. Treatments including meal recorded the lowest costs/animal/day, per kg LW and per $ and higher benefit/cost ratio. T4 also showed lower percentage of income utilization to cover its variable expenses, higher net income level, gross margin/animal and economical profitability. Results although preliminary showed the economical possibilities of using *T. diversifolia* forage meal in diets for lactating calves with a greater utilization of natural resources and, in this way, savings for the economy of the country.

Key words: *Tithonia diversifolia, forage meal, lactating calves, economical analysis*

From the economical standpoint calf rearing is the main link for livestock development. Hence, the study of sustainable technological systems requiring lower investment of material and financial resources is of great importance.

Traditionally, in Cuba calf rearing is based on fresh milk and imported dietary supplement consumption which increases considerably the price of the productive process. Thus, all efforts are channeled into the search for less expensive protein sources as well as foliage evaluation of some tree species due to their potentiality to guarantee in volume and quality the diets.

Among the present promissory forage species for cattle feeding, Mahecha *et al*. (2007) recommended *Tithonia diversifolia* as a strategic option for the development of economical sustainable cattle production systems due to its nutritional value, rusticity and high rate of biomass production.

Even though the use of this plant is reported in cattle diets (Mahecha and Rosales 2005), buffalo cattle (Premaratne 1990) and goat (Wambui *et al*. 2006) feeding, however, studies on the productive response of animals consuming forage or other feeds derived from this species are still very incipient regarding the research field at international level (Anon 2012), and in Cuba they are also scarce the animal nutrition experiments (Savón *et al*. 2008, Mosquera *et al*. 2011, Alonso *et al*. 2012) as well as data on its economical performance (Cino *et al*. 2012).

Presently, experiments on production and management of *T. diversifolia* and its evaluation in integral diets for cattle are carried out at the Institute of Animal Science (ICA) of Cuba. In view of the importance of learning the economical effect of the use of this species in young cattle feeding, this study aimed at the economical evaluation of the production process of *T. diversifolia* and the inclusion of different levels of Tithonia foliage meals (0-15%) for lactating calf feeding through some economical and financial indicators.

Materials and Methods

For the development of this study the technical and economical elements involved in the sowing and establishment of *T. diversifolia* reported by Ruiz (2010) at ICA, were taken. Two possible technological variants in cattle production systems were considered: a) as forage and b) as grazing species.

Cost data cards were prepared for each one of these alternatives, grouping the expense elements according the labors to be executed considering salary investment, fuels, machinery and other expenses (seeds, chemicals, etc.). The investment estimation as seeds, since there was no price available at home market, the marketable price per cutting reported by Ramírez (2008) in Colombian pesos was taken and it was valued according to dollar-Colombian peso monetary exchange (0.094 USD/cutting) cited by this author. Also, seed requirements for the sowing per ha (4-4.5 t) and average measurement per cutting to estimate the required amount of cuttings were considered.

When sowing and establishment cost results per ha (cost data cards) for the forage area were taken, expenses implicated in forage cut and yields obtained in the experimental area, the unit cost (t) of Tithonia forage was estimated.

In order to learn the cost per t of meal, the activities performed for its preparation were considered: moving and placing the forage in the plate, forage turning, dry forage bag up, moving to the feed factory, milling and addition of the elements included in the integral diet designed and finally bag up once finished the mixing process of the ingredients. Primary data were taken at the processing plant and feeds factory of ICA.

The economical analysis of the inclusion of meal in the diet was based on the experimental results reported by Martínez (2009) with 4 treatments with different inclusion levels of Tithonia meal in integral diets (ID) combined with ground hay of Cynodon nlemfuensis grass:

T1 – ID with 20% ground hay of pasture (Control)

T2 – ID with 5% ground hay + 5% Tithonia meal

T3 – ID with 10% ground hay + 10% Tithonia meal

T4 – ID with 15% ground hay + 15% Tithonia meal

Integral diet components: maize, soybean, wheat bran, vitamin-mineral pre-mixtures, monocalcium phosphate, calcium and varying common salt percentages according to the treatments.

Treatments were evaluated from the sample of 80 dairy crossbred (H x Z) calves with average live weights of 40 ± 3 kg from 30 to 120 days of age fed milk from 30 to 60 days at a rate of 4 liters in two takings daily until weaning. Integral diets were supplied as solid feed ad libitum throughout the whole stage according to the treatments and water ad libitum.

The cost for each one of the experimental treatments was estimated using the cost data cards considering the fixed expenses, depreciation of facilities and the variables: salaries, feeding, medicine and others. The following economical indicators were estimated: cost/animal; cost/kg, cost/$, benefit/cost ratio and variable expenses/production value ratio and the financial indicators: gross margin per animal: GM = production value (incomes/animal) – direct cost/animal and economical profitability: P = gross margin (GM) + production value (incomes)/animal according to the methodology of Gargano *et al*. (1997).

As calculation basis for estimating salary expenses the information reported by IEA (2011) and the farm work time of the equipments and agricultural machinery according to IEA (2009) were used.

For the estimates were taken the mechanized and manual labor time and fuel expenses according to data published by Minaz (2002) and the Technical Patterns for using agricultural machinery (Minag 2011).

The Northamerican dollar (USD) was used as money standard.

Results and Discussion

Table 1 shows the cost data cards prepared to determine the sowing and establishment costs of *T. diversifolia* per ha. The analysis reveals a lower cost in favor of the sowing intended for grazing (499.66 USD) regarding the forage area (790.62 USD) which requires greater resource investments.

Traditionally the literature reports the use of this plant as forage species and Ramírez (2008) indicated establishment costs per ha in Tithonia higher than 1800 USD. Other cost reports on the promotion of forage species register an investment of 1388.00 USD/ha in Gliricidia sp. forage areas directed to meal production for animal feeding (Calle and Murgueito 2011). These authors indicate that establishment costs depend on culture density and the presence or not of perimetral fences. In the present study a low input sowing methodology was used without fertilizers, chemical products, irrigation or any other element making more expensive the culture.

The economical analysis of the forage cutting activity for meal production (considering 2.5 cuts in the dry season and 4 in the rainy season) recorded a range between 4.74 and 4.26 USD per t of fresh matter, while one ton of dry matter showed values between 14.94 and 17.07 USD. There were no records regarding forage cost in any other forage species. However, Medina *et al*. (2008) emphasized in that the economical importance of using the culture foliage as an alternative source for animal feeding will be closely linked to the production level and to its nutrient composition when it comes the time of selecting it.

The economical evaluation of meal production (table 2) shows an investment of 128.40 USD/t, while the total cost of one ton of the integral diet once mixed all components of the programmed diet with the meal for every one of the treatments was of $471.93 (T1), $500.49 (T2), $479.33 (T3) and $457.57 (T4).

Table 3 shows the economical result for each treatment including different levels of Tithonia in the diet for young calves from the performance of their main economical indicators. Treatments using meal evidenced the lowest levels in their costs per animal per kg LW and per live weight produced with the highest benefit/cost ratios regarding T1 (control), excepting T3 which revealed a decrease in the live weights of the calves (at 120 days old).

Treatment T4 registered the best performance in their unitary costs which have according to Peruchena (2004) a fundamental importance to evaluate the technological application costs and the potential of expected productive response, as well as its variable expenses ratio with a range of 58% expenses. This is also of special interest taking into account that it indicates the possibility of the system of covering their direct expenses with a lower utilization of their incomes and fulfills according to FONAIAP (1992) not to exceed 60% for the treatments employing meal.

The most frequent experimental studies are not with

Table 1. Analysis of the sowing and establishment costs of *T. diversifolia* (USD)

	Forage area				Grazing area			
	Salary	Fuel	Machinary	Others	Salary	Fuel	Machinary	Others
I. Land preparation								
Ploughing	10.94	29.16	612.00	-	10.94	29.16	6.12	-
Medium harrowing	4.00	10.28	3.42	-	4.00	10.28	3.42	-
Crossing	8.50	21.39	5.27	-	8.50	21.39	5.27	-
Thin harrowing	2.38	10.13	1.95	-	2.38	10.13	1.95	-
Plowing through	5.36	16.42	3.48		5.36	16.42	3.48	-
Sub Total	31.18	87.38	20.24	-	31.18	87.38	20.24	-
II. Sowing labors								
Seed cutting	38.40	-	-	-	12.80	-	-	-
Seed carrying	12.00	23.30	7.32	-	12.00	23.30	7.32	-
Manual sowing	92.16	-	-	-	30.72	-	-	-
Covering cultivator	3.12	9.25	2.21	-	3.12	9.25	2.21	-
Seed	-	-	-	405.00	-	-	-	135.00
Hand weeding	123.44	-	-	-	123.44	-	-	-
Sowing and establishment costs	237.94 $790.62	117.93	29.75	405.00	213.26 $499.66	119.93	31.77	135.00

Table 2. Cost analysis per t of *T. diversifolia* meal (USD)

	$/ha
Fresh forage (5.77 t)	$23.08
Moving field-dish	6.44
Forage turning and dish drying	34.94
Forage bagging	14.43
Milling of dry forage	46.29
Moving to ICA's Feed Factory	3.22
Cost/t Tithonia forage meal	128.40

Table 3. Analysis of the main economical indicators (USD)

Indicators	Treatments			
	T1 ID+20% hay	T2 ID+5 hay+5 % tithonia	T3 ID+10% hay+ 10% tithonia	T4 ID+15% hay+15% tithonia
Total expenses	15308.75	15200.29	14540.97	15146.37
Production value	23704.56	23967.36	22968.72	24598.08
Cost/animal	191.35	190.00	181.76	189.32
Cost/animal/d	2.12	2.11	2.01	2.10
Cost/kg	1.70	1.67	1.66	1.62
Benefit/cost ratio	1.55	1.58	1.58	1.62
Cost/$	0.64	0.63	0.63	0.61
Variable expenses/ production value	61 %	60 %	60 %	58 %

ruminants. However, it is important to highlight studies conducted by Restrepo (2005) in Colombia, Aguirre *et al*. (2006) and Hernández (2011) in México related to poultry, calf and rabbit feeding, respectively. These authors found that as the inclusion of Tithonia, Gliricida and mulberry foliage meal was increased, the costs/kg LW decreased. In the results of this paper, costs recorded for all treatments with the use of meal were lower to those reported by Anon (2012a) of 3.12 USD/kg in the rearing of lactating Holstein calves.

The financial analysis (table 4) illustrates that the system including Tithonia meal in the integral diet recorded the highest gross margins/animal which implies an efficient performance of their direct costs. In that regard, González and Klee (2003) found a direct correspondence between the incomes (production value) and the direct costs in livestock rearing. On this matter, Espinosa and Wiggins (2003) emphasized that in livestock production this indicator plays an important role since it contributes to increase the rate of capital rotation.

In the calf rearing activity it is important to value that the gross margin will be closely related to the commercialization process, that is, to the purchase-sale process of the animal (Álvarez 2012) and to the optimization of diverse factors (inputs, facility availability, management) linked to it, in order to obtain a gross margin that makes feasible a maintainable and sustainable livestock exploitation, in spite of the cyclic market variations (Valenciaga 2012).

The rising tendency of the percentage of profitability, although small, showed the potentialities of the use of foliage meal in the diets for young cattle. This indicator is of interest, since it represents the benefit obtained by the producer over the capital invested plus the production costs. It is recommended as an auxiliary means at the time of taking decisions on the gross margin not including the analysis of fixed costs (Saucedo 2012 and Quisigüeña 2012).

In the treatments assessed with the use of meal as element of the integral diet, a lower level in their direct costs was seen regarding those recorded in the control diet, due to a better utilization of the home resources in the composition of the animal diet and, in this way, a contribution to the substitution of imports and a saving in strong foreign currencies to the economy of the country.

Another aspect to be evaluated is the increase of the net income/animal as response to higher inclusion of meal in the diets, since from the economic point of view the intensification of the system is a factor contributing to the increase of the level of incomes per production unit (Cino *et al* 2011). Similar results were reported by Estupiñán *et al* (2009) in experiments using mulberry foliage meal in the fattening of pigs under confinement conditions.

In the economical and financial analyses carried out treatments with the addition of Tithonia foliage meal (T2, T3 and T4) showed the best indicators with respect to the control treatment (T1). However, treatment T4 displayed the greatest relevancy indicating the possibility of using up to 15% of inclusion in the integral diet for the lactating calf with promissory results in the performance

Table 4. Analysis of financial indicators per animal (USD)

Treatments	Direct expenses	Net income	Gross margin	Profitability (%)
T1	139.60	296.31	156.71	0.528
T2	138.32	299.59	161.27	0.538
T3	130.46	287.10	156.64	0.545
T4	137.67	307.47	169.81	0.552

of the productive indicators.

Results herein presented are preliminary and indicate the need of continuing further research, in order to exploit the possibilities of *T. diversifolia* as a way of using non-legume tree species, but with possibilities of contributing "in situ" to small and medium production scale as nutrient source with a lower economical investment and a rational use of the available home resources.

References

Aguirre, H.A., Ramírez, O., Pérez, J., Jiménez, R., Herrera, J., Hernández, J. & Hernández, A .2006. Rendimiento de una pradera de pangola y cambios de peso de becerros por efecto de la inclusión de harina de cacahuananche (*Gliricida sepium*) en el suplemento. Rev. Electrónica Vet. REDVET. Vol. II. No 11

Alonso, J., Ruíz, T.E., Fraga, G.A., Tuffi, L.D. & Arridne, R. 2012. Productividad de *Tithonia diversifolia* y comportamiento animal a diferentes momentos de comenzar el pastoreo. Evento I Internacional Agrodesarrollo 2012. Varadero. Cuba. p. 22

Álvarez, G.2012. Carta Tecnológica Agropecuaria: Aumentar la producción de carne. Available: <http: //www.ipcva.com.ar/files/ct10.pdf> [Cosultado: 20/9/2012]

Anon 2012. Producir terneros machos Holstein puede ser altamente rentable. En: Gaceta Reuter. INTA. Available <http://www.intainforma.intagov.ar/?p=316> [Consulted: 9/9/2012]

Anon 2012 a. Tecnología agroalimentaria. Ceba de terneros. Boletín informativo. Available <http://www.Serida.org/pdfs/1815> [Consulted: 9/9/2012]

Calle, Z. & Murgueito, E.R. 2011. El matarratón elemento de los paisajes tropicales: Proceso de producción de harina de matarratón a partir de bancos forrajeros. Carta Fedegan No 103. Centro de Investigación en Sistemas Sostenibles para la producción pecuaria (CIPAV). Available: <http;//proyectosfedegan.co/carta/carta Fedegan/103/por%20secciones/cf_103%20ambiente.pdf.> [Consulted: 28/9/2012]

Cino, D.M. & Díaz, A. 2011. Cattle fattening in Leucaena leucocephala: some economic and financial indicators for making decision. Cuban J. Agric. Sci. 45:7

Cino, D.M. & Ruíz, T.E. & Martínez, Y. 2012. Empleo de *Tithonia diversifolia* como harina de follaje en dietas integrales en alimentación de terneros lactantes: resultados económicos preliminares. En: Alternativas de alimentación no convencional del ganado. II Evento Internacional Agrodesarrollo. Varadero. Cuba. p. 46

Espinosa, J. & Wiggins, S. 2003. Beneficios económicos potenciales de tecnologías bovinas de doble propósito en el trópico mexicano. Rev. Técnica Pec. en México 4:19

Estupiñán, K., Vasco, D. & Torres, C. 2009. Evaluación de harina de forraje de morera (*Morus Alba*) en un sistema de ceba de porcinos en confinamiento. Rev. Tecnológica ESPOLRTE. 22:81

Fondo Nacional de Investigaciones Agropecuarias. 1992. Evaluación económica de sistemas mejorados de producción de leche de vaca Maute para la zona El Laberinto. FONAIAP. Estado de Zulia. Serie de Publicaciones Misceláneas. Venezuela. p. 52

Gargano, A.O., Saldungaray, M. & Anduriz, M.A. 1977. Parámetros físicos y económicos de los agrosistemas del partido Coronel Rosales. Rev. Facultad de Agronomía (Luz). Universidad de Zulia. Venezuela. p. 68

González, U. & Klee, G. 2003. Análisis económico de un sistema vaca-ternero en la pre cordillera. Informativo Agropecuario. Bioleche. INIA. QUILAMAPU. Boletín No. 52. Pp: 1-5.

Hernández, C.A. 2011. Utilización de la morera (*Morus Alba*) y Botón de Oro (*Tithonia diversifolia*) como reemplazo parcial del concentrado en conejos. Tesis Dr. Medicina Vet. Universidad Michoacana San Nicolás de Hidalgo. Facultad de Medicina Veterinaria y Zoología. México

IEA 2009. Informaçoes Estatísticas da Agricultura. Análisis Tarifas Salariales estimadas en Agricultura (USD). Anuario. Serie Apta. Brasil.

IEA 2011. Informaçoes Estatísticas da Agricultura. Análisis estimado Costos de Operaciones Maquinarias e Implementos Agrícolas (USD). Brasil.

Mahecha, L. & Rosales, M. 2005. Valor nutricional del follaje de Botón de Oro (*Tithonia diversifolia* (Hemsl) Gray) en la producción animal en el trópico. Livestock Res. Rural Dev. Vol.17. Artículo 100. Available <http://www.cipav.org.co/lrrd17/9/mahe17100.htm> [Consulted: 17/2/2009]

Mahecha, L., Escobar, J.P., Suárez, J.F. & Restrepo, J. 2007. *Tithonia diversifolia* (Hemsl) Gray (Botón de Oro) como suplemento forrajero de vacas F1 Holstein por cebú. Livestock Res. Rural Dev. 19(2)

Martínez, Y. 2009. Efecto de la inclusión de harina de *Tithonia diversifolia* en la dieta integral para terneros. Tesis de Maestría en Producción Animal para la Zona Tropical. Instituto de Ciencia Animal. La Habana, Cuba

Medina, M.G., García, D.E., Cova, L.J., Soca, M., Domínguez, C.E., Baldizán, A. & Pisar, P. 2008. Preferencias de rumiantes por el follaje de árboles, arbustos y herbáceas en la zona del estado de Trujillo. Zoot. Trop. ical 26(3):1-5.

Minag. 2012. Carta tecnológica agrícola. Ministerio de la Agricultura. La Habana. Cuba.

Minaz 2002. Normas técnicas para el uso de la maquinaria agrícola. Complejo Agroindustrial "Rubén Martínez Villena". Ministerio del Azúcar. Cuba

Mosquera, A., Hernández, A., Merlany, G. & Hernández, M. 2011. *Tithonia diversifolia* (Hemsl) Gray, planta multipropósito con potencialidades para las fincas integrales forestales. V Congreso Internacional Forestal de Cuba. In: <http://www.bva.fac.cu/pub_doc/FORESTALES/Revista%20Espec.%20202011/Tithonia%20diversifolia%20_Hemsl_%20Gray%20Planta%20Multipropósito%C3%93%20Con%20Potencialidades.pdf> [Consulted: 20/9/2012]

Premaratne, S.1990. Effects of non protein and fodder legumes on the intake, disgestibility, and growth parameters of buffaloes. Domestic buffalo production in Asia. Proceedings of the final research co-ordination meeting on the use of nuclear techniques to improve domestic buffalo production in Asia. Phase II. Pp. 20-24

Quisigüeña, F.J. 2012. Toma de decisiones gerenciales en base a costos. Gestiopolis. In: <http://www.Gestiopolis.com/recursos4/docs/ger/tubasecostos.htm>[Consulted: 20/9/2012]

Ramírez. 2008. Cultivo Botón de oro (*Tithonia diversifolia*). Empresa Agropecuaria Vetivernet. Colombia

Restrepo, A.M. 2005. Evaluación de la harina de hojas de Botón de oro (*Tithonia diversifolia* (Hemsl) Gray) en la alimentación de gallinas en periodos de postura. Universidad Nacional de Colombia. Sede Medellín. In: <http://www.agro.unalmed.edu.co/agrodocs/index.php?/link=verdocs&id=234> > [Consulted: 5/9/2012]

Ruíz, T.E. 2010. *Tithonia diversifolia* (Hemsl) Gray. Arbusto de interés para la ganadería. Informe Final de Proyecto. Programa nacional de mejoramiento de recursos filogenéticos. Instituto de Ciencia Animal. La Habana. Cuba

Saucedo, M. 2012. Relación Costo-Volumen-Utilidad. Gestiopolis. In: <http://www.Gestiopolis.com/recursos/documentos/full/docs/fin/costovolumenutilidad.htm> [Consulted: 20/9/2012]

Savón, L., Mora, L., M., Dihigo, L., Rodríguez, V., Rodríguez, J., Scull, I. & Hernández, Y. & Ruíz, T.E. 2008. Efecto de la harina de follaje de *Tithonia diversifolia* en la morfometría del tracto gastrointestinal de cerdos en crecimiento ceba. Zootec. Trop. 26:387

Valenciaga, R. 2012. Empleo del margen bruto como herramienta de decisión y control que condiciona la rentabilidad de la actividad. En: Cuestionario Agropecuario. In: < http://wwwslideshare.net/ramirovalenciaga.cuestionarioagropecuario.pdf> [Consulted: 20/9/2012]

Wambui, C.C., Abdulrazak, S. & Noordin, Q.2006. The effect of supplementary ura treated maize stover with Tithonia, Calliandra and Sesbania to growing goats. Livestock Res. Rural Devel. 18:64 In:<http://www.cipav.org.co/lrrd18/5/adu/8064.htm(20/9/2012)> [Consulted: 20/9/2012]

Received: December 13, 2012