Use of mulberry foliage for pigs in the integrated tropical systems

J. Ly[1] and Pok[2]

[1]*Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, Mayabeque, Cuba*
[2]*Centre for Livestock and agriculture Development (CelAgrid), Phnom Penh, Camboya*
Email: jly@ica.co.cu

An intense work of research was carried out in different areas of the tropics between 1993 and 2003. The investigation was about the use of shrub-like and arboreous foliage of mulberry (*Morus alba*) as a source of protein for feeding pigs. The mulberry can be used in the tropic as a permanent crop integrated to systems of animal production, mainly of swines. According to the existing information about the use of mulberry foliage for feeding growing/fattening pigs, the conclusion was that between 20 and 25 % of the total ration could be constituted by mulberry foliage. The age of cut and the management of the planting fertilization are among the factors that can influence on the response of the herd. Further researches should be required but, over all things, the implementation of the available results for increasing the efficiency of the systems of swine production through the integration of the tree component as an essential subsystem because there are already enough data that benefit the use of mulberry foliage for feeding pigs.

Key words: *pigs, mulberry, Morus alba, integrates systems, tropics*

From ancient times, human beings have used trees for feeding animals. However, sometimes the shrub and arboreous foliage is thought to be an exclusive food for ruminants, like cows and lambs, or for herviborous like rabbits and horses (Sánchez 1999). This is not completely true and the clearest example is the silkworm, which eats mulberry leaves only. For instance, in China, the humans learned, many centuries ago, to go from collecting wild mulberry leaves to cultivate them, improve them and harvest them systematically, like any other plant of feeding purposes (Tingzing *et al.* 1988).

Development

Advantages and disadvantages of forage trees for feeding pigs. The use of trees as a source of forage enriched with protein is always a really good option for feeding pigs because these tropical trees are locally available and there is no need of planting them more than one time after each harvest, and several have a high yield of green biomass (Ly 2004). Which are the disadvantages? Leguminous trees like leucaena (*Leucaena leucocephala*) or guazuma (*Guazuma ulmifolia*) do not supply very digestible forages for pigs due to the presence of very active antinutritional factors (Carvajal 2010), or they are less palatable like tithonia (*Tithonia diversifolia*) or gliricidia (*Gliricidia sepium*), which reduces considerably the acceptability and intake. Another disadvantage is that they can contain a lot of fiber, sometimes of difficult digestion for pigs, mainly when they are young. However, it is not a big problem for them, specially with mulberry, during the fattening stage (Osorto 2003, González *et al.* 2004, Araque *et al* 2005, Tepper 2006, Contino *et al.* 2008 and Phiny 2012), or for the breeding sows, mainly the pregnant ones (Muñoz 2003 and Contino *et al.* 2006).

Trees for cultivation. The tropical trees with the best results in pigs feeding have been, until this moment, the non leguminous trees, like mulberry (*Morus alba*) and the trichantera or nacedero (*Trichanthera gigantea*) according to tests performed with animals, and the moringa (*Moringa oleífera*) according to laboratory tests. In the case of the mulberry foliage, its content of nutrients is between 15 and 25 % of crude protein (N x 6.25), and between 15 and 20 % of crude fiber, in a biomass that, in a humid base, can contain between 25 and 35 % of dry material. The nutrient content of mulberry foliage can vary according to different factors, like, mainly, the age of the cut and the level of fertilization. According to studies carried out in Cambodia, the most used mulberry foliage for feeding pigs was the one of periodic cuts, every 90 days, in plantations fertilized with effluents from digestors filled with pig excretions (Phiny *et al*. 2009). A second variant also researched was the association of non legume trees with other leguminous, with the objective of having, mainly, consumables of N addition to soil, provided by the legume trees (Khieu 2005). Table 1 shows some characterisitics of the chemical composition of the type of mulberry foliage evaluated in Cambodia.

In the arboreous production for feeding pigs, the system used is the cut and transportation of green biomass. For the treatment of mulberry it is recommended to separate the leaves with their petioles and the tips of the branches, of the stems or the rachis. This strategy decreases the yield but elevates considerably the digestive usage. On the other hand, the stems could be used for feeding herviborous animals. This feeding strategy is supported by data from Pok *et al.* (2005), who demonstrated that the nutritional value of mulberry foliage was clearly superior when using young leaves, apicals, instead of basals, still in buds of 90 d (table 2).

Table1. Some characteristics of the content of nutrients in mulberry foliage (dry base)

Item	Range, %
Mineral matter	15-20
Crude fiber	15-20
Crude protein	15-25

Ly (2005, unpublished data)

Animal response. It is always advisable to serve grinded foliage when it is a green fresh material. It is also possible to produce meal through the drying of biomass in the sun for two or three days during dry seasons. Besides, the silage technique can be used to freshly preserve great volumes of harvested biomass. The use of molasses at 50 %, in the proportion of five partes per 95 of green foliage, can be a good recipe.

The Mexican researchers from Conkal and those from Aragua, Venezuela have possibly been who have evaluated more systematically the zootechniques of feeding pigs with mulberry foliage. Table 3 shows information about features of the behavior and the carcass of pigs fattened with variable levels of mulberry foliage meal.

Table 4 shows Mexican data related to the use of

Table 2. Physical and chemical characteristics of six tropical arboreous foliages, %

Leaves	N[1]	IVND	NDF-N	SOL-N
	Leguminous species			
Gliricidia				
Apicals[1]	4.31	45.28	19.11	47.45
Basals	4.08	33.72	21.92	38.60
Flemingia				
Apicals	4.04	22.52	42.94	41.62
Basals	3.82	16.99	50.65	21.17
	Non leguminous species			
Tricantera				
Apicals	3.74	32.08	49.81	42.56
Basals	2.98	28.15	66.18	26.18
Hibiscus				
Apicals	2.91	27.99	46.30	34.71
Basals	2.77	21.91	52.77	39.35
Moringa				
Apicals	5.23	57.51	12.05	61.86
Basals	4.80	30.87	16.97	57.71
Mulberry				
Apicals	4.95	63.36	34.99	65.23
Basals	3.60	29.09	45.03	29.31

[1] N: N content;
IVDN: *in vitro* digestibility (pepsine/pancreatine) of N
NDF-N: N connected to the cellular wall
SOL-N: N solubility in water
[2] Leaves (sheet and petiole) in branches from pruned trees every 90 d and fertilized with bio-digestor effluents
Source: Pok *et al* (2005)

Table 3. Features of the behavior and the carcass of fed pigs (20-90 kg) with variable levels of mulberry foliage meal

Indicator	Meal of mulberry foliage, %			
	0	10	15	20
Intake, kg DM/day	1.89	1.82	1.83	1.79
Weight gain, kg/day	0.715	0.687	0.674	0.738
Conversion of DM, kg/kg	2.64	2.65	2.71	2.43
Carcass yield, %	77.66	78.71	78.06	77.75
Dorsal fat, mm	23.5	20.7	16.5	15.2

Source: Osorto (2003)

Table 4. Feed intake in pregnant sows fed with mulberry forage *ad libitum*

Indicator	Mulberry meal *ad libitum*		
	AC	AC	AC, 75%
Intake, kg			
Commercial feed (CF)	205.20	205.20	153.90
Mulberry forage	-	46.44	45.47
Total	205.20	251.64	199.37
Thickness of the dorsal fat, mm			
Beginning of pregnancy	13.75	15.50	13.50
End of pregnancy	12.00	13.50	11.25
Difference	-1.75	-2.00	-2.25

Source: Muñoz (2003)

mulberry foliage offered *ad libitum* to pregnant sows.

Nutritional value. The studies of digestibility in pigs, from the first ones carried out in Cambodia (Ly *et al*. 2001 and Chiev Phiny *et al*. 2003) to the most recent performed in Cuba and in Cambodia (Caro and Ly 2012 and Phiny 2012), have demonstrated that the precaecal usage of nutrients, the N among them, is relatively high in the mulberry foliage, probably because of the low tenor of antinutritional factors. Young apical leaves of mulberry with branches of no more than 90 days, are very digestible for pigs (Pok Samkol *et al* 2005).

Conclusions

Mulberry is a non legume that can be used in the tropical areas as a permanent crop integrated to systems of animal production, mainly of pigs. According to the existing information about the use of mulberry foliage for feeding growing/fattening pigs and pregnant sows, between 20 and 25 % of the ration can be constituted by mulberry foliage. The age of cut and the handling of plant fertilization are among the factors that can influence on the response of the pig herd.

Further studies are required, as well as the implementation of the results in order to increase the efficiency of the systems of pig production through the integration of the arboreous component, as an indispensable subsystem. Meanwhile, there are already enough data that benefit the use of mulberry foliage for feeding pigs.

Acknowledgements

Thanks to Dr. Roberto Sanginés, from the Technological Institute No.3 of Conkal, México, for the valuable information provided about the use of mulberry for feeding pigs. Likewise, thanks are given to Dr. T.R. Preston, from the Fundación para la Producción Agropecuaria Sostenible, El Socorro, Colombia, for lending the facilities of the Fundación en Chamcar Daung, Cambodia, for the research developed between 1994 and 2003. This study would not be carried out satisfactorily without the optimistic and efficient collaboration of Dr. Carlos González in the facilities of the Faculty of Agronomy, Universidad Central de Venezuela, in El Limón, Aragua.

References

Araque, H., González, C., Pok, S. & Ly, J. 2005. Comportamiento productivo de cerdos en etapa de finalización alimentados con harinas de hojas de morera y tricantera. Revista Científica (FCV-LUZ), 15:517

Caro, Y. & Ly, J. 2012. Estudios de digestibilidad *in vitro* ileal (pepsina/pancreatina) y fecal de harinas de follaje de morera y tricantera. En: La Morera, un árbol multipropósito. San José de las Lajas, electronic version available in compact disc ISBN

Carvajal, J.I. 2010. Digestibilidad *in vitro* prececal y cecal de plantas forrajeras tropicales para la nutrición en cerdos. Master Thesis. Universidad Nacional de Colombia (UNAL). Palmira. Colombia

Contino, Y., Ojeda, F., Herrera, R., Altunaga, N. & Pérez, M.G. 2006. Algunas observaciones sobre el consumo de morera (*Morus alba*) fresca en cerdas reproductoras. Rev. Computadorizada de Producción Porcina. 13:39

Contino, Y., Ojeda, F., Herrera, R., Altunaga, N. & Pérez, M.G. 2008. Comportamiento productivo de cerdos mestizos en ceba alimentados con follaje fresco de *Morus alba* como sustituto parcial del concentrado comercial. Zootecnia Trop. 26:391

González, C., Ttepper, R. & Ly, J. 2004. An approach to the study of the nutritive value of mulberry leaves and palm oil in growing pigs. Rev. Computadorizada de Producción Porcina 11(suplemento 1):15-17

Khieu, B. 2005. Cassava foliage for monogastric animals. Forage yield, digestion, influence on gut development and nutritive value. Thesis Dr.Sci. SwedishUniversity of Agricultural Sciences. Uppsala, pp 55

Ly, J. 2004. Arboles tropicales para alimentar cerdos. Ventajas y desventajas. Rev. Computadorizada de Producción Porcina, 11:11-33

Ly, J., Chhay T., Phiny C. & Preston, T.R. 2001. Some aspects of the nutritive value of leaf meals of *Trichantera gigantea* and *Morus alba* for Mong Cai pigs. Livestock Research for Rural. Development, 13(3): Available: //www.cipav.org.co/lrrd/lrrd13/3/ly133.htm

Muñoz, C. 2003. Sustitución parcial de alimento comercial por morera (*Morus alba*) en la alimentación de cerdas gestantes, Aspectos técnicos y económicos. MSc. Thesis. Instituto Tecnológico Agropecuario No. 2. Conkal, pp 65

Osorto, W. 2003. Harina de morera como ingrediente de la ración alimenticia de cerdos en crecimiento y engorde.

Master Sci. Instituto Tecnológico Agropecuario No. 2. Conkal, pp 86

Phiny, C. 2012. Evaluation of some local forages (mulberry, sweet potato and taro) as feeds for smallholder pig production in Cambodia. Thesis Dr.Sci. HuéUniversity. Hué, pp 28

Phiny, C., Khieu B., Preston, T. R. & Ty, C.. 2009.. Effect of level of effluent from plastic biodigesters ,loaded with pig manure on the growth of mulberry (*Morus alba*) trees. Livestock Research for Rural Development. 21(7): versión electronic disponible in http://www.lrrd.org/lrrd21/7/phin21114.htm

Phiny C., Preston, T.R. & Ly, J. 2003. Mulberry leaves as protein source for young pigs fed rice based diets. Digestibility studies. Livestock Research for Rural Development, 14(6): Available: http://www.cipav.org.co/lrrd/lrrd14/6/phiny146.htm

Pok S., Bun Y., & Ly, J. 2005. Physico-chemical properties of tropical tree may influence its nutritive value for monogastric animal species. Rev. Computadorizada de Producción Porcina, 12:31

Sánchez, M.D. 1999. Comentarios generales. In: Agroforestería para la Producción Animal en América Latina (M.D. Sánchez y M. Rosales, editores). Estudios FAO de Producción y Sanidad Animal No. 143. Roma, p 363-365

Tepper, R.J. 2006. Comportamiento productivo de de cerdos estabulados y a campo alimentados con recursos alternativos. MSc. Thesis. Universidad Central de Venezuela. Maracay, pp 57

TingZing, Z., YungFang, T., GuangXian, H., HuaiXhoung, F. & Ben, M. 1988. Mulberry Cultivation. FAO Agricultural Services Bulletin No. 73/1. Roma, pp 127

Received: September 2013