Short communication

Inclusion of *Morus alba*, Linn. forage in Pelibuey sheep fattening in Cuba

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Abstract

Objective: To evaluate different inclusion levels of *Morus alba*, Linn. in the feeding of Pelibuey sheep, fattening category, in Guantánamo province, Cuba.

Materials and Methods: The unit was characterized through interviews to managers and workers and direct observation. The chemical composition of *M. alba* foliage was analyzed and its inclusion was evaluated. Thirty-two castrated sheep in good health were selected. Four groups were formed. Three groups were fed *M. alba* forage at 15, 20 and 25 % after grazing. The fourth group was not given forage (control). A randomized design was applied, with eight replicas. The data were analyzed by ANOVA and economic analysis was performed.

Results: *M. alba* foliage had a crude protein content of 22,4 %. The treatment with 25 % inclusion had the highest values for final weight (11,4 kg) and average daily gain (127,4 g). In the economic analysis, the 25 % treatment reported gain at slaughter of $129,8 kg/animal in national currency.

Conclusions: With the inclusion of *M. alba* as a supplement after grazing in fattening sheep, higher values of mean daily gain and weight gain at slaughter were obtained. The economic assessment indicated that the inclusion of this forage as supplementation is feasible to achieve higher profits, which were between 117,6 and 129,8 $/kg in national currency.

Keywords: weight gain, grazing, feeding supplements

Introduction

In Cuba, mainly in the Guantánamo province, animal husbandry does not meet the nutritional requirements of a growing population; in addition, the economic situation of the country makes it necessary to increase the production of animal foodstuffs (Herrera-Toscano, 2018).

Sheep production on the island is characterized by low and unstable productive yields, which lead to low levels of sales and consumption of this product at national scale (Herrera-Toscano and Carmenate-Figueredo, 2018).

Sheep play a very important role in the diets of the most vulnerable population, as a substantial part of the protein supply (Ganzábal *et al*., 2016). This animal species belongs to the group of small ruminants of economic interest. Its main function is to transform forages and grains into animal products (Avendaño-Rodríguez and Navarro-Ortiz, 2020).

In different rearing systems, protein forage banks are necessary, due to the contribution of protein, fat, minerals and fiber for maintenance and production (Fonseca-López, 2019). Therefore, it is necessary to apply and develop the program of forage plants of high nutritional quality. Among them, *Morus alba*, Linn. is compared to cereals and can substitute concentrate feeds in sheep production processes. This forage plant shows high production of edible biomass and is considered an interesting alternative in ruminant feeding to supplement low-quality forage diets (Martín *et al*., 2014).

M. alba has a high protein and energy content; moreover, it is used in several regions of the world (Mejía-Castillo, 2019). It is of good palatability and small ruminants avidly consume the fresh leaves and fresh stems, even if they have not been previously exposed to this forage. If the forage is offered to them whole, they may tear the bark off the branches (Manterola, 2014). The objective of this research was to evaluate different levels of inclusion of *M. alba* in the diet of Pelibuey sheep, fattening category, in the Guantánamo province, Cuba.

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Materials and Methods

Location. The research was developed in the dry season, from January to April, 2020, in the Base Enterprise Unit (UEB for its initials in Spanish), located between the coordinates 20.31911,-76.3629, with territorial extension of 70,73 km, belonging to El Salvador municipality, Guantánamo province.

Characterization of the sheep production system. The sheep production system of the UEB was characterized based on a survey carried out in this unit through interviews with its managers, workers and laborers. Tours were carried out in the permitted areas and direct observations were made to determine the total area of the unit, climate, soil, existing pastures and fodder, as well as the constructive state of the facility, live fences, body condition of the animals and health status, among other indicators.

Experimental design and treatments. A randomized experimental design was applied, with four treatments and eight replicas in a semi-intensive rearing system. The established treatments are described in table 1.

Experimental procedure. The *M. alba* forage came from a forage bank (3 ha) established in the entity, with a planting frame of 1,2 × 0,4 m and a density of 20 833 plants/ha on a carbonate soil, without irrigation or fertilization. The first cutting was done at one year of age and bromatological analysis was carried out to determine the nutrient content.

For the evaluation of the different levels of inclusion of *M. alba* forage, 32 castrated Pelibuey sheep were selected, in good health and previously dewormed. They were five months old and had an average live weight of 20,5 kg. Four treatments were formed, with eight animals each.

The feedstuff was supplied at a rate of 0,30 kg *M. alba*/animal/day for 15 %; 0,40 kg/animal/day for 20 % and 0,51 kg/animal/day for 25 %. Water was supplied *ad libitum*.

The sheep grazed eight hours a day, in a *Bothriochloa pertusa* (L) A. Camus (Indian bluegrass) pasture. Upon returning to the pen, in the afternoon, they were supplemented with *M. alba*.

Chemical composition. *M. alba* leaves were collected and 1,5 kg of fresh material was sent to the chemistry-physics laboratory of the Mountain Development Center (CDM for its initials in Spanish), where dry matter (DM) was determined in an oven at 50 ºC for 48 h, to obtain stable weight of the sample. Subsequently, the material was ground to determine crude protein (CP), calcium (Ca) and phosphorus (P), according to official method 967. 22 (AOAC, 2019).

Productive indicators. During the experimental period, live weight (LW), mean daily gain (MDG) and final weight were evaluated. The LW of the animals was recorded every 15 days to determine the mean daily gain (MDG, g/animal/day). For this purpose, the initial weight (kg) and final weight (kg) of the treatments were taken into account.

Economic assessment. The economic assessment of the inclusion of *M. alba* as supplementation for fattening sheep was carried out. The basic premise considered was the weight gain with the inclusion of this forage as supplementation for grazing sheep. The production cost of *M. alba* was calculated according to the values obtained with the inclusion of the different percentages and the weight of sheep in the market (Herrera, 2010).

Statistical analysis of the data. The data were statistically analyzed from a simple-classification ANOVA. Means were compared using Tukey's multiple range test for $p < 0,05$; when these variables met the normality and homogeneity of variance test. The statistical package Statgraphic Plus®, version 5.1, was applied.

Table 1. Description of treatments.

Group	Treatment
1	Grazing + inclusion of 15 % of *M. alba* forage
2	Grazing + inclusion of 20 % of *M. alba* forage
3	Grazing + inclusion del 25 % of *M. alba* forage
4	100 % grazing (control)

Table 2. Chemical composition of *M. alba* foliage, %.

Feedstuff	DM	CP	Ca	P
M. alba	22,8	22,4	1,8	0,24

Source: Physical-chemical laboratory of the Limonar Mountain Development Center, El Salvador, Guantánamo.

Results and Discussion

M. alba, used at the different inclusion levels, showed excellent nutritional quality (table 2), with high CP content (22,4 %), close to the value reported by Martín *et al.* (2014) and Alpízar-Naranjo (2014).

The protein content in this research was higher than that achieved by Martín *et al*. (2014), when determining the chemical composition of leaves and stems (20, 27 %). Gómez-Gurrola *et al.* (2017) and Espinosa-Reyes *et al*. (2019) state that the CP content is between 20 and 25 % and DM digestibility is higher than 80 %.

Zapatier-Santillan *et al*. (2021) state that the decrease in protein with harvest age could be related to the reduction in the synthesis of protein compounds and the increase in the synthesis of structural carbohydrates (cellulose and hemicellulose), although other factors, such as water availability and soil nitrogen, could influence this performance.

Table 3 shows the initial and final weight, as well as MDG of the animals with the different *M. alba* inclusions. The highest values for final weight were reached in treatments II and III, without significant differences between them, but differing from treatment I and the control.

The treatment with 25 % of *M. alba* fed to the animals achieved the highest values of weight gain and MDG. In both cases, they statistically outperformed the other variants. All treatments, when *M. alba* was included, showed higher values than the control for both indicators. In turn, when *M. alba* was included at 20 and 25 %, MDG was higher than 100 g/animal/day, considered very good for sheep.

Similar performance was obtained by Pacheco *et al.* (2002), who observed increasing LW gains in hair sheep, supplemented with progressive levels of *M. alba*, which varied from 0 to 100 %, and in all cases exceeded the control, with significant differences after 50 % inclusion.

Alpízar (2014), when evaluating the effect of supplementation with *M. alba* (M-1 %, M-0,75 % and M-0,50 %) and concentrate feed, on the MDG of confined Pelibuey sheep, found no statistical differences between the highest concentrations and the control.

Ganzábal (2016) and Martín-Martín *et al*. (2017) stated that increasing levels of *M. alba* forage in the ration (up to 1,5 %) produced an increase in the intake of the accompanying grass [*Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs]. In terms of conversion and weight gain, the best efficiency was obtained with the inclusion of the tree at 2,5 %. However, it was considered that 1,5 % optimized the role of the grass in the diet and nutrient absorption.

In semi-intensive systems, it is important to supplement with forage plants of high nutritional value to increase meat production, in addition to weaning the lambs at approximately four months of age and transferring them to the area for fattening, with the purpose of slaughtering the males at one year of age or earlier, with good weight and carcass quality.

It is economically viable to include *M. alba* as supplementation during the experimental stage, with a value ($ kg) of 0,18 in national currency (MN), according to international prices, although *M. alba* shows an additional cost in foreign currency of 0,37 USD/ kg (Alpízar, 2014). The production costs of the different levels of *M. alba* inclusion in kilograms offered during the experiment depended, fundamentally, on the use of labor force, agronomic components, cut and carry (Herrera, 2010). MDG and final weight were evaluated with regards to the control group and the price of sheep in the Cuban market (table 4).

M. alba had a cost in MN of 23,7 ($ kg) during the three months of the experiment. Table 5 shows the weight gain at slaughter and carcass weight, in correspondence with the price of sheep in the national market. The experimental groups showed

Table 3. Effect of different levels of *M. alba* inclusion on final weight and MDG.

Treatment	Initial weight, kg	Final weight, kg	Weight gain, kg	MDG, g
Control	20,5	24,5^{c}	4,1^{d}	45,6^{d}
I-15 % *M. alba*	20,5	28,4^{b}	8,5^{c}	94,4^{c}
II-20 % *M. alba*	20,5	31,5^{a}	11,0^{b}	122,3^{b}
III-25 % *M. alba*	20,5	31,9^{a}	11,4^{a}	127,4^{a}
SE ±		0,272	0,011	0,125

a, b, c and d: unequal letters in the same column differ significantly according to Tukey's test at p ≤0,05.
MDG: mean daily gain

Table 4. Intake and costs of *M. alba* in each experimental group.

Treatment I-15 % *M. alba*	Treatment II-20 % *M. alba*	Treatment-25 % *M. alba*	Total fresh *M. alba*
0,30 kg/animal/day	0,40 kg/animal/day	0,51 kg/animal/day	108,9 kg/day
Cost *M. alba* /animal, $/kg			
0,432	0,5886	0,7344	1,755
Final price of *M. alba* in MN, $/kg			157,95

Table 5. Weight gain with the different inclusion percentages and the price of sheep in the market.

Indicator	Treatment I-15 % *M. alba*	II-20 % *M. alba*	III-25 % *M. alb*a	Controls
Weight at slaughter, kg	28,9[c]	31,5[b]	31,9[a]	24,5[d]
Carcass weight, kg	14,2[b]	17,0[a]	17,0[a]	10,0[c]
Gain, $ kg	117,6	128,2	129,8	99,7
Sheep price, kg				
Price at slaughter, $/kg		15,0		
Carcass price, $/kg		75,9		

significant differences in treatments II and III compared with the control.

The treatments where *M. alba* was included as supplementation showed higher costs in MN with regards to the control (pasture). However, the inclusion of *M. alba* at 15, 20 and 25 % represented an economic gain of 117,6, 128,2 and 129,8 $/kg in MN for each sheep, respectively.

Conclusions

With the inclusion of *M. alba* as a supplement after grazing in fattening sheep, higher values of mean daily gain and weight gain at slaughter were obtained. The economic assessment indicated that the inclusion of this forage as supplementation is feasible to achieve higher profits, which were between 117,6 and 129,8 $/kg in MN.

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Conflict of interest

The authors declare that there is no conflict of interest among them.

Authors' contribution

- Nancy Noa Lobaina. Designed the research, worked on the set-up and evaluation of the experiment, wrote the scientific paper.
- Marisol Lafargue Savón. Wrote the scientific paper.
- Elba Lidia Castellanos McCook. Worked on the set-up and evaluation of the experiment.
- Alieski Meriño Mayné. Processed the statistical analysis and did the economic evaluation.

Bibliographic references

Alpízar-Naranjo, A. *Efecto de la suplementación con Morus alba Linn en la ceba de ovinos Pelibuey en estabulación*. Tesis en opción al título académico en Pastos y Forrajes. Matanzas, Cuba: EEPF Indio Hatuey, Universidad de Matanzas. https://1library.co/document/zw56p17z-efecto-suplementacion-morus-alba-linn-ovinos-pelibuey-estabulacion.html, 2014.

AOAC. *Official methods of analysis of he AOAC International*. Washington: Association of Official Analytical Chemists, 2019.

Avendaño-Rodríguez, V. A. & Navarro-Ortiz, C. A. Alimentación de ovinos en regiones del trópico en Colombia. *Rev. Sist. Prod. Agroecol*. 11 (2):71-108. https://revistas.unillanos.edu.co/index.php/sistemasagroecologicos/article/download/471/808/3023, 2020.

Espinosa-Reyes, Á.; Silva-Pupo, J. J.; Bahi-Arevich, Marisel & Romero-Cabrera, Dariannis. Influencia del tamaño de las plantas *in vitro* y tipo de sustrato en la aclimatación de *Morus alba* L. *Pastos y Forrajes*. 42 (1):23-29. http://www.redalyc.org/articulo.oa?id=269159592003, 2019.

Fonseca-López, Dania; Salamanca-López, Anyela E.; Niño-Monroy, Laura E.; Rodríguez-Molano, C.

E.; Hoyos-Concha, J. L.; Otero-Ramírez, I. D. *et al*. Caracterización nutricional y de producción de biomasa de *Sambucus peruviana*, *Sambucus nigra* y *Morus alba* en un banco forrajero. *Ciencia en Desarrollo*. 10 (2). https://revistas.uptc.edu.co/index.php/ciencia_en_desarrollo/article/view/9098, 2019.

Ganzábal, A., Ed. *Guía práctica de producción ovina en pequeña escala en Iberoamérica*. Montevideo: CYTED. https://inta.gob.ar/sites/default/files/inta-produccionovina_inta.pdf, 2016.

Gómez-Gurrola, A. del S.; García, G.; Sanginés-García, L.; Loya-Olguín, L.; Benítez-Meza, A. & Hernández-Ballesteros, A. Rendimiento en canal de corderos de pelo, alimentados con diferentes proporciones de *Tithonia diversifolia* y *Pennisetum* spp. *Abanico Vet*. 7 (2):34-42, 2017. DOI: http://dx.doi.org/10.21929/abavet2017.72.3.

Herrera, J.; Jordán., H.; Senra., A. F. Aspectos del manejo y alimentación de la reproductora ovina Pelibuey en Cuba. *Rev. cubana Cienc. agríc.* 44 (3):211-219. https://www.redalyc.org/articulo.oa?id=193015664001, 2010.

Herrera-Toscano, J. A. & Carmenate-Figueredo, O. Selección de recursos locales para La alimentación de ovinos en el municipio Las Tunas, Cuba. *Pastos y Forrajes*. 41 (3):176-182. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-03942018000300003&lng=es&tlng=es , 2018.

Manterola, H. *La morera una interesante alternativa forrajera para la ganadería mayor y menor en Chile*. https://www.produccion-animal.com.ar/produccion_y_manejo_pasturas/pasturas%20artificiales/44-morera.pdf, 2014.

Martín, G. J.; Pentón, Gertrudis; Noda, Yolai; Contino, Y.; Díaz, Maykelis; Ojeda, F. *et al*. Comportamiento de la morera (*Morus alba* L.) y su impacto en la producción animal y la crianza de gusanos de seda en Cuba. *Rev. cubana Cienc. agríc*. 48 (1):73-78. https://www.redalyc.org/articulo.oa?id=193030122016, 2014.

Martín-Martín, G. J.; Noda-Leyva, Yolai; Pentón-Fernández, Gertrudis; González-Ybarra, Niurca Martínez-Peréz, Madeleidy; Díaz-Solares, Maykelis *et al. Morus alba*, L. Una planta multipropósito para la producción animal en Cuba. *Revista Anales de la Academia de Ciencias de Cuba*. 7 (1):1-12. http://www.revistaccuba.cu/index.php/revacc/article/view/466, 2017.

Mejía-Castillo, H. J. La morera (*Morus* sp) como alternativa en sistemas silvopastoriles. *Rev. Iberoam. Bioecon. Cambio Clim*. 5 (9):1157-1160, 2019. DOI: https://doi.org/10.5377/ribcc.v5i9.7951.

Pacheco, D.; Lara, P. E. & Sanginés, R. Niveles crecientes de morera (*Morus alba*) en la ración de ovinos de engorda. *Memorias V Taller Internacional Silvopastoril y I Reunión Regional de Morera*. [CD-ROM]. Matanzas, Cuba: EEPF Indio Hatuey, 2002.

Zapatier-Santillan, D. A.; Meza-Bone, C. J.; Avellaneda-Cevallos, J. H.; Meza-Castro, Melanie T.; Vivas-Arturo, W. & Meza-Bone, G. A. Evaluación agronómica y valor nutricional de la morera (*Morus alba*). *Cienc. Tecn. UTEQ*. 14 (1):85-93, 2021. DOI: https://doi.org/10.18779/cyt.v14i1.447.