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Original

Behavior of Some Production and Economic Indicators of Pelibuey Sheep Fed Maize (*Zea mays.* L.) Silage

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ABSTRACT

Background: The Cuban economic hardships have made it necessary to raise food production. **Aim.** To demonstrate the effect of maize (*Zea mays.* L.) silage on the behavior of some production and economic indicators of Pelibuey sheep fed maize (*Zea mays.* L.) silage. **Methods:** The study took place at El Hoyo Sheep Farm, in Jimaguayu, Camaguey. A total of 40 ovine males were selected at random, at six months of age, and approximately 16 ± 0.5 kg, then they were distributed in two groups. One of the groups was administered the maize (*Zea mays.* L.) silage. The mean daily gain (MDG), feed consumption in the pen (CMS), and feed consumption while grazing, were calculated. The economic analysis was performed according to the fixed and variable costs. Data normality was corroborated through the Kolmogorov-Smirnov test. And SPSS, 21 for Windows (2012) was used for statistical analysis. **Results:** The production indicators of the sheep that consumed the maize (*Zea mays* L.) silage showed significantly higher values ($p \leq 0.5$) than the control group, reaching 23.3 kg at 60 days, and total increases of 7.2 kg, in terms of feed consumption and conversion. Concerning the economic side, there was a 12.2% increase over the costs of the process. **Conclusions:** The results demonstrated the positive effect of the maize (*Zea mays.* L.) silage administered to the animals.

Key words: consumption, gains, sheep (*Source*: *AGROVOC*)

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INTRODUCTION

The harsh economic conditions of Cuba call for the need of increasing food production considerably within the country as an effort to achieve food sovereignty, which is a top priority of the government and state authorities.

Hence, it is important to diversify farm productions to supply quantity and quality products to the people. In terms of animal foods, ovines are a significant source of meat, given the conditions of the country.

As stated by Arece *et al.* (2013), (p. 356), the Pelibuey breed has the best potential for meat production in Cuba, with a significant role for both the small-scale household economy and the large business sector.

However, ovine production poses a number of shortcomings that cause little and unstable yields due to the lack of feeds, medications, and, on many occasions, mismanagement that leads to poor use of the possibilities offered by this species.

In that sense, the implementation of crossbreeding programs of creole sheep with improved breeds still falls short. Besides, there is inappropriate sanitary management, though the quantitative and qualitative limitations are thought of as the main issue, and the one hardest to address (Aguilar *et al.*, 2017, p. 430).

The above shows the relevance of using feasible technologies to identify the resources available with a potential for animal nutrition and husbandry locally. Therefore, the concept of local resource is understood as a philosophy that might be defined as any resource obtained in a given area, which can be used for the benefit of the people (Mesa, 2017, p 3).

Among the nutritional alternatives internationally, maize *(Zea mays*. L) silage is highly used. Nevertheless, it poorly used by cattle farmers in Cuba, so there must be a change in the farmers' mindset as to the adoption of this technology. It offers high-quality feed supplementation during the dry season (Aguirre *et al.*, 2016, p. 78).

Accordingly, this paper aims to demonstrate the effect of maize (*Zea mays.* L.) silage on the behavior of some production and economic indicators of growing Pelibuey sheep.

MATERIALS AND METHODS

Location

This study took place at El Hoyo sheep breeding farm, in the municipality of Jimaguayu, Camaguey, belonging to the Maraguan Basic Production Unit, Company for the Protection of Wildlife. It extends over 75.7 ha, and its social goal is to raise and improve sheep. The farm has

600 breeding animals, which mate with the studs based on the three-parturition-in-two-year system between March and May. The experiment lasted 60, between September and November 2021.

Experimental procedure

A number of 40 six-month-old Pelibuey ovine males were selected at random, weighing approximately 16 ± 0.5 kg, and then they were distributed into two groups. The animals were under limited grazing conditions (4-6 hours), in areas dominated by natural gramineous *Botriochloa pertusa (L). A. Camus, Ann., Dichanthium caricosum (L). A. Camus, Bull* and *Sporobolus indicus (L). R. Br., Prodr,.* The rest of the time, the animals stayed in cubicles inside a thatch-roof house. Each experimental group filled a cubicle with sufficient vital room, and access to troughs with enough feed and water.

The feeds were supplied by the same person, always at the same time; a first ration was supplied in the morning (9:00), and the other in the afternoon (17:00). The two groups were given a base diet made of commercial feedstuffs (0.250 kg), gramineous plants, mineral and common salt at will, whereas the control fed Napier grass (*Cenchrus purpureus* Shum), and the experimental group consumed the maize (*Zea mays L.*) silage. The bromatological composition of feeds is shown in table 1. Drinking water was supplied *ad libitum.* The animals had a 15-day adjustment period prior to the experiment.

A dynamometer scale (50 kg and 0.2 kg accuracy) was used to weigh the animals. Weight measurements took place on days 0, 30, and 60 of the experiment, during the early hours of the morning, before supplying the feeds.

Table 1. Bromatological composition of the diet component (CALRAC, 1982)

Feeds	Bromatological composition				
	DM (%)	CP (g/kg DM)	ME (Mcal/kg)	Ca(g)	P (g)
Feeds for calves	87.00	219.00	2.91	12.00	12.00
Gramineous hay	75.60	69.00	1.80	5.60	2.40
Kin grass forage*	24.00	68.00	1.86	4.20	1.90
Native pasture	26.00	72.00	2.04	3.90	1.70
Maize silage**	42.60	78.00	3.42	5.30	1.85

*** Only supplied to the control group.**
**** Only supplied to the experimental group animals.**

Measurements

The mean daily gain (MDG) was calculated according to the formula below:

$$MDG = \frac{\text{Start weight (kg) - final weight (kg)}}{\text{Experimental days}}$$

The feeds consumed by each group in the pen (CMS) were calculated by subtracting the weight of the leftovers from the amount of feed supplied. Samples were collected from the feeds supplied and rejected, then they were dried in the sun to achieve constant weight and estimate the DM content.

The consumption while grazing was calculated according to the description of Pérez Infante (2003).

A stockpiling silo was used to silage maize (*Zea mays. L.*). Hence, the silage material had been in silos for over 60 days when it was supplied to the animals.

The financial analysis was done according to the fixed and variable costs, as described by Aguirre *et al*. (2016, p. 79). The fixed costs included the salary of the farm workers and the transport costs to the slaughterhouses. The variable costs included the silage costs, as well as cutting and transportation of fresh silage, mineral salts, and the plastic blanket for silage.

The formula below was used:

Total costs = Fixed costs + Variable costs

That way, the total costs were subtracted from the total income of the animal sales to the slaughterhouse, to obtain net profit.

Statistical analysis

Data normality was corroborated through the Kolmogorov-Smirnov test. The experiment relied on a completely randomized design to contrast the response variables where the start weights were regarded as co-variable, and fit to 16.66 kg. SPSS, 21 for Windows (2012) was used.

RESULTS AND DISCUSSION

As shown in table 2, the production indicators of the sheep that consumed the maize (*Zea mays* L.) silage showed significantly higher values ($p \leq 0.5$) than the control, reaching 23.3 kg at 60 days, with overall increases of 7.2 kg.

Table 2. Production indicators of Pelibuey sheep fed the maize (*Zea mays* L.) silage

Indicators	Treatments		SE	Sig.
	Control	Silage		
Start live weight (kg)	16.0	16.1	0.54	NS
Final live weight (kg)	21.4	23.3	0.68	**
Weight increase total (kg)	5.4	7.2	0.26	*
Mean daily gain (kg/animal/day)	90.0	120.0	0.10	**

Similar results were reported by Del Sol, (2018, p 29) when comparing the silage of maize (*Zea mays.* L.) with different Tithonia diversifolia and Pennisetum spp. proportions, supplemented with the fruit of guasima. Besides, Hernández *et al.* (2016, p. 215) reported similar responses in Jalisco, Mexico. However, the weight gains of both groups were lower than the ones reported by Toro *et al*. (2018) (p. 203), in Ecuador, which included the silage diet containing *Cenchrus purpureus* and maralfalfa, in grazing ovine herds, with 122 g/day gains.

The results observed are perhaps associated with the fact that the animals that consumed the silage had a better nutrient balance than the control, though the energy and protein contributions did not permit greater gains. Various papers mention positive responses in terms of weight gains and consumption using silage with different plant sources, such as soybean, maize, sunflower, sugarcane, and potatoes, (Ballesteros, 2018, p); (Martínez *et al*., 2015, p 5); (Núñez *et al*., 2019, p. 32).

Although no differences were observed in consumption between the groups, feed conversion was better in the animals fed silage, which means that they made better use of the nutrients consumed, probably due to improved balance in the diet, producing greater weight increases and daily gains (Table 3).

Table 3. Consumption and conversion in Group A and Group B in the period studied

Indicators	Group A	Group B	SE
DM consumption (g)	834.8	827.8	6.1643
Conversion (DM kg/gain kg)	8.9	11.1	0.6838

The consumption observed in the two groups was higher than the ones reported in Mexico (Mejías *et al.*2021, p. 4) in hair sheep, supplemented with Prosopis laevigata seeds. They were also higher than the values reported by Saavedra *et al.* (2020) (p. 37), in a study done in Colombia using stabled growing Pelibuey sheep, whose basal diet included liquid silage of peach residues (*Prunus pérsica.* L.), supplied freely.

Moreover, in Mexico, Hidalgo and Serralde (2016, p.) referred to higher consumption values in Pelibuey sheep stables on elevated flooring, which may be linked to the fact that besides maize (*Zea mays. L*) silage, it contained Moringa foliage (*M. oleífera Lamarck*).

The results from this experiment seem to confirm the findings of Yanti and Yayota, (2017, p. 70) who remarked the silage is a relevant choice to store feeds during the harvest seasons, to be supplied in times of shortages while maintaining their low-cost quality and palatability. It also permits a higher number of animals per hectare, and the replacement of feedstuffs, in addition to embracing intensive, semi-intensive, or stabled animal management. It is an excellent nutritional choice for livestock nationally, due to the great variety of forages that can be used, and the number of harvests in a year.

Another favorable element of silages (*Zea mays.* L.) is associated with the economic response. Table 4 shows the structure of supplementation costs using maize silage to feed Pelibuey sheep during the experiment.

Table 4. Costs of supplementation with the maize (*Zea mays* L.) silage to Pelibuey sheep

Fixed costs	
1. Transport	2000.00
2. Salary	7000.00
3. Subtotal (1+2)	9000.00
Variable costs	
4. Silage	20 000.00
5. Green forage	15 000.00
6. Other feeds	10 000.00
7. Polyethylene blanket	2 500.00
8. Electric power	550.00
9. Subtotal (4+..+9)	48050.00
Total (3+9)	57050.00

Under similar conditions, Sánchez *et al.* (2019) (p. 5) reported lower costs in stabled growing Pelibuey females in elevated flooring. Though the calculations were made with lower values than the ones used before the currency ordering in Cuba, in early 2021.

The income from the sales of animals to the Small Livestock Company (AGAME) in Camaguey is shown in table 5; the company pays 50.00 CUP.kg for live sheep.

Table 5. Total income (CUP)

1. Sale values	64000.00
2. Total costs	57050.00
Total income (1-2)	6950. 00.

Although the income was only 12.2% higher than the costs, the results are promising and can be improved through actions that ensure high maize yields, and the utilization of enhanced varieties that permit harvesting the cob for human consumption, while the rest of the plant is in silage with secondary cobs.

Vandermeulen *et al*. (2018) (p.774) noted that 40% of maize (Zea *Mays.* L.) produced in tropical countries is used for animal nutrition. Maize provides the highest conversion rate into meat of all the other grains used for the same purpose. Its high starch contents and low fiber make it an energy concentration source for the production of ovine.

CONCLUSIONS

The results demonstrated the positive effect of the maize (*Zea mays.* L.) silage on the production indicators of Pelibuey sheep, in terms of growth and economic feasibility.

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AUTHOR CONTRIBUTION STATEMENT

Research conception and design: CSF, LCCR, APP, OAR, WHV; data analysis and interpretation: CSF, LCCR, APP, OAR, WHV; redaction of the manuscript: CSF, LCCR, APP, OAR, WHV.

CONFLICT OF INTEREST STATEMENT

The authors declare the existence of no conflicts of interests.