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Research Article

# Effect of Silage of Ripe Totumo Fruit (*Crescentia cujete*) and Commercial Balanced on Weight Gain in Lambs of Hair, Caribbean Region, Colombia

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## Abstract

In order to evaluate the effect of silage ripe fruit of *Crescentia cujete* effect supplementation and commercial balanced, we compared the live weight and growth (GDP) between the lift and adulthood of cross haired lambs, Ovis aries, grazing tropical dry forest meadows (bs-T) Pinto, Magdalena, Colombia.

We used 24 Katadin x OPC (Colombian Creole) crossbred lambs in the lifting stage aged 120 days and subjected to grazing in a silvopastoral, randomly distributed in three groups challenged with the following treatments: T1: 25g of commercial balanced; T2: 100g of saline silage of totumo fruit, and T3: control group without supplementation. The experiment was divided into three stages, 1) 140 days 2) 160 days and 3) 200 days where it ended with the sale of the lambs; at each stage GDP was determined. Prior to statistical analysis, data were corrected for sex, type of delivery and age of the mother. GDP was analyzed between periods: 140, 160 and 200 days and the results were analyzed by ANOVA for a completely randomized design. The growth of the lambs was evaluated with the methodology of repeated measures over time. The initial (12.8kg) and final (26.99kg) live weight was similar in the three treatments ($P > 0.05$); however, GDP was higher in lambs supplemented with totumo saline silage after 160 days. Hence the importance of grazing lambs receiving locally sourced energy supplements, and processed by rural communities.

**Keywords:** *Ovis Aries*; Sheep; Haired Sheep; *Crescentia Cujete*; Saline Silage; Silvograzing

## Introduction

The worldwide distribution of sheep is focused on tropical and subtropical regions. In the world, the largest herd is on the Asian continent and America owns only 7.8% of the world's herd. In Colombia there is a low participation of the species in the livestock census, there are 1,500,000 sheep, the largest proportion (73%) are in the tropical plains of the Caribbean region, where this study was carried out [19,23].

The Colombian Creole sheep (OPC) called rams, were the result of crosses between wool sheep, brought from Europe in the sixteenth century, with the fur sheep or "camuros", of African origin; today OPCs are being crossed with fur sheep of breeds specialized in meat production. The rams in the Caribbean Region have been managed in extensive grazing systems in a mixed way with different ruminants (cattle, sheep, goats) taking advantage of the vegetable strata of the prairie, related to the consumption habits of each species; consuming improved and naturalized grasses, legumes and native shrubs. Eventually, they receive mineralized salts, and the water is consumed in jagüeyes or dams. Furred sheep are very hardy animals, which can survive and reproduce in areas with extremely high temperatures, low humidity and low food availability. Significant livestock contributions to rural families, contributing to livelihood acquisition in depressed economies [11-13,32].

The sheep sector in Colombia must face different barriers, which in one way or another have limited its technological and economic development. Represented by high input costs, high degree of parasitosis, poor nutrition and feeding, low investment and difficulty in marketing products [14].

One of the most significant problems in grazing conditions is the decrease in the quality and quantity of forage consumed during the dry season. The objective of this research was to evaluate the effect of energy-protein supplementation in cross-haired lambs grazing for seven hours a day, through two protein energy supplements, on post-weaning GDP.

## Materials and Methods

### Study area

The study was conducted at Finca la Florida, Caribbean region; Colombian low tropics, tropical dry forest plant formation (bs-T); subhumid agro-physical zone with relief of well-drained hills (Cv, Cu), warm climate, average temperatures of 28 ° C, relative humidity of 75% and annual rainfall of 1,100mm, clay loam soils [10]. Geographical coordinates, Latitude 9°27'31.00"N, Longitude 74°39'29.52"W, height at 28msnm. The test was carried out at the beginning of the light rainy season, between April 14 and June 30, on the farm where the animals were managed in a silvograzing with their parental herd, with goats and cattle.

### Experimental units and treatments

We used 24 lambs of hair in the lifting stage (Katadin x OPC), weaned at 120 days of age, with 12.8 ± 2.8kg of average live weight, which were registered by means of a necklace with a badge with their identification number. They weighed themselves at 7:00 a.m. on the initial day of the experiment with a 50kg watch scale, fastened with a harness one by one, and wrote down the initial weight. Then they were randomly grouped by sex and weight, in three groups identified with the letters A, B, C, the first two corresponded to the two treatments, and the third to the control group (T1: A-25g of commercial balanced; T2: B-100g of totumo saline silage; T3: C-witness, no supplement).

The commercial balance for fattening lambs, contained: PC 35%; gauze 2.0%; crude fiber 6.0%; ash 17.0%; MS 88.0%; FLN 28.0%; vitamins A, D3 and E, trace minerals: manganese, zinc, copper, iodine, selenium and cobalt.

The silage was prepared using the fleshiness of the ripe fruits of totumo and common salt (NaCl) added to 1%, stored in a sealed container for 30 days. The composition of silage in 100g was: 22.60% dry matter (DM); 93.35% *in vitro* digestibility of MS; 9.70% of PB; 9.96% lignin; 7.53% ash and 2900Kcal ME/kg DM.

### Facilities and equipment

The production system managed in the silvopastoral modality, the lambs at 10:00 a.m. went out with the whole flock to graze with a carrying capacity of seven sheep and goats per hectare (7/ha) in different physiological stages. It was established that at that time they dispersed less. Around 5:00 p.m., both sheep and goats returned, without the need for a shepherd and entered the corral where they rested until the next day. The lambs slept in community pen with the whole flock.

### Animal management and supplementation

Each day of the experiment, before 10:00 a.m., they were sorted and put into two pens with individual linear plastic feeders with 25 cm of space for each animal, where they were supplied with the ration of totumo silage or heavy commercial balancing with a portable digital scale of 40kg WeiHeng®, which they consumed in its entirety. They had no period of getting used to it.

### Live weight

It was determined by weighing the animals at the beginning of the experiment and later, at 20, 40 and 80 days (7:00 a.m. with fasting), for a final age of the lambs of 200 days. It was determined how many grams of weight the lambs increased per day in each of the stages according to formula: GDP period = (final weight - initial weight)/sampling days. Prior to statistical analysis, data were corrected for sex, type of delivery and age of the mother.

The three lots went out to the paddocks where a silvograzing is established. They had a great variety of trees that browsed, among them, totumo or jícaro or tecomate (*Crescentia cujete*), hobo (*Spondias mombin*), campano (*Pithecellobium saman*), guácimo (*Guazuma ulmifolia*), trupillo (*Prosopis juliflora*), dividivi (*Libidibia coriaria*), uvito (*Cordia alba*), and large number of cardones (*Opuntia spp* ), shrubs and vines that formed an open and scattered vegetation, with ground cover in colosuan grass or kikuyina (*Botriochloa pertusa*), and many annual and perennial noble weeds. They consumed mineralized salt voluntarily when they locked themselves in the pen. The water was consumed in jagüeyes when they went out to graze. A month earlier they had been dewormed with a dose of albendazole® corresponding to the weight of the lamb.

### Statistical analysis

The data obtained were captured and organized into spreadsheets and analyzed through.

- Descriptive numerical and graphical statistics [7,27,34]
- A completely randomized design to determine the effect of the type of feeding (A, B and C) on weight gain at each time stage (20, 40, 80 days), using the following model: Yij = **μ** + TAi + Eij; where: Yij = is the j-th observation under the ith treatment, **μ** = is the overall mean, TAi = is the

effect of the ith treatment, Eij = is the component of error; for the quantified variables they underwent the Shapiro-Wilk test to verify their normality and the Bartlett test to verify the homogeneity of variances [33].

- To determine differences between treatments, Tukey's test was used at5% significance [33]
- The growth (live weight) of the lambs was evaluated with the methodology of repeated measures over time with the following statistical model: Y ijk = μ + αi + β j + τk + eijk; where: Y*ijk* = Daily weight gain; μ = Overall average; αi = Effect of the ith week (time); βj = Effect of the j-th repetition; τk = Effect of k-th treatment (supplementation); eijk = Random effect of the variance.

Statistical analysis was performed using the R. program [31,33].

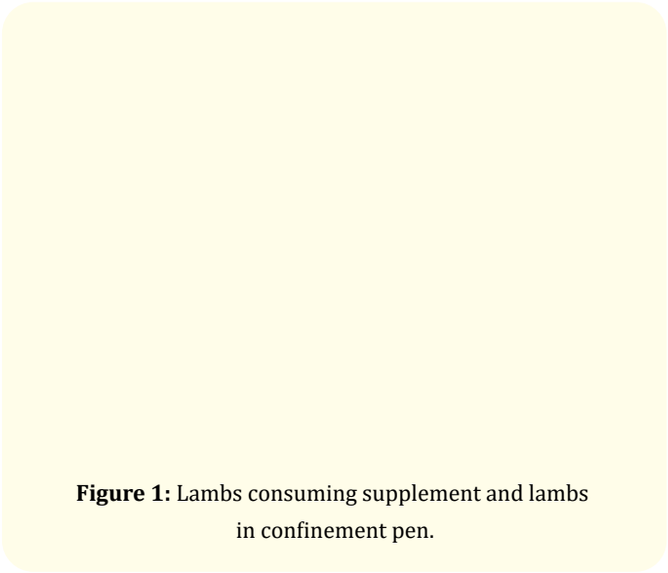

**Figure 1:** Lambs consuming supplement and lambs in confinement pen.

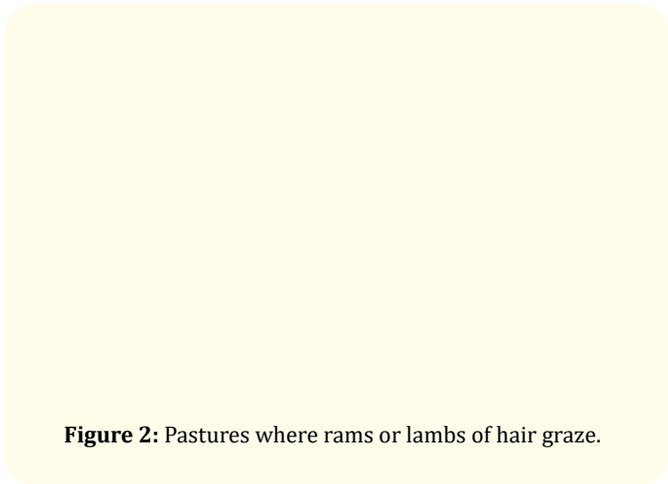

**Figure 2:** Pastures where rams or lambs of hair graze.

## Results and Discussion

At present, sheep production in tropical and subtropical areas is limited, among other factors, by poor nutritional and food management. Sheep must face in their short productive period, a rainy period where the food represented in plants is available for harvest, and a period of drought where food is scarce and dry forages are not suitable for an efficient rumination process. This situation results in the weight gain of the period of plenty being lost in the dry season, and even some lambs die. Itis necessary to propose alternatives or feeding strategies for the time of scarcity of fodder that allow to stabilize the production of food during the productive life of the rams, which would result in higher incomes for rural sheep farmers. The study presented here aimed to evaluate the effect of energy-protein supplementation through two foods on the daily weight gain after weaning cross-haired sheep, managed under silvopastoral conditions in a bs-T of the Colombian Caribbean region. To achieve this, two supplements were selected, one easily accessible in the area such as saline silage of ripe totumo fruit, and the other, commercial balanced for sheep, a protein feed, although difficult to achieve. The important thing was to challenge the rams to determine whether or not to make a strategic supplementation.

Next, it can be observed that the live weight at the beginning and end of the lifting stage of the 24 lambs of hair (Table 1) was similar in the three treatments (P > 0.05). However, daily weight gain was higher in lambs with treatment B (Figure 3) from 160 days of age.

| Stage | Treatment | N | Weight (kg) | D.E | Average weight (kg) |
|---|---|---|---|---|---|
| Beginning Experiment (120 days) | T1: A-25 g balanced | 8 | 12.99 | 2,50 | |
| | T2: B-100 g andnsilaje totumo | 8 | 13.55 | 3,61 | 12,84 |
| | T3: C-Witness | 8 | 11,99 | 2,08 | |
| 140 days | T1: A-25 g balanced | 8 | 17,85 | 3,27 | |
| | T2: B-100 g andnsilaje totumo | 8 | 18,06 | 3,18 | 17,49 |
| | T3: C-Witness | 8 | 16,56 | 2,22 | |
| 160 days | T1: A-25 g balanced | 8 | 21,71 | 3,85 | |
| | T2: B-100 g andnsilaje totumo | 8 | 22,56 | 3,09 | 21,55 |
| | T3: C-Witness | 8 | 20,36 | 2,09 | |
| Final Experiment (200 days) | T1: A-25 g balanced | 8 | 26,63 | 4,50 | |
| | T2: B-100 g andnsilaje totumo | 8 | 28,38 | 2,85 | 26,99 |
| | T3: C-Witness | 8 | 25,94 | 2,91 | |

**Table 1:** Live weight in kg of lambs of hair in the different stages in each of the treatments under study.

D.E: Standard deviation.

It has been considered that the weight gain of grazing lambs, in the absence of supplementation, may be low [3,6,8,24], in accordance with that obtained by the control group of this experiment. Many authors among them [1,9,28], agree that the use of strategic

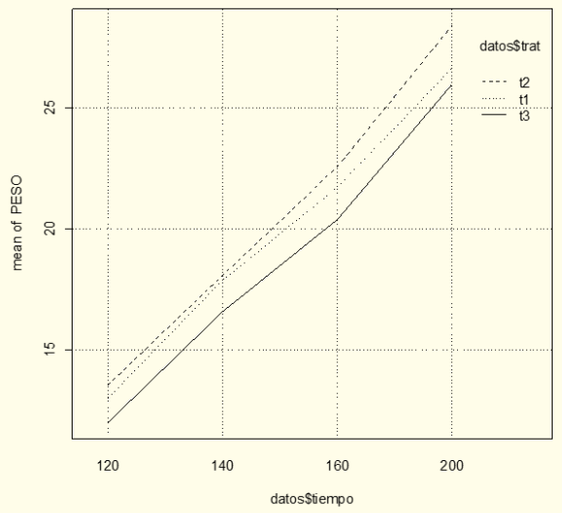


**Figure 3:** Live weight in kg for diet interaction x time.

supplementation in lambs improves weight gain and reduces the fattening period compared to those who only consume pastures, either in paddock or in stabling.

Table 2 and figure 4 show that there were no significant differences in the average daily weight gain at 140 and 200 years of age of the lambs. But, at 160 days of age, significant differences were shown at the 5% level in the diets of lambs fed totumo silage, who showed better average weight gain according to Tukey's test.

The increase in GDP due to the effect of supplementation has been indicated in many studies, especially when provided to animals at critical times [15,17,25]. In this study, GDP was higher than that reported by Maza., *et al.* [21], in lambs of the Sudan breed in the Colombian Caribbean region, with animal GDP of 29.36 ± 9.4g in non-supplemented lambs and 64.68 ± 8.1g in supplemented lambs. Also, superior in the study of Piaggio., *et al.* [28], in wool

| Time (days) | Treatments | | | ANOVA |
|---|---|---|---|---|
| | T1: 25g commercial balanced | T2: 100g ofand totumo saline nsilaje | T3: control without supplementation | p-value |
| 140 | 216,13 ± 33,77 a | 215,24 ± 50,17 a | 217,98 ± 32,88 a | 0,99 $^{ns}$ |
| 160 | 174,70 ± 29,67 b | 232,40 ± 59,8 a | 88,34 ± 21,98 c | 0,00 $^{*}$ |
| 200 | 140,86 ± 30,76 a | 166,25 ± 39,67 a | 159,36 ± 43,64 a | 0,41 $^{ns}$ |

**Table 2:** Numerical descriptive statistics (Mean ± Standard Deviation), analysis of variance and Tukey's test of GDP (g) of the different treatments at each stage of the study.

Mean ± standard deviation of the variables evaluated for each treatment; * Significant differences at p < 5%; ** Significant differences at p < 1%; ns: There are no significant differences at 5%.

lambs grazed in winter in Uruguay with a carrying capacity of 15 lambs/ha, and supplemented with grains, where weight gains between 94 and 103g/lamb/day were obtained. Also lower was that reported by Martínez., *et al.* [22], in West African lambs in Venezuela with GDP of 133.83g and 146.46g, in supplemented animals and 87.40g, in non-supplemented animals. However, GDP was similar to those found by Celso Villar., *et al.* [9], who supplemented wool lambs in corral with corn and oat grain and obtained GDP of 140g and 150g respectively, against the control group that only received hay and gained 110g/day.

Although this study did not measure the consumption of forage and foliage by lambs in the three groups, therefore, the effect of the supplement and fibrous feed cannot be differentiated; Although, if the evidence remains that the three experimental groups presented average gains of 176g/lamb/day, higher than those found by the authors cited above. It could be inferred the positive effect of silvopastoral systems on the performance of ruminants, according to what was found by Botero and De La Ossa [4], when they measured the performance of cattle in silvopastoral systems of the bs-T of the Caribbean region. According to a review carried out by Castillo-López and Domínguez-Ordoñez [6], by improving the energy-protein ratio, rumen microbial activity is favored, digestibility and the speed of passage of rumen content is increased and therefore the consumption of fibrous foods. De agreement, with Lira and Strauch [20], when making crosses in sheep for greater meat production, it is necessary to improve the diet both in grazing, as well as preserving fodder and giving supplements.

In this experiment the lambs of hair, which received the energy supplement represented in the silage of totumo, showed the best behavior of GDP; according to Piaggio [2009], toachieve high live weight gains in lambs, the energy concentration required should be high (2.8 Mcal ME/kg DM) and the crude protein concentration in a range of 14 to 18% Bw (BS). Celso., *et al.* [9] recommend that, at the time of separation of mother and lamb, foods with high energy concentration (4 Mcal ME/kg DM) should be provided, which will help them overcome the stress of weaning and make a successful transition to fibrous food rumination.

Regarding the performance of lambs that received a protein supplement (commercial balanced), it was lower than the other two groups, supplemented with totumo silage and those that did not receive supplementation, which coincides with what was reported by Piaggio., *et al.* [28] and Celso., *et al*. (2013), who suggest that protein balances do not stimulate rumination in animals that are in a grazing system, instead fibrous or energetic foods are very important, because they maintain rumination and saliva production necessary for the correct function of the rumen and its microorganisms.

Diets based on grains, commercial foods, and by-products have also been reported by other authors in the State of Veracruz, Mexico [30], Argentina [2,15], and Colombia [21]; and all agree with the judgment issued by Góngora-Pérez., *et al*. [16] and Muñoz., *et al.* [26], where the use of commercial feeds leads to dependence on external inputs in ruminant fattening systems, with a consequent decrease in profitability.

The growth (live weight) of the lambs was evaluated with the methodology of repeated measures over time (Table 3) and showed that diets and interaction time x diets had no significant differences. However, time was a factor that influenced the live weight of lambs and average daily weight gain (Figure 3).

In lambs, which have received tender pastures while being breastfed, from eight weeks of age, the development of the prestomachs reaches a necessary development to be able to resist weaning or separation from the mother, without suffering problems in their growth and development [5]. However, in dry tropic conditions, weaning is late, in the case of this work at 120 days due to the adverse conditions they face during lactation. For this reason, it becomes a stage of risk both for the welfare of the lambs, and for the productive performance. When lambs manage to overcome the stress of weaning, they successfully transition to fibrous feed rumination, and GDP increases, as evidenced in all three treatments.

| Sources of Variation | Degrees of Freedom | Sum of Square | Median Square | $F_{calc}$ (P-value)) |
|---|---|---|---|---|
| Diet | 2 | 59,79 | 29,76 | 0,90 (0,42) $^{ns}$ |
| Time | 3 | 2602,21 | 876,40 | 484,66 (0,00) ** |
| Error (A) | 21 | 691,98 | 32,95 | - |
| Diet x Time | 6 | 5,90 | 0,98 | 0,55 (0,76) $^{ns}$ |
| Error (B) | 63 | 112,75 | 1,79 | - |
| Total | 95 | 3472,63 | - | - |

**Table 3:** Analysis of Variance of the methodology of Repeated measures in time for the growth (live weight) of lambs.

*Significant differences at p < 5%; ** Significant differences at p < 1%; ns: There are no significant differences at 5%.

## Conclusions

Integrated production systems, with different species of ruminants, and diversity of grass and tree species, are a sustainable option from the social, economic and environmental dimension, for rural communities in Latin America.

When the Creole breeds of fur sheep are crossed with improved breeds to obtain greater meat production, it is necessary to use a strategic supplementation, which allows to strengthen the effect of the crossing and that translates into greater productivity.

Local food resources such as fruits and crop residues, which do not compete with human food, should be explored, as an energy option for the supplementation of minor ruminants as in the case of lambs, to achieve greater meat production, without increasing costs beyond the possibilities of rural producers.

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