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Rabbit Nutrition with Tropical Foliage and Sugar Cane

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ABSTRACT

The behavior of productive indicators was assessed in 45 growing Cuban Brown rabbits (498 g average mean weight), fed with tropical foliage and sugar cane stems. A completely random design was used, with three treatments and 15 repetitions: foliage of *Teramnus labialis*+sugar cane stem; foliage of *Ipomoea batata*+sugar cane stem; and foliage of *Phyla nodiflora*+sugar cane stem. The highest consumption of fresh foliage was observed in *Ipomoea batata (*269 g) and *Teramnus labialis* (205 g). Animal variants *Phyla nodiflora*+sugar cane had a basic consumption of sugar cane (144.87 g). The *Teramnus labialis*-sugar cane alternative produced the highest consumption levels of raw protein (9.32 g) and digestible energy (0.79 MJ). Live weight gains were observed between 10.46 and 16.96 g/d, and feed conversion between 4.06 and 5.23, similar in both indicators for *Teramnus labialis-sugar cane* and *Ipomoea batata*-sugar cane. Live weight gain was extremely low in the *Phyla nodiflora*-sugar cane variant, with the highest values observed for feed conversion. *Teramnus labialis*-sugar cane and *Ipomoea batata*-sugar cane may be used by rabbit breeders with lands for tropical foliage, and sugar cane in Cuba. The opposite was observed for P*hyla nodiflora*-sugar cane, which turned out little attractive for rabbit fattening.

Key Words: *rabbit nutrition, tropical foliage, sugar cane*

INTRODUCTION

Since the beginning of this millennium, Vázquez (2002) noted that Cuba needs to take quick steps into animal protein production increases, using methods that take up maximum use of local resources and little dependency on imported feedstuffs.

Today, animal feedstuffs face the complexities of grain production, especially soybean and corn, because humans are strong competitors. Breeders are concerned about corn prices and rises in production costs (Pérez, 2007).

Foliage of *Teramnus labialis, Phyla nodiflora* and *Ipomoea batata* have adequate chemical composition and digestibility of suitable nutrients, along with positive acceptability by rabbits (La O *et al.*, 2005), suggesting the possibility to evaluate them as staple sources of protein in alternative nutritional systems, without drying foliage or investing time and money in feedstuff production.

Sugar cane stems are well accepted by rabbits (Pérez, 2002), and they are rich in sucrose, glucose, fructose and raw fiber (Fundora, 2006), which turns it into an attractive energy source to fatten rabbits.

The purpose of this paper was to assess the productive behavior of fattening rabbits, using a nutrition system that combines *Teramnus labialis*, *Phyla nodiflora* and *Ipomoea batata* forages, as main sources of protein, and the sugar cane stem, as energy source.

MATERIALS AND METHODS

This research took place on the experimental farm, at the University of Guantanamo Agroforestry Faculty, in Cuba. Forty-five Cuban Brown rabbits weaned at 35 days of age, mean live weight of 498 g were used in the investigation for 45 days. The rabbits were placed at a rate of three animals per cage, using a completely random design to assess three nutritional variants for treatments: foliage of *Teramnus labialis* and sugar cane stems; foliage of *Ipomoea batata* and sugar cane stems; and foliage of *Phyla nodiflora* and sugar cane stems.

Each animal was considered a repetition for the variables: initial weight, final live weight and mean daily gain; and the averages of every cage for the variables: feed consumption and feed conversion.

The foliage and the sugar cane were administered at two different times (8:00 a.m. and 4:00 p.m.), in the sufficient amounts so the animals had free access 24 h a day. Adjustments in forage and sugar cane supplies were made based

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on the differences between supply and rejection. Water was supplied *ad libitum* and the drinking troughs were cleaned daily.

Foliage production was based on estimated daily and weekly consumption for every animal group, and the fresh and dried yields for each kind of pasture. Harvest was made between 45 and at 60 days of plant age. As a result, a strategy for gradual sewing on brown soil with carbonate was designed for foliage of *Ipomoea batata* in five 1 000 m^2 lots. *Teramnus labialis* and *Phyla nodiflora* foliage was grown in previously planted areas. In such cases, scaled up cuts were performed within each forage field. Feed samples were sent to the laboratory for determination of the bromatological composition.

Dry matter (MS), organic matter (MO), and raw protein (PB) contents were determined, based on the methodology described by AOAC (1995). Fiber fractionation was made according to Van Soest *et al.* (1991), calcium (Ca) and phosphorous (P) were determined, according to Herrera (1980), and raw energy was measured directly using an adiabatic calorimeter (Gallemkamp) made in Britain, whose values are shown in Table 1. A triple beam balance scale was used to weigh the feeds, with a range of 2 610 g.

Feed consumption was determined at the supply times, by difference between the amount supplied and rejection. Leaf, stem and integral foliage consumption was determined as well. To do that, a sample was weighed before the administration, then the leaf-stem ratio was determined, and in that way, the number of leaves and stems supplied were established. The rejection volume was weighed as a whole, and the leaves were separated from the stems for weighing.

Simple analysis of variance was performed to determine the effect of nutrition variants on the rabbit´s productive indicators. The mean values were compared by Duncan (1955) multiple comparison test.

RESULTS AND DISCUSSION

Fresh feed consumption is shown in Table 2. Fresh foliage consumption was related to palatability of foliage and its dry matter contents. Variant *Ipomoea batata*-sugar cane had was observed to have the highest consumption of fresh foliage (leaves+stems), with values of 269 g, followed by animals supplied with *Teramnus labialis*-sugar cane (205 g). The lowest consumption values ($P < 0.05$) were observed in the animals within the *Phyla nodiflora*-sugar cane variant (175 g). The consumption of fresh leaves had a similar trend to consumption of whole foliage, with the highest consumption values of *Ipomoea batata*, followed by *Teramnus labialis,* and the lowest values were observed in *Phyla nodiflora.* Regarding sugar cane stems, the highest consumption values ($P < 0.05$) were achieved in *Phyla nodiflora*, without any differences from foliage of *Ipomoea batata; Teramnus labialis* foliage was the least consumed.

It is important to note that the selection rate observed in the rabbits consuming fresh forage was more inclined to leaves of *Teramnus labialis and Ipomoea batata*.

Fresh sugar cane consumption by the animals in variant *Phyla nodiflora*-sugar cane was higher than by the animals in variants *Teramnus labialis*-sugar cane and *Ipomoea batata*-sugar cane.

Overall fresh feed consumption (foliage+sugar cane) had differences ($P < 0.05$) within the feeding variants, with values ranging between 318.74 and 404.14 g. The highest consumption values were observed in *Ipomoea batata*-sugar cane, and the lowest values were observed for the *Phyla nodiflora*-sugar cane variant.

Dry foliage consumption in *Teramnus labialis*-sugar cane was higher than in the other two variants (Table 3), due to higher contents of MS (18.54), regarding foliage of *Ipomea batata* and *Phyla nodiflora* analyzed in Table 1. The lowest MS consumption values were observed in animals within the *Phyla nodiflora*-sugar cane variant, with low MS content and less palatability than foliage of *Ipomoea batata* and *Teramnus lbialis*. Dry leaf consumption was also observed to be different ($P < 0.05$), within the three forages studied. The highest consumption was for *Teramnus labialis*, followed by *Ipomoea batata*, and then by *Phyla nodiflora.* Stem consumption had the highest consumption values for *Phyla nodiflora* and the lowest values, for *Teramnus labialis.*

It was corroborated that sugar cane consumption within the *Phyla nodiflora*-sugar cane variant caña was higher than the one observed for the animals with *Teramnus labialis*-sugar cane and *Ipomoea batata*-sugar cane.

Total MS consumption (foliage+sugar cane) had values that ranged between 54.81 and 68.80 g, the

Teramnus labialis-sugar cane variant was the one with the highest consumption, and *Phyla nodiflora*-sugar cane had the lowest MS consumption.

MS consumption corresponded to age and weight of animals, and was similar to the ones achieved by Bautista *et al.* (2002), who obtained 62.7 g of MS, by incorporating 20% Amaranth, as an ingredient in the diet for growing rabbits; as well as results achieved by Nieves (2002), with consumption of 58.57 – 74.36 g of MS, by incorporating 0 – 40% of *Leucaena leucocephala* in the diet for rabbits.

Nutrient and digestible energy consumption by the rabbits in the period studied (Table 4) is in concert with feed consumption and foliage nutritional composition. Variant *Teramnus labialis*-sugar cane was observed to reach the highest consumption values of raw protein and digestible energy, followed by *Ipomoea batata*-sugar cane, and then by *Phyla nodiflora*-sugar cane.

Raw protein and digestible energy consumption were low in the *Ipomoea batata*-sugar cane and *Phyla nodiflora*-sugar cane variants, with protein ingestion values ranging from 3.85 to 5.99 g/d, and digestible energy, between 0.67 and 0.69 MJ/d.

Raw protein and digestible energy consumption in relation to fattening rabbit requirements, according to González (1996) and Lebas (2004), in the *Teramnus labialis*-sugar cane variant, was 97% for raw protein, and 92% for digestible energy. The values for *Ipomoea batata*-sugar cane showed protein coverage of 62%, and digestible energy of 82%; the values for *Phyla nodiflora*-sugar cane showed that the raw protein was covered 40%, and digestible energy, 79%.

These results validate the sugar cane stems as an important energy source in rabbit diet, and point to the need of supplementing these feeding variants with richer protein and digestible energy sources, such as sunflower seed, that contains 20.50 % of PB, 34.4 % of lipids, and 22% of raw fiber, according to Ensminger *et al.* (1990),.

The highest consumption of FDN was for *Teramnus labialis*-sugar cane, in contrast to the *Phyla nodiflora*-sugar cane and *Ipomoea batata*-sugar cane. Consumption achieved for the three variants was higher than the rabbit needs, according to González (1996) and Lebas (2004), with 112.50 % for *Ipomoea batata*-sugar cane; 122.60 % for *Phyla nodiflora*-sugar cane; and 139 % for *Teramnus labialis*-sugar cane.

FDA consumption in the *Teramnus labialis*-sugar cane variant produced the highest consumption values, whereas variants *Phyla nodiflora*-sugar cane and *Ipomoea* batata-sugar cane had similar consumption values. In all the variants FDA consumption, according to González (1996) and Lebas (2004), was way higher than the rabbits´ needs, with values of 214, 218, and 244 % for *Ipomoea* batata-sugar cane, *Phyla nodiflora*-sugar cane, and *Teramnus labialis*-sugar cane, respectively.

FDN and FDA consumption behaviors are associated with high content of these components in the nutrients used in the feeding variants.

Table 4 shows that the feeding variants are insufficient to satisfy calcium and phosphorous needs, according to reports by González (1996) and Lebas (2004), between 0.86 and 1.41 g of calcium, and 0.51 and 0.81 g of phosphorous.

Viability was 100% in all the treatments, which demonstrates the innocuity of the new feeding variants for fattening rabbits.

Live weight at 45 days of fattening (80 days of age), was similar between the variants of *Ipomoea batata*-sugar cane and *Teramnus labialis*-sugar cane (Table 5), but it was lower for *Phyla nodiflora*-sugar cane, corresponding to the variant animals had the least consumption of nutrients; therefore, the least consumption of protein and energy.

Daily weight gain during fattening had no differences in variants *Teramnus labialis*-sugar cane and *Ipomoea batata*-sugar cane, which were higher than ($P < 0.05$) the values observed for *Phyla nodiflora*-sugar cane. The live weight values are the logical result of using the feeding variants, and are in correspondence with the nutrient consumption in Table 4.

The extremely low live weight gain with *Phyla nodiflora*-sugar cane is explained by the low MS consumption. Additionally, 60.34 % of MS ingestion was based on sugar cane, an important source of digestible energy; though it has low levels of protein and high levels of cell wall components that reduce its nutritional value. These results suggest that this feeding variant is not recommendable for rabbit breeders, and other protein and energy sources must be added to achieve better nutrient balance.

Mean live weight gain with *Teramnus labialis*-sugar cane is similar to 17.1 g/d achieved by Pérez (2002), with rations of corn kernels, sugar cane knots, and legume forage, and they are regarded as suitable by small and mid-size rabbit breeders in Cuba.

The best feed conversion values were achieved for *Teramnus labialis*-sugar cane and *Ipomoea batata*-sugar cane, with the best live weight gains, along with the highest consumption values of MS and raw protein. *Phyla nodiflora*-sugar cane had the highest feed conversion values, which is related to very low live weight gains in animals using that variant.

CONCLUSIONS

Teramnus labialis-sugar cane and *Ipomoea batata*-sugar cane variants favored adequate productive behaviors, which made them suitable for rabbit breeders with fields for protein forage and sugar cane. *Phyla nodiflora*-sugar cane was little attractive for rabbit fattening.

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Table 1. Nutrient and digestible energy contents in the feedstuffs

	Digestible energy and nutrients						
Feeds	MS %	PB %	ED MJ/kg de MS	FDN %	FDA %	Ca %	P %
Teramnus labialis	18.54	22.29	9.33	42.98	26.47	0.64	0.16
Phyla nodiflora	12.37	16.18	9.23	45.14	26.03	2.93	0.24
Ipomoea batata	12.40	16.49	8.23	25.95	20.29	0.56	0.23
Sugar cane stems	23.00	2.02	14.09	64.35	52.18	0.42	0.22

Table 2. Fresh feedstuffs in variants Teramnus labialis-sugar cane, Phyla nodiflora-sugar cane, and Ipomoea batata-sugar cane

Feedstuffs	Feeding variants			EE sig
	T. labialis-sugar cane	*P. nodiflora*-sugar cane	*I. batata*-sugar cane	
Leaves	172.63[b]	109.27[c]	196.37[a]	4.44**
Stems	33.05[b]	65.64[a]	62.19[a]	1.56**
Foliage	205.68[b]	174.92[c]	269.76[a]	3.42**
Sugar cane	133.43[b]	144.87[a]	134.38[b]	2.21**
Total	339.11[b]	318.74[c]	404.14[a]	4.09**

abc Values with different letters within the same row differ significantly P < 0.05 (Duncan, 1955)
**P < 0.01

Table 3. Dry feed consumption in Teramnus labialis-sugar cane, Phyla nodiflora-sugar cane, and Ipomoea batata-sugar cane

Feedstuffs	Feeding variants			EE sig
	T. labialis-sugar cane	*P. nodiflora*-sugar cane	*I. batata*-sugar cane	
Leaves	28.14[a]	12.42 [c]	23.23 [b]	0.59**
Stems	7.32[c]	9.42 [a]	8.54 [b]	0.27**
Foliage	38.11[a]	21.84 [c]	31.77[b]	0.51**
Sugar cane	30.69 [b]	33.07 [a]	30.91[b]	0.51**
Total	68.80[a]	54.81[b]	62.68 [c]	0.74**

abc Values with different letters within the same row differ significantly P < 0.05 (Duncan, 1955)
**P < 0.01

Table 4. Daily nutrient (g) and digestible energy (MJ) consumption per growing rabbit, under the three feeding variants

Nutrients	Feeding variants			EE ± Sig.
	Teramnus labialis-sugar cane	*Phyla nodiflora*-sugar cane	*Ipomoea batata*-sugar cane	
PB	9.32 [a]	3.85 [c]	5.99 [b]	0.13**
FDN	34.79 [a]	30.61[b]	28.09 [c]	0.36**
FDA	25.66 [a]	22.93 [b]	22.51[b]	0.29**
Ca	0.36 [b]	0.74 [a]	0.32 [c]	0.006**
P	0.13 [b]	0.13 [b]	0.14[a]	0.001**
ED	0.79[a]	0.67[c]	0.69[b]	0.001*

abc Values with different letters within the same row differ significantly P < 0.05 (Duncan, 1955)
*P < 0.05 **P < 0.01

Table 5. Growing rabbits´ productive behavior

Indicators	Feedstuffs			EE± Sig
	T. labialis-sugar cane	*I. batata*-sugar cane	*P. nodiflora*-sugar cane	
Initial weight, g	481.48	509.02	502.32	15.97
Final weight, g	1244.64[a]	1195.13[a]	972.88[b]	22.41**
Mean daily gain, g	16.96[a]	15.25[a]	10.46[b]	0.32**
Feed conversion g/g of MS	4.06[b]	4.11[b]	5.23[a]	0.21**

abc Values with different letters within the same row differ significantly P < 0.01 (Duncan, 1955)

** P < 0.01