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EFFECTS OF SUGAR CANE MOLASSES, RICE BRAN AND *LEUCAENA LEUCOCEPHALA* LEAVES ON DIGESTIBILITY AND PERFORMANCE OF GROWING RABBITS

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ABSTRACT

Two experiments were conduced to evaluate the rice bran (RB) and sugar cane molasses (SM) as energy feeds, with dry *Leucaena leucocephala* leaves (LL), in diets for growing rabbits. A total of 24 rabbits (77± 5 d age), weighting 2157 ± 46.1 g, were distributed in individual digestibility cages. A full random experiment design with 6 treatments and 4 rabbits/treatment were used. Treatments were: T_1 (0% SM and 50% RB); T_2 (12.5% SM and 37.5% RB); T_3 (25% SM and 25% RB); T_4 (37.5% SM and 12.5% RB); T_5 (50% SM and 0% RB) and T_t (100% commercial balanced food). The first 5 treatments also contained 49% dry LL and 1% mineral premix. Experimental period was 14 days (8 days of adaptation of diets and 6 days of recording data). The dry matter intake (DMI) was higher in T_t (135 g/d, P<0.05) respect to T_4 (82.4 g/d). Likewise, the apparent digestibility of crude protein was higher T_1 (85.9 %, P<0.001) with respect to T_t (56.9 %). From the first experiment, T_2, T_3 and T_t were selected to evaluate weight daily gain (WDG), DMI, feed conversion rate (FCR) and feeding cost (USD/kg live weight) in 45 rabbits from 40 to 110 days of age (3 rabbits for cage and 5 cages/treatment). Significant differences (P<0.05) were detected in all variables studied, WDG g (T_3 20.1 lower than T_t 50.4); DMI g/d (T_2 223 lower than Tt 294); FCR g/g (T_3 11.5 higher than Tt 5.9). In conclusion, the results obtained this work may be influenced by the low availability of crude protein that could be caused for heat damage on feed processing in evaluated diets.

Key Words: dry mater intake, *Leucaena leucocephala*, live weight gain, rabbits feeding, rice bran , sugar cane molasses

INTRODUCTION

One of the major limitations in the development of feed for rabbits is the source of energy used, especially in Venezuela where there are few grain surpluses. In this work it has been proposed to evaluate the nutritional quality of two raw materials available in the local market in the preparation of feed for birds and pigs by seasonal availability and high potassium content (molasses) or because of the low levels of monthly production and easily oxidized oils (Ambreen *et al.,* 2006). So, the aim was to evaluate the effect of different proportions of cane molasses and rice bran in extruded feeds as sources of energy on the production of rabbit in a growth phase, with the use of *Leucaena leucocephala* leaf meal as a source of protein, which has been evaluated on several occasions as part of diets for growing rabbits in Venezuela (Nieves *et al.,* 2008).

MATERIALS AND METHODS

Animals and experimental design

In the first experiment 6 treatments (Table 1) in a randomized design were used: T_1 (0% sugar cane molasses (SM) and 50% rice bran (RB)), T_2 (12.5% SM and 37.5% RB), T_3 (25% SM and 25% RB), T_4 (37.5% SM and 12.5% RB), T_5 (50% SM, 0% RB), all of them mixed with 49% of *Leucaena leucocephala* leaf meal without rachis and 1% vitamin-mineral premix, and Tt (100% commercial balanced feed, CBF). All the diets meet the nutritional requirements for rabbits (De Blas and Mateos, 2010). Twenty-four rabbits (77± 5 d of age), weighting 2157 ± 46.1 g were randomly assigned to the six diets (4 rabbits/treatment). Rabbits were housed in individual digestibility steel cages (36 cm wide, 36 cm long and 25 cm high), which had available capacity hoppers for 1.65 kg of feed and automatic drinkers. The experiment lasted 14 days (8 days of diet adaptation and 6 days of recording). Animals were offered 150 g of feed/d every day at 08:00 h. Faecal apparent digestibility of dry matter (ADDM), organic matter (ADOM), neutral detergent fibre (ADNDF) and crude protein (ADCP .- calculated by using the difference between the CP and the protein damaged by heat, HDCP, were determined). HDCP: acid detergent nitrogen content (Van Soest *et al.*, 1991).

Harvesting and processing of *Lecucaena* leaves was performed pruning the branches less than 5 mm of diameter of each of the selected trees, drying them in the shade for 48 to 72 hours and defoliating partially the dried material. Then, they were placed on trays and were dried in oven at 60°C for 24 hours, ground in a sieve of 2 mm, and stored in plastic bags for later use. The five treatments process was done by hand, using an electric mill for meat Bohia (2 HP) which allowed obtaining feed in granular form by following these steps: i) it was weighed each feed based on the proportions of the treatments ii) it was mixed the dry material, so that the mixture remained homogeneous, it was added molasses and premix vitamins and was estimated to add 30% water to the mixture iii) the wetted mixture was passed through the mill trying not to overload mixing to avoid heating the mixture and equipment iv) the pellets were placed in trays and introduced into the oven at 60 °C for 48 hours.

In the second experiment the best treatments from experiment 1 were selected (T_2 - 12.5% SM and 37.5% RB -, T_3 - 25% SM and 25% RB- and T_t -100% commercial balanced feed-) to evaluate weight daily gain (WDG), dry matter intake (DMI) and feeding costs in a completely randomized design, with 3 treatments and 5 replicates per treatment (3 rabbits 6 weeks old per experimental unit). A total of 15 experimental units and 45 rabbits of 682 ± 20.9 g/rabbit were housed in cages for fattening galvanized steel with the following dimensions: 50 cm wide, 43 cm long and 46 cm high with galvanized bins and automatic waterers. The rabbits were weighed at the beginning of the trial and then once a week for 8 weeks. WDG was determined per animal per cage (linear regression), feed intake (by difference between feed offered and feed refusals) power cost (opportunity costs of commercial feed and raw materials that were part of the ration used). The variables were analysed statistically by ANOVA using the Statistix software version 1.0 for Windows (1996). Means comparison were analysed by Tukey test.

Chemical Analyses

Procedures of AOAC (1984) were used to determine dry matter (DM) and ash. Crude protein (CP) was analysed by the method proposed by Bilbao *et al.* (1999). Acid detergent fibre (ADF) and neutral detergent fibre (NDF) by the method of Van Soest *et al.* (1991). Gross energy was measured by adiabatic bomb calorimeter.

RESULTS AND DISCUSSION

Diarrhoea was observed in treatments when molasses content in feed increased, spheres of faeces were smaller, less fibrous, and darker, without observing soft faeces. Table 2 shows that treatments had no effect on ADDM and ADOM (P >0.05). With respect to intake, Lebas *et al.* (1997) reported that the leaves of Leucaena can be used in rabbits' diets, with a feed intake around 111-113 g/d and ADDM of 60-63%. Values of feed intake were similar to those obtained in this study with T_1 and T_2, while ADDM values were lower than those reported by (Nieves *et al.*, 2008). In diets with higher rice bran and lower molasses content (T_1, T_2 and T_3) ADCP and ADNDF were higher than in the other groups. This could be related to the higher level of potassium rations with molasses that could increase the speed of passage and thus decrease the absorption of nutrients (Scott, 1953 and Briggs and Heller, 1943; cited by Findlay, 1983). Table 3 shows that CP values obtained are suitable for growing rabbits. The OM of T_2 was lower compared to the other two treatments, but the most striking feature is that it can be seen HDCP is very high in T_2 and T_3. This protein is not available to be digested by the digestive enzymes of the rabbit, so it has a low availability of amino acids to be absorbed. This may be related to the way of developing an experimental balanced diet, which consisted in dehydrate raw materials at 60 °C for 48 hours and then rehydrate to produce granules in a mill to flesh, according to Nouel *et al.* (2006), who evaluated different methods for feeding of rabbits with the same raw materials. ADF levels for T_2 and T_3 were greater than the optimum level to a balanced feed for growing rabbits (Gidenne *et al.,* 2002). It also occurred for the NDF of the three treatments, but with an advantage for the Tt where hemicellulose accounted for 35% of the total fibre, which is a digestible energy source in the caecum (Van Soest, 1994).

Table 1: Ingredients and chemical composition of diets

Ingredients, %	Diets					
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**Tt**
Sugar Cane molasses	0	12.5	25	37.5	50	0
Rice Bran (CP was 13.7%)	50	37.5	25	12.5	0	0
Leucaena foliage meal (CP was 35.9%, was removed after dried rachis)	49.0	49.0	49.0	49.0	49.0	0
Salt	0.25	0.25	0.25	0.25	0.25	0
Vitamins and minerals[1]	0.75	0.75	0.75	0.75	0.75	0
Commercial Balanced Feed[2]	0	0	0	0	0	100
Chemical composition, % DM						
Dry Matter (60ºC)	93.3	92.9	94.6	92.3	91.8	93.8
Neutral Detergent Fibre	53.4	47.2	40.5	36.1	31.9	52.1
Acid Detergent Fibre	23.8	21.1	12.9	19.5	18.8	16.9
Ash	8.5	8.8	8.8	9.9	10.3	15.1
Gross Energy (Mcal/kg DM)	3.83	3.80	3.78	3.75	3.73	3.74
Digestible Energy (Mcal/kg DM)[3]	2.39	2.38	2.36	2.35	2.33	2.34
Crude Protein (%)	24.4	22.7	21.0	19.3	17.6	13.7
Crude Protein Heat damaged (HDCP, %)	20.2	17.6	11.3	11.3	12.3	3.0

[1]Premix provided per kg: Thiamine, 1000 mg; Riboflavin, 300 mg; Pyridoxine, 200 mg; Cyanocobalamin, 700 µg; Niacinamide, 4000 mg; Folic acid, 3,5 mg; Choline, 3000 mg; Fe, 10 mg; [2]Ingredients of CBF (%): corn, corn bran , soy cake, minerals and vitamins, vegetal oil, sorghum, rice, rice bran , alfalfa hay, cotton cake. [3]Estimated according De Blas and Mateos (2010).

Table 2: Feed intake (g/d) and fecal apparent digestibility (%)

Diets	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**Tt**	**P-value**
Feed intake (g)	100±3.63^{bc}	118±6.54^{ab}	92.2±6.93^{c}	82.4±3.65^{c}	84.4±4.97^{c}	135.5±3.77^{a}	<0.001
ADMS	50.7±1.47	54.6±2.59	58.7±1.79	53.8±2.61	43.0±14.5	57.6±1.84	0.35
ADCP	85.9±1.17^{a}	74.9±2.90^{abc}	82.2±2.85^{ab}	60.4±4.68^{c}	62.6±10.1^{bc}	56.9±5.77^{c}	<0.001
ADNDF	67.6±1.37^{a}	61.1±2.33^{a}	58.7±1.99^{a}	48.7±2.76^{ab}	30.3±15.4^{b}	60.3±1.87^{a}	<0.001
ADMO	52.2±1.42	55.7±2.48	58.8±1.78	52.8±2.62	40.8±15.09	61.6±1.66	0.14

Apparent digestibility of dry matter (ADMS); Apparent digestibility of Crude Protein (ADCP.-determined by using the difference between the CP and the HDCP in the calculation.-); Apparent digestibility of neutral detergent fibre (ADNDF); Apparent digestibility of organic matter (ADMO). [a,b,c] - means with different superscripts are significantly different (P<0.05).

Table 3: Chemical Analysis of diets used in growing phase (%)

	DM (60 ºC)	*OM*	*CP*	*NDF*	*ADF*	*Ash*	*HDCP*
Tt	93.8	85.5	17.1	51.2	15.8	8.25	3.45
T_2	92.9	81.5	23.8	41.3	23.2	10.9	14.4
T_3	94.6	85.3	25.1	44.9	20.7	9.30	16.1

Dry Matter (DM), Organic Matter (OM), Crude Protein (CP), Acid Detergent Fibre (ADF), Neutral Detergent Fibre (NDF), Crude Protein Heat Damaged (HDCP).

The feed intake (Table 4) of the experimental diets (T_2 and T_3) were similar but lower than T_t, even though the three levels achieved were normal values for rabbits from 35 to 45 days (Lebas *et al.*, 1997). Weight gains were lower for treatments evaluated (approximately 6.9 g/animal/d) compared with T_t. This result should be directly related to the available protein of the experimental treatments, since only 9.2% was not damaged by heat or bound to fibre, resulting about 6.88 g of total CP rabbit per day, an amount which represents a third of the requirements for growing rabbits (Fraga, 1998), which limits the synthesis of muscle tissue during growth. CP source used, Leucaena meal, has the peculiarity of tannins that present significant content of polyphenols .-mimosine.- (Wheeler *et al.*, 1999), substances that can produce links to sugars, cell wall components and proteins, which decreases the ability of digestion by digestive tract enzymes. The low WDG of the control can be related to the high fiber content of CBF. Feeds employees have an opportunity cost of 560, 544 and 678 USD/kg DM for T_2, T_3 and T_t, respectively, in its craft production or acquisition in the market. However, the feed cost per kg live weight produced was high for all cases evaluated, although proposed rations was significantly higher than T_t, which is associated with an inefficient feed conversion achieved using high fiber rations (low energy density) and low amount of protein available. Although, the most limiting factor in conversion of feed into meat was the CP deficit for T_2 and T_3.

Table 4: Effect of treatments on biological and economic traits

	T_2	T_3	Tt	P-value
Initial weight, g	674.8±30.4	690.9± 42.4	682±37.7	0.953
Final weight, gt	1173±48.0^b	1160±48.5^b	1857±49.3^a	<0.001
Feed Intake, g/d/cage	223± 6.3^b	226±8.0 ^{b}	294±2.9 ^{a}	<0.001
Live weight gain, g/d/cage	21.3±0.41^b	20.1±0.53^b	50.4±0.76^a	<0.001
Feed Conversion Ratio, g intake/g gain	10.5±0.23^b	11.5±0.92^b	5.80±0.30^a	<0.001
Cost USD/kg live weight gain	3.66±0.08^a	3.90± 0.31^a	2.46± 0.13^b	<0.001

^{a,b,c} - means with different superscripts are significantly different (P<0.05).

CONCLUSIONS

In conclusion, from the five evaluated combinations of molasses and rice , the greatest intake and nutrient digestibility were obtained for T_2 and T_3 (12.5 and 25% molasses and 37.5 and 25% of rice bran, respectively). Diets assessed in growing phase (T_2 and T_3) did not improved the commercial balanced feed effect on productive performances nor the feed opportunity cost.

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Leucaena foliage meal (CP was 35.9%, was removed after dried rachis)	49.0	49.0	49.0	49.0	49.0	0
Salt	0.25	0.25	0.25	0.25	0.25	0
Vitamins and minerals[1]	0.75	0.75	0.75	0.75	0.75	0
Commercial Balanced Feed[2]	0	0	0	0	0	100
Chemical composition, % DM						
Dry Matter (60ºC)	93.3	92.9	94.6	92.3	91.8	93.8
Neutral Detergent Fibre	53.4	47.2	40.5	36.1	31.9	52.1
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Rice bran

Leucaena leucocephala

Experimental pellets

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CONCLUSIONS

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Leucaena leucocephala