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Intake and digestibility of rations with distillery yeasts byproducts, molasses and ammoniated sugar cane tops in lambs in total confinement

Consumo y digestibilidad de raciones con levaduras de destilería, melaza y cogollo de caña amonificado en corderos confinados totalmente

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ABSTRACT

Were evaluated sodium bicarbonate- F_1 - and urea- F_2 - (two factors), each factor at two inclusion levels (F_1 and F_2 : 0 and 1%), and its effect on intake and digestibility in rations with byproduct of the fermentative process of starches and / or molasses (mixture of yeast and unfermented material)-LD-, sugarcane molasses and ammoniated sugar cane tops for lamb. Eight crossbred lamb (19.31±5.96 kg/lamb) was included in a 2x2 factorial in a 4x4 Latin square design. Treatments were combinations of LD (14% in T_1 , 13.8% for T_2 , T_3 and T_4) and molasses (26% in T_1 , 25.8% for T_2 , T_3 and T_4), with or without urea, and / or sodium bicarbonate to 1% w/u, and source of fiber were used 60 % of ammoniated sugar cane tops in all treatments. The supply of rations was gradually adjusted to 7% dry matter (DM) of body weight (28±8.66% rejection of the offer), digestibility was measured by total collection for seven days adaptation period preceded of seven day. Differences ($p<0.01$) for intake where intake had the highest T_2 and T_4 the lower (1239 vs 1066 gDM/animal/day) in the digestibility of organic matter ($p<0.01$) were found where T_4 reached one 72% while the T_2 was the lowest with 57.35%. The coefficients of digestibility of hemicelluloses, acid detergent fiber, neutral detergent fiber and were different ($p<0.01$) and were higher in the same T_1 . The results showed that T_4 was the best treatment, urea and sodium bicarbonate can be used effectively with agro-industrial byproducts in lambs in confinement.

Keywords: Lambs, distillery yeast, sodium bicarbonate.

RESUMEN

Se evaluaron nivel de bicarbonato de sodio- F_1 - y nivel de urea- F_2 -, cada factor a dos niveles (F_1 y F_2 : 0 y 1%) de inclusión, y su efecto sobre el consumo y digestibilidad en raciones con subproducto del proceso fermentativo de los almidones y/o de la melaza (mezcla de levaduras y material no fermentado)-LD-, melaza y cogollo de caña para corderos. Ocho corderos mestizos (19.31±5.96 kg/animal), fueron incluidos en arreglo factorial 2x2 con diseño en cuadrado latino 4x4. Los tratamientos fueron combinación de LD (14% para T_1 , 13.8% para T_2 , T_3 y T_4) y melaza (26% para T_1 , 25.8% para T_2 , T_3 y T_4), con o sin urea y/o bicarbonato de sodio al 1% c/u., como fuente de fibra se utilizó 60% de cogollos de caña amonificado en todos los tratamientos. Oferta de raciones se ajustó gradualmente hasta 7% de MS del peso vivo (rechazo 28±8.66% de lo ofrecido), digestibilidad se determinó por colección total, durante siete días, precedidos por siete días de adaptación. Se encontraron diferencias ($p<0.01$) para consumo donde T_2 presento mayor consumo y T_4 el menor (1239 vs 1066 gMS/animal/día), la digestibilidad de la materia orgánica ($p<0.01$) donde T_4 alcanzó 72% mientras que el T_2 fue

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el menor con 57.35%. Los coeficientes de digestibilidad de fibra ácido detergente, fibra neutro detergente y hemicelulosa fueron diferentes ($p < 0.01$) y los mismos fueron superiores en T_1 . Resultados obtenidos demostraron que T_4 fue el mejor tratamiento, y el bicarbonato de sodio puede usarse eficientemente con los subproductos agroindustriales en corderos en confinamiento.

Palabras claves: Corderos, Lavaduras de destilería, bicarbonato de sodio

INTRODUCTION

The rearing of post-weaning lambs requires balanced diets capable of maintaining weight gains that facilitated attaining the weight at the time of slaughter or the first service quickly (1,2), at a competitive feeding cost and preferably using readily available resources locally (3,4). For the year 2014 in Venezuela, 102,877 hectares of sugarcane were harvested, obtaining 6,483,755 tons of cane, of which 367,000 tons of molasses were extracted (5).

Likewise, according to the same source, for the same year 2014, 232,528 sheep were slaughtered, with a yield of 16.00 kg/carcass, which generated 3,718 tons of carcass meat. From harvest sugar cane, between 411,508 and 514,385 tons of dry matter of buds can be obtained (own calculations according to data collected in Lara State, Venezuela), with an average of 89.7% of dry matter, 5.1% of ash, 3.7% crude protein, 78.2% fiber insoluble in neutral detergent, 40.7% fiber insoluble in acidic detergent and 11.54% lignin (6). When the fibrous by-products of sugar cane are dry-ammoniated (using the moisture of the fresh vegetable), it is possible to increase the availability of nitrogen in the plant material and release the components of the lignin cell wall (7,8) improving the nutritional value for ruminants, increasing the intake of dry matter and the digestibility of the cell wall (8).

Most of the sheep assets of Venezuela are located in the province of dry sub-humid to humid, which is characterized as follows: altitude 511-921 meters above sea level, average temperature between 25 and 27°C, precipitation 663-805 mm (mm), evapotranspiration 1,186- 1,274 mm, humidity deficit of 0-637 mm, dry months of 4 to 11, highly seasonal according to Andrade-Benítez (9), in the states of Lara, Falcón and Zulia (10), with strong limitations for the production of fodder throughout the year (11).

The liquor industry uses molasses and / or cereals, not suitable for human intake to make drinks such as rum, whiskeys among others, as a by-product of the fermentative process of starches and / or reducing sugars of molasses is a mixture of yeast and unfermented material of interest in animal feed, especially in sheep and lambs, whose composition on dry basis can vary from 89.1 to 94.2% of DM, 25.4 to 49% of CP, 8.9% of EE, 41.8 to 42.7% NDF, 3.95 to 5.6% of ashes (12, 13, 14). Due to the need to offer rations that can cover the nutritional requirements of weaned lambs, which are exploited in dry areas, it was proposed to evaluate locally available resources, such as: sugar cane harvest residues mixed with brewer's yeast, molasses, urea, and / or sodium bicarbonate to determine its effect on the intake of rations and its digestibility in lambs confined after weaning.

MATERIALS AND METHODS

Location. Animal Production Research Unit (UIPA), Experimental Shed in Small Ruminants, Agronomy Deanship of the Lisandro Alvarado Centroccidental University, (UCLA), Palavecino Municipality, Lara State. The average annual climatic data of the area are: temperature of 25°C, precipitation of 812.6 mm, relative humidity of 74.6%, solar radiation of 371 cal cm⁻² and evaporation of 2,084.9 mm and a height of 550 meters above sea level (15). The experiment was carried out from the month of June to the month of December.

Animals, management and treatments. Combinations of yeasts (byproduct of the fermentative process of starches and / or molasses.-mixture of yeast and unfermented material.-) of liquor factory and sugarcane molasses, with urea and / or 1% sodium bicarbonate (Table 1), in a completely random 2x2 factorial arrangement in a 4x4 Latin square design (Table 2). Two factors were evaluated: sodium bicarbonate level-F₁- and urea level-F₂-, each factor at two levels: F₁ in 0 and 1%; F₂ at 0 and 1% of inclusion, each treatment was a complementary part of the ration offered at a rate of 40% of the total dry matter, the other 60% of the dry matter of the ration was an ammoniated sugar cane tops.

Statistical model: factor I. level of sodium bicarbonate with two (2) levels, factor II: level of urea with two levels, y_{ijk} being the answers for the k-th experimental unit of level I of factor I and j of factor II

$$y_{ijk} = \mu + T_i + \beta_j + \gamma_{ij} + \epsilon_{ijk}$$

with $i = 0, 1$; $j = 0, 1$ and $k = 1, 2, 3, 4$

With the hypotheses:

$$H01 \gamma_{ij} = 0 \forall i, j$$

$$H02 T_i + \bar{\gamma}_i = 0 \forall i$$

$$H03 \beta_j + \bar{\gamma}_j = 0 \forall j$$

Determining the nutritional quality of these mixtures, taking samples of forages and raw materials that were analyzed to determine dry matter, crude protein, energy and ash by the methods described by the AOAC (16) and fractions of the cell wall, as insoluble fiber in neutral detergent and acid, and hemicellulose by the methodology described by Van Soest et al

(17). As well as the intake and digestibility in sheep described by Nouel-Borges et al (3), with the use of 8 young animals (2 per treatment and per period) crossbreed West African, 19.31 ± 5.96 Kg Initial Live Weight (LW), an average metabolic weight (MW, LW^{0.75}) of 9, 58±0.14 kg during the experiment, in four experimental periods of 14 days each, with 7 days of habituation and 7 days of observation to make the measurements of intake and feces of 24 h, for a total of 56 days (3), controlling the experimental period and the animals (Table 1), determining the food intake and the apparent digestibility of the nutrients when they receive a base ration of ammoniated sugar cane tops (18). For the analysis of all the variables described, the software Statistix for Windows version 8.0 (19).

Table 1. Composition of the Experimental Treatments Used.

Ingredients (%)	Experimental Rations			
	T ₁	T ₂	T ₃	T ₄
Molasses	14	13.8	13.8	13.6
Yeast	26	25.8	25.8	25.6
Urea	0	0	0.4	0.4
Sodium bicarbonate	0	0.4	0	0.4
CCA	60	60	60	60

CCA: Ammoniated sugar cane tops

The percentages that represent each one of the raw materials used for the elaboration and composition of the experimental rations are presented in Tables 2, 3 and 4. The combination of molasses and yeasts, in a proportion of 35% Molasses and 65% yeast, comes from a pre-test performed just before the experiment, where 12 combinations of molasses and yeast were tested, to achieve the best way to preserve the agro-industrial by-product, stabilizing it at a pH of 4.55 (initial of 4.62, after 6 weeks of weekly measurements, June-July) and with the minimum loss of energy in the pre-mix. The agro-industrial by-product was collected in a stainless steel tank of 10,000 liters, at the outlet temperature of 84°C, it was allowed to cool to room temperature for 24 hours, 90% of the supernatant liquid was extracted by siphons on the surface and the Tank bottom (1000 liters) was collected from a lower valve in a 250 liter plastic tank, to be processed later. Due to the acidity of the pre-mix, it is decided to propose the incorporation of sodium bicarbonate as a pH modulator in the rations evaluated.

Table 2. Arrangement and Experimental Design.

Animal	1	2	3	4	5	6	7	8	
PERIODS	1-14	T ₁	T ₁	T ₂	T ₂	T ₃	T ₃	T ₄	T ₄
	15-28	T ₄	T ₄	T ₁	T ₁	T ₂	T ₂	T ₃	T ₃
	29-42	T ₃	T ₃	T ₄	T ₄	T ₁	T ₁	T ₂	T ₂
	43-56	T ₂	T ₂	T ₃	T ₃	T ₄	T ₄	T ₁	T ₁

Table 3. Composition of the Evaluated Treatments.

Bromatological Composición	Treatments			
	T ₁	T ₂	T ₃	T ₄
DM (%)	83.41	67.22	82.51	90.62
OM (%)	71.98	55.85	72.20	79.51
GE (Mcal/g)	3.87	3.75	3.85	3.85
CP (%)	16.48	16.35	16.14	18.73
NDF (%)	59.26	60.07	51.67	56.47
ADF (%)	40.15	41.84	37.65	39.97
Hemicell(%)	19.11	18.23	14.02	16.50

DM: Dry matter, OM: Organic matter, CP: Crude protein, GB: Gross energy, ADF: Fiber insoluble in acid detergent, NDF: Fiber insoluble in neutral detergent. Hemicell: Hemicellulose

Table 4. Composition of raw materials.

Bromatological Composición	raw materials		
	Yeast	Molasses	CCA
DM (%)	82.63	14.74	73.5
OM (%)	62.88	66.54	68.3
GE (Mcal/g)	3.75	3.76	3.31
CP (%)	2.99	50.97	7.3
NDF (%)	--	42.74	56.9
ADF (%)	--	24.86	39.9

CCA: Ammoniated sugar cane tops

The animals received the rations in individual pens, they had water to freedom in each pen, with cement floor and roof, and the feeders were 0.5 m long and 10 kg capacity and an area of 1.5 m² for each animal. At the beginning of the afternoon (12:00 m), a well-known amount of ammoniated sugar cane was offered, uniformly mixed with the ration emphasizing that treatments previously dehydrated, were offered to the animals. For the dehydration process of the mixtures, a handmade coffee dryer was used, subjecting the mixtures to temperatures that oscillated between 60-80°C for a period of time of 24 hours. In the same way, the intake was measured daily by the difference between what was offered and what was rejected in the feeders at the same time of the afternoon, maintaining a 5% excess in the feeders (in order to guarantee intake to freedom), for the weighing was using an electronic scale with a capacity of 4 kg and 1 gram of appreciation. The animals were dewormed 3 months before the test (at weaning) and the dose was repeated once it was started, moxidectin was placed in a 1% solution for injection (Cydectin®), at a rate of 0.5cc / animal subcutaneously.

The sugarcane tops were chopped in a chopping machine (2.5 cm in length), then dry ammoniated, using pearl urea, at a rate of 3 Kg per 100 Kg of sugar cane tops (7,18), without adding water because the bud possessed more than 40% moisture. In order to facilitate the ammonification, the material was mixed with the urea and stored in black polyethylene bags, eliminating excess air and sealing them.

RESULTS

The highest DM intakes, cell wall components (NDF, ADF, hemicellulose) and CP reached (Table 5) were higher for T₂, with the highest OM intake for T₄. With an apparent digestibility of dry matter and similar energy for all treatments, greater OM digestibility for T₄ and T₃, greater cell wall digestibility (NDF) and hemicellulose for T₂, higher digestibility of ADF for T₄ and T₂, and a greater digestibility of the CP for T₄ and T₁. In general, T₂ presented the highest intake with the best overall performance of fiber digestion. But the T₄, with a lower intake in DM per kg of MW and a higher intake of CP, the digestion of OM was the highest, as well as that of ADF and CP, with an intermediate level of digestion of the wall cellular (NDF).

Table 5. Analysis of Variables for intake and digestibility by treatment.

Variables	Tratamientos				P
	T ₁	T ₂	T ₃	T ₄	
DM (g) intake	1059.5 ^b	1239.3 ^a	1111.5 ^{ab}	1065.7 ^b	0.0145
OM (g) intake	758.81 ^{ab}	696.55 ^b	808.49 ^{ab}	843.09 ^a	0.0105
NDF (g) intake	624.72 ^b	749.18 ^a	578.59 ^b	598.78 ^b	0.0000
ADF (g) intake	423.26 ^b	521.82 ^a	421.60 ^b	423.82 ^b	0.0002
Hemicell(g) intake	201.46 ^{ab}	227.36 ^a	156.99 ^c	174.96 ^{bc}	0.0000
CP (g) intake	173.73 ^b	203.91 ^a	180.73 ^{ab}	198.60 ^{ab}	0.0228
Urea intake (g)	0.00 ^b	0.00 ^b	4.48 ^a	4.24 ^a	0.0000
Bicarbonate intake (g)	0.00 ^b	2.84 ^a	0.00 ^b	2.48 ^a	0.0000
MW intake gDM/kg ^{0.75}	118.18 ^{ab}	139.08 ^a	124.72 ^{ab}	105.63 ^b	0.0013
MW intake gCP/kg ^{0.75}	18.00 ^b	20.69 ^a	18.33 ^b	20.24 ^a	0.0000
ADDM (%)	36.98 ^a	37.88 ^a	34.94 ^a	39.35 ^a	0.4828
ADOM (%)	67.96 ^a	57.35 ^b	66.39 ^a	72.00 ^a	0.0000
DNDF (%)	30.88 ^{ab}	37.11 ^a	26.00 ^b	30.70 ^{ab}	0.0161
DADF (%)	25.62 ^{ab}	31.26 ^a	22.46 ^b	31.74 ^a	0.0090
DHEMICELL (%)	53.65 ^{ab}	56.30 ^a	43.35 ^b	26.33 ^c	0.0000
GEDIG (%)	33.06 ^a	31.33 ^a	30.38 ^a	35.31 ^a	0.3851
ADCP (%)	51.91 ^a	42.88 ^b	42.17 ^b	57.15 ^a	0.0000

MW: metabolic weight. ADDM: Apparent Digestibility of Dry Matter, ADOM: Apparent Digestibility of Organic Matter, DNDF: Digestibility of Neutral Detergent Fiber, DADF: Digestibility of Acid Detergent Fiber, DHEMICELL: Digestibility of Hemicellulose, GEDIG: Digestible Energy, ADCP: Apparent digestibility of crude protein. Different letters in the same row indicate significant differences (a, b and c).

When analyzing the independent effects of the factors of the arrangement, Table 6, it can be seen that for the 1% bicarbonate factor, it showed the highest values for intake of cell wall components (NDF, ADF, hemicellulose) and protein and apparent digestibility of NDF, ADF and CP; being similar 0 and 1% for intake and apparent digestibility of DM, OM and digestible energy. Urea factor at the 0% level presented the highest values for intake of cell wall components (NDF, ADF, hemicellulose) and for the apparent digestibility of NDF and hemicellulose; being the level 1% of the factor Urea superior in intake of OM and apparent digestibility of the OM and CP. There was an interaction effect between the Bicarbonate and Urea factors for DM, NDF, ADF and apparent digestibility of OM, hemicellulose and CP.

Table 7 shows the results based on eight observations per treatment and expressed every 14 days that was the time of change between each treatment of the arrangement, where clearly the best weight gain was that of T₄, followed by T₁ and the worst T₂ and T₃, the daily intake of DM was higher for T₂ and T₃ (Table 5), although no differences were detected when globalizing it every 14 days, to make it related to the weight gain in the same period and obtain the conversion. But it gives a very approximate idea to confirm that the best conversion can be that of T₄.

Table 6. Analysis of Variables for intake and digestibility by factors evaluated and inclusion levels.

Variables	Sodium Bicarbonate		P	Urea		P	Interaccion
	0%	1%		0%	1%		
DM (g) intake	1085.5 ^a	1152.5 ^a	0.1591	1149.4 ^a	1088.6 ^a	0.2010	0.0082
OM (g) intake	783.65 ^a	769.82 ^a	0.6722	727.68 ^b	825.79 ^a	0.0030	0.1393
NDF(g) intake	601.66 ^b	673.98 ^a	0.0074	686.95 ^a	588.69 ^b	0.0003	0.0526
ADF(g) intake	422.43 ^b	472.82 ^a	0.0080	472.54 ^a	422.71 ^b	0.0087	0.0112
Hemicell(g) intake	179.23 ^b	201.16 ^a	0.0062	214.41 ^a	165.98 ^b	0.0000	0.6174
CP (g) intake	177.23 ^b	201.26 ^a	0.0028	188.82 ^a	189.67 ^a	0.9154	0.4402
Urea intake (g)	2.24 ^a	2.12 ^a	0.3285	0.00 ^b	4.36 ^a	0.000	0.3285
Bicarbonate intake (g)	0.00 ^b	2.66 ^a	0.000	1.42 ^a	1.24 ^a	0.4406	0.4406
MW intake g DM/kg ^{0.75}	111.37 ^b	117.31 ^a	0.0203	117.87 ^a	110.81 ^b	0.0059	0.0000
MW intake g CP/ kg ^{0.75}	18.16 ^b	20.47 ^a	0.0000	19.34 ^a	19.28 ^a	0.8905	0.3678
ADDM (%)	35.96 ^a	38.58 ^a	0.2019	37.40 ^a	37.15 ^a	0.9001	0.3853
ADOM (%)	67.18 ^a	64.67 ^a	0.1916	62.66 ^b	69.20 ^a	0.0007	0.0000
DNDF (%)	28.44 ^b	33.91 ^a	0.0215	34.00 ^a	28.35 ^b	0.0176	0.7442
DADF (%)	24.04 ^b	31.50 ^a	0.0011	28.44 ^a	27.10 ^a	0.5493	0.4188
DHEMICELL (%)	48.50 ^a	41.32 ^b	0.0188	54.97 ^a	34.84 ^b	0.0000	0.0014
GEDIG (%)	31.72 ^a	33.32 ^a	0.4582	32.19 ^a	32.84 ^a	0.7642	0.1250
ADCP (%)	47.04 ^a	50.01 ^a	0.1189	47.39 ^a	49.66 ^a	0.2342	0.0000

MW: metabolic weight. ADDM: Apparent Digestibility of Dry Matter, ADOM: Apparent Digestibility of Organic Matter, DNDF: Digestibility of Neutral Detergent Fiber, DADF: Digestibility of Acid Detergent Fiber, DHEMICELL: Digestibility of Hemicellulose, GEDIG: Digestible Energy, ADCP: Apparent digestibility of crude protein. Different letters in the same row indicate significant differences (a, b and c).

Table 7. Analysis of Variables for weight gain, intake and conversion by Evaluated Factors and inclusion levels.

Variables	Sodium Bicarbonate Urea				P Interacción
	0%		1%		
	T ₁	T ₃	T ₂	T ₄	
Daily weight gain (kg)	0.084 ^{ab}	0.053 ^b	0.088 ^{ab}	0.131 ^a	0.0837
Weight gain 14 d (g)	1.356 ^{ab}	0.875 ^b	1.225 ^b	1.969 ^a	0.0193
DM Intake 14 d (kg)	14.37	14.73	16.31	14.25	0.4900
Conversion kg DM / kg live weight gain	16.96	19.14	14.47	10.07	0.3502

Different letters in the same row show different means by the LSD test (p <0.05)

DISCUSSION

López-Yáñez et al (20) Pelibuey (West African) male lambs with an average live weight (LW) of 18.3±1.21 kg confined by consuming rations with dry distillers grain 30.0%, corn ground grain 51.5%, sugar cane molasses 15.0%, Premix mineral-protein 3.5% Dry matter 95.5%, Raw protein 16.7%, Nitrogen free extract 36.2%, Ethereal extract 4.0%, NDF 35.3%, ADF 14.4%, Ashes 5.2%, achieving a DM intake of 1.120 g/day with an estimated DM degradability of 46.9%, the intake being similar to this experiment and the degradability higher than the apparent digestibility. Bonilla-Cárdenas et al (21) in Pelibuey sheep of 40 kg of average body weight, confined by consuming rations with 60.7% of corn stubble, 24.6% of dried distillers grains with solubles, 10.6% of canola, 2.1% molasses and 1.1% calcium carbonate, whose composition was 87.2% DM, 89.6% OM, 10.4% ash, 15% CP, 53.9% NDF, 30.2% ADF and 21.8% of hemicellulose achieved intakes of 860.2 g of DM, 770.6 g of OM, 129.3 g of CP, 518 gr of NDF, 330 g of ADF and 188 g of hemicellulose per animal per day, with apparent digestibility of 67.6% DM, 47.5% OM, 63.5% CP, 34.4% NDF, 18.4% ADF and 62.4% for hemicellulose; the results of this experiment were superior in intake for most of the treatments and components analyzed, as well as for the digestibility of the OM, NDF and ADF, and lower for the digestibility of the DM, CP and hemicellulose.

Castro-Pérez et al (12) using Katahdin male lambs weighing 25.9±2.9 kg, receiving rations with dry rolled corn 44.5 to 54.5%, dry distillers grains with solubles 20 to 30%, soy cake 5%, Sudan grass hay 10%, tallow 1.5 and molasses 6.1% whose final composition was CP 13.98 to 15.51%, EE 5.38 to 5.95% NDF 22.55 to 26%, 12% and GE 18.32 to 18.41 MJ / kg and with a DM intake of 684 to 689 g/d, of OM of 639 to 646 g/d and NDF of 154 to 180 g/d and digestibility of the DM from 76.7 to 74.9%, from OM 79.3 to 77.3% and from the NDF from 57.1 to 59.2%; reaching lower values of fiber intake and much higher digestibility of the same, being relatively similar in the apparent digestibility of OM, both experiences. Despite having similar levels of distillery grains, the rations of Castro-Pérez et al (12) were much more concentrated in easily degradable energy (non-structural carbohydrates) and less fibrous, which would explain their greater digestion.

Curzaynz et al (22) formulated a base diet with 15% forage (stubble of ground corn) and 85% concentrate (corn, 47.3%, soybean paste, 12.8%, wheat bran, 7%, gluten of corn, 7%, molasses, 6%, fat surpassing 2.4%, calcium carbonate, 1.0%, minerals 1.0% and salt 0.5%), containing 18.5% CP, in the which included dried distiller grains with soluble in 20 and

40%, partially replacing corn, soybean paste and corn gluten to maintain iso-nitrogenated experimental diets, which were offered to whole Creole lambs of 24 ± 2.41 kg LW reaching intakes of 1261 to 1281 g/animal/d and apparent digestibility of the DM of 75.3 to 70.1%, NDF of 49.5 to 45.1% and ADF of 44.8 to 40.4% for the rations of 20 and 40% of distillery grains, the results of them exceed intakes and digestibility to all treatments and are similar in intake to T_2 , something similar to the previous comparison where a ration was evaluated Highly concentrated and relatively low in fiber.

Miccoli et al (23) using sheep with ruminal fistula (70.0 ± 7.13 kg of LW), using as treatments: dried distillers grains with solubles (DM 75.4%, PB 27.3%, NDF 46.8%; ADF 12.3%; EE 12.3%); Soybean Expeller (DM 97.0%, PB 40.4%, FDN 20.2%, ADF 7.0%, EE 12.31%); sunflower pellet (PG) (DM 96.3%, PB 36.6%, NDF 31.0%, ADF 18.0%, EE 6.7%) and pasture hay (HP) (DM 96.4% PB 7.0%, NDF 70.4%, ADF 36.8%, EE 1.5%) as basal diet; digestion was 47.4% of the DM, 51.4% of the OM, 47.1% of the NDF and 32.3% of the ADF, when the supplementation represented 52g of DM for each kg of PV^{0.75} and that of hay of 51g of DM for each kg of PV^{0.75}; being a lower performance both in metabolic weight intake and in digestibility with respect to T_2 and T_4 of this experiment, probably due to the positive effect of molasses as a source of non-structural carbohydrates of easy degradation and digestion.

Arcos-García et al (24) evaluating Suffolk Sheep, weighing 30kg, that received a consistent base ration, on a dry basis, of sugar cane core (50%), sorghum grain (21%), wheat bran (15%), molasses (12%) and urea (2%), having the following composition: 90.23% DM; 92.37% of OM; 11.47% CP; 62.57% of NDF; and 28.45% of ADF, to which *Saccharomyces cerevisiae* was added or not as a complement, reaching a dry matter intake of 1401 g/d, a digestibility of DM 79.3%; OM 89.1%; NDF 32.1%; and ADF of 18.6%, achieving better performance in the digestion of the DM and OM, similar in the NDF and lower in the ADF than in this trial, with similar rations in the structural carbohydrate content of the cell wall.

Aguirre et al (25) evaluated the animal response using male lambs, Pelibuey breed, weaned with average live weight of 20.24 ± 3.17 kg confined with selected diets based on the whole milled sugar cane (ammoniated and enriched with zeolite) at 50% of the ration and the other 50% was a mixture of whole corn flour and soybean cake, for a 13.25% of CP and 59.1% of NDF and 37.7% of ADF, achieved an individual intake of 1.405 g of DM/animal/d, with weight gain of 106.5 g LW/animal/d, being lower in weight gain and higher in DM intake at T_4 of this experiment, which is of interest since there is no corn and soy in the ration. Although Aguirre et al (25), have an experience using sugar cane harvest residues and sugar cane silage without ammonification (to 50% of the ration) also with soybean cake and corn integral flour with 10.9% of CP and 59.9% of NDF, where achieved intake of 1,350 g DM / animal / d and 130.7 g LW / animal / d being similar in weight gain to T_4 , but higher in the intake, which means less conversion, with the same incorporation of soybean cake and corn.

Pedraza et al (26) evaluating Pelibuey sheep of 14.2 kg of LW, fed with "B" cane molasses and *Digitaria decumbens* hay sprayed with a solution of a urea-molasses mixture offered *ad libitum*, receiving as a supplement three levels of inclusion of saccharina (40 to 60%), sugar cane (10 to 20%) and brown sugar sweeping (17%), reached weight gains of 81 to 127 g LW / animal / day, the best treatment being the one 40% saccharin, 18% sunflower meal, 17% brown sugar sweep, with a conversion of 10.9 kg DM / kg of LW gained, being similar in weight gain to T_4 , with a slightly higher conversion, despite to have used molasses, 117 g DM / animal / day of molasses, sweeping sugar and sunflower cake, whose nutritional value is high.

Rivas-Jacobo et al (27) evaluated the supplementation with humid brewery bagasse (BHC) in substitution of a grain of corn and sorghum in the productivity of Rambouillet sheep of 25.5 kg of LW grazing on crop residues (*Zea mays* L. and *Avena sativa* L.) receiving 500 g of DM from BHC as a supplement reached weight gains of 138.8 g / animal / d, values similar to those found in this experiment.

Obeidat (28) evaluated Awassi lambs of 24.9 ± 1.93 kg LW, to which they were offered a completely mixed ration of barley grain, soybean cake and 15% dried distillers grains with solubles, consuming 1,059 g DM / animal / d and achieving live weight gain of 212 g / animal / d and a conversion of 5.03 kg of DM / kg of LW gained, much higher than T_4 .

Obeidat et al (29) was to evaluate the effect of feeding low (LO)- or high (HI)-fiber diets supplemented with *Saccharomyces cerevisiae* (0.25 gr/day/lamb), Awassi female lambs (6 months old) were used, diet HI was 13.8% CP, 52% NDF, 21.9% ADF; the DM and CP intake were 1143 g/d and 158 g/d; digestibility were: DM 66%, CP 70.2%, NDF 59.8% and ADF 60.9%. This experience had a similar performance in the DM intake and higher in all the digestible fractions evaluated than the one achieved here, this was surely marked by a soybean and barley grain content of 43% and only 43% of wheat straw.

The possibility of supplementing ammoniated forage with molasses and distillery grains to an ammoniated forage, significantly improves the weight gains in lambs, because Rodríguez-Prado and Ventura (2) in crossbred West African lambs receiving ammoniated hay from *Brachiaria humidicola* could only achieve weight gains of 27 g LW/animal/d.

The higher intake of sodium bicarbonate and urea in the ration of T_4 (Table 5) allowed a higher intake of raw protein and organic matter; likewise, a greater apparent digestibility of dry matter, organic matter, crude protein, NDF and ADF in said treatment was achieved; This resulted in greater weight gain in such treatment. These achievements are based on the possibility of having a higher pH, close to neutrality (6.2 to 6.7), and a longer retention time of ammonia in the ruminal liquor without being absorbed by the ruminal wall, allowing a greater Synthesis of microbial protein and lower loss of energy in urea synthesis for urinary removal, evidenced by the lower intake of dry matter of T_4 and the higher intake of crude protein, of which almost a third or more was non-protein nitrogen (urea and ammoniated forage), as supported by the findings of Lu et al (30); Sartre et al (31); Hsu et al (32); Xu et al (33) and Phillip (34).

In conclusion, low-value local resources for the nutrition of human and non-ruminants, such as sugarcane harvest by-products of and the liquor industry by-products in the feeding of weaned lambs, using of sodium bicarbonate and urea as improvers of ruminal function. Production tests must be carried out on a larger scale to determine the economic value of the evaluated practice.

Conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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