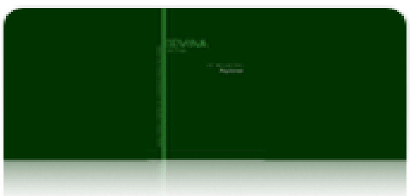

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Quantitative measures of lambs fed hydrolyzed sugarcane under aerobic and anaerobic conditions

Características quantitativas de cordeiros alimentados com cana-de-açúcar hidrolisada em condições aeróbica e anaeróbica

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Abstract

This study aimed to evaluate the influence of aerobic and anaerobic conditions on hydrolyzed sugarcane, over the *in vivo* morphological measurements, quantitative traits of carcass and non-carcass components of lambs. Twenty four Ile de France lambs, from 15 to 32 kg of body weight (BW) were used. Treatments were: *in natura* sugarcane (IN), sugarcane hydrolyzed using 0.6% calcium oxide (CaO) under aerobic condition (AER), and sugarcane hydrolyzed using 0.6% CaO under anaerobic condition (ANA). Treatments were supplied to animals along with concentrate. Before slaughtering, the lambs were weighed and morphological measurements were taken. After slaughtering, carcasses were evaluated for weight, dressing, non-carcass components, as well as their morphological measurements and weight loss by cooling. A completely randomized design with three treatments and eight replicates was used and the means were compared by Tukey test at 5% of significance. Lambs fed hydrolyzed sugarcane in aerobic condition had higher leg length (32.21 cm) and lower rump height (55.23 cm) *in vivo*, whereas empty body weight (24.84 kg) was lower for lambs fed *in natura* sugarcane. No difference for the other variables was observed. Sugarcane hydrolyzed under aerobic and anaerobic conditions is not an important factor affecting the *in vivo*, neither the carcass measurements of the animals. The choice between supplying *in natura* or hydrolyzed sugarcane will depend on an economic analysis.
Key words: Hydrolysis, morphology, dressing, *Saccharum officinarum*

Resumo

Este estudo teve como objetivo avaliar a influência das condições aeróbicas e anaeróbicas da cana-de-açúcar hidrolisada sobre as medidas morfológicas *in* vivo, características quantitativas da carcaça, e os não-componentes da carcaça de cordeiros. Foram utilizados 24 cordeiros Ile de France dos 15 aos 32 kg de peso corporal (PC). Os tratamentos foram: cana-de-açúcar *in* natura (IN), cana-de-açúcar hidrolisada com 0,6% de óxido de cálcio (CaO) em condição aeróbica (AER), e cana-de-açúcar hidrolisada com 0,6% de CaO em condição anaeróbica (ANA). Os tratamentos foram suplementados com concentrado. Antes do abate, os cordeiros foram pesados e foram obtidas as medidas morfológicas. Após o abate, as carcaças foram pesadas e avaliadas para rendimento, não-componentes, assim como suas medidas morfológicas e perda de peso por resfriamento. Foi utilizado o delineamento inteiramente casualizado com três tratamentos e oito repetições. As médias foram comparadas pelo teste de Tukey a 5% de significância. Cordeiros alimentados com cana-de-açúcar hidrolisada em condição aeróbica,

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que tiveram maior comprimento de perna (32.21 cm) e menor altura de garupa (55.23 cm) *in vivo*, Enquanto que o peso corporal vazio (24.84 kg) foi inferior para cordeiros alimentados com cana-de-açúcar *in natura*. Não foi observada diferença para as demais variáveis. A cana-de-açúcar hidrolisada em condições aeróbica e anaeróbica não é um fator importante em afetar as características *in* vivo, nem as medidas da carcaça de cordeiros. A escolha entre o fornecimento da cana-de-açúcar *in natura* ou hidrolisada dependerá de uma análise econômica.
Palavras-chave: Hidrólise, morfologia, rendimento, *Saccharum officinarum*

Introduction

Specialized breeds for meat production have greater potential for weight gain in shorter time, and better dressing and finishing degree of the carcasses. The carcass dressing is directly related to the marketing of lambs and interfered with the type of feeding and finishing, gender, age and slaughter weight (RIBEIRO et al., 2001; SILVA SOBRINHO; SAÑUDO; OSÓRIO, 2008).

Some measurements are performed both *in vivo* in animal and in the carcass as a way to standardize the final product. For example, the conformation and body condition of the living animal will reflect the finishing degree of carcass, as well as indexes of body and carcass compactness will reveal more compact animal carcasses. Cooling loss is another quantitative parameter measured in the carcass. It may be influenced primarily by temperature and its permanency time in the chamber, besides the finishing degree of the carcass (PINHEIRO; SILVA SOBRINHO; ANDRADE, 2009).

Study of non-carcass components assists to add value in sheep-meat production. Its importance is associated with an alternative food source, especially for populations with low purchasing power. The use of non-carcass components for human consumption constitutes a significant source of animal protein. Nutritional value of organs can be compatible or even superior to the beef meat. The organs and viscera have different growth rates over the life of the animal when compared to other parts of the body and may be related to the chemical composition of the food, especially the energy rate, requiring valorizing of the whole animal (LOUVANDINI et al., 2007).

In a feedlot farming system, feed cost is one of the fundamental aspects to the viability or not in meat production (YAMAMOTO, 2006). Therefore, the choice of the feed that will be provided to the animals must account for favorable nutritional and economical aspects for production. There are many advantages of using sugarcane: easily cultivated, high content of energy, and high potential of dry matter production per unit of area, especially when forage is scarce. It has, however, some disadvantages: low crude protein content that requires protein supplementation, and a need for daily cut due to the high concentration of soluble carbohydrates which makes the environment propitious for the development of microorganisms that deteriorate the chopped sugarcane. To overcome the latter disadvantage, alkaline treatment of sugarcane has been promoted using calcium oxide (CaO), which can also improve the nutritive value of sugarcane by increasing the digestibility of fibers (ZEOULA et al., 2006; MORENO et al., 2010; OLIVEIRA, 2010; BERCHIELLI; PIRES; OLIVEIRA, 2011; CARVALHO et al., 2011).

A pH increase due to the application of CaO in sugarcane is followed by a gradual pH decrease due to aerobic exposure of sugarcane. This decrease is linear, but it is not interesting, because the pH decrease occurs by action of microorganisms. These microorganisms consume the soluble carbohydrates and cause acidification of sugarcane, therefore its aerobic stability decreases (RABELO et al., 2011). With the hydrolysis of sugarcane under anaerobic condition, i.e., with no exposure to oxygen, theoretically, in the course of time, pH gradually decreases slower than in hydrolysis under aerobic exposure, which may result in a less favorable environment for the development of aerobic microorganisms, such as yeasts (ENDO et al., 2014). Therefore, this study aimed to evaluate the influence of aerobic and anaerobic conditions on hydrolyzed sugarcane included as roughage in the diet, over the *in vivo* morphological measurements, quantitative traits of carcass and the non-carcass components of lambs.

Material and Methods

The experiment was carried out at São Paulo State University (Unesp) in Jaboticabal, Brazil. Twenty-four Ile de France lambs, uncastrated and weaned at 14 kg body weight (BW) were used. At 15 ± 0.221 kg BW, lambs were identified with numerical marking on the back region. Lambs were housed in individual pens (1.0 m^2), with slatted and suspended floor. These facilities were equipped with bunks and waterers installed in covered sheds. Lambs were distributed in a completely randomized design with three treatments and eight replicates: *in natura* sugarcane + concentrate (IN), sugarcane hydrolyzed using 0.6% CaO in aerobic condition + concentrate (AER) and sugarcane hydrolyzed using 0.6% CaO in anaerobic condition + concentrate (ANA). Chemical composition of the ingredients is in Table 1. Composition, percentage and chemical analysis of diets are in Table 2.

Table 1. Chemical and crude energy composition of the ingredients of the experimental diets (expressed in DM).

Nutrient	Sugarcane			Soybean meal	Ground corn
		Hydrolyzed with CaO (0.6%)			
	in natura	Aerobic	Anaerobic		
Dry matter (%)	33.75	30.64	30.71	90.18	89.80
Organic matter (%)	32.01	27.06	26.78	83.29	87.39
Crude protein (%)	1.51	1.49	1.46	47.50	10.48
Ether extract (%)	1.85	1.45	1.27	1.75	6.85
Lignin (%)	5.63	5.19	5.53	7.75	2.51
Neutral detergent fiber (%)[1]	41.09	37.54	37.67	20.89	10.11
Acid detergent fiber (%)	22.90	20.10	20.11	8.51	2.70
Hemicellulose (%)	18.19	17.44	17.56	12.38	7.41
Cellulose (%)	17.27	14.91	0.76	7.60	0.19
Total carbohydrates (%)[2]	95.87	92.72	94.29	43.87	80.25
Non-fibrous carbohydrates (%)[3]	58.33	55.05	53.20	22.89	70.14
Crude energy (Mcal kg^{-1})	3.88	3.70	3.82	4.56	4.37

[1]Neutral detergent fiber corrected for ash and protein
[2]Total carbohydrates = 100 - (%CP + %EE + %MM)
[3]Non-fibrous carbohydrates = 100 – (%NDFap + %CP + %EE + %MM).
Source: Elaboration of the authors.

Diets were formulated according to NRC (2007) for lamb weight gain of 250 g day^{-1}, constituting diets with 22% CP and 3.9 Mcal of crude energy (CE) and 2.68 Mcal of metabolize energy (ME) per kg of dry matter (DM), with roughage:concentrate rate of 50:50.

Lime had a chemical composition of 93.37% CaO, 0.6% of magnesium oxide (MgO), and 0.1% phosphorus (P). The IAC 86-2480 was the variety of sugarcane used. A second cut of sugarcane with nine months of growing, non-defoliated and chopped in particle size from 0.8 to 1.0 cm was provided *in natura* or hydrolyzed under aerobic and anaerobic conditions, depending on the treatment. *In natura* sugarcane was cut daily and was kept for 2-day ripening, after that, it was chopped in specific equipment and provided to the lambs. Hydrolyzed sugarcane was cut daily, chopped and treated using 0.6% CaO per 100 kg of sugarcane (OLIVEIRA, 2010). A suspension was made by diluting 0.6 kg of CaO in 2.0 liters of water. Sugarcane remained under aerobic and anaerobic conditions for 2-day ripening before being provided to the lambs.

Table 2. Ingredients percentage, chemical, bromatological and gross energy composition of the experimental diets (express in dry matter, DM).

Percentual composition	Treatment		
	IN	AER	ANA
Sugarcane	49.93	52.69	50.99
Urea	1.27	1.20	1.21
Ground corn	8.09	7.64	7.76
Soybean meal	37.97	35.87	36.41
Sodium chloride	0.33	0.31	0.31
Limestone	1.15	1.08	1.10
Phosphate dicalcium	0.80	0.76	0.77
Mineral mixture[1]	0.47	0.44	0.45
Chemical and bromatological (on DM basis)			
Dry matter (%)	50.07	47.31	48.01
Crude protein (%)	22.73	21.48	21.80
Mineral matter (%)	6.24	6.96	7.19
Neutral detergent fiber (%)[2]	27.53	28.15	29.79
Acid detergent fiber (%)	13.17	13.56	14.92
Hemicellulose (%)	14.36	14.59	14.87
Cellulose (%)	7.48	7.85	9.03
Lignin (%)	5.69	5.71	5.89
Ether extract (%)	2.14	1.92	1.83
Organic matter (%)	93.76	93.04	92.81
Total carbohydrates (%)[3]	68.89	68.72	69.18
Non-fiber carbohydrates (%)[4]	41.36	40.57	39.39
Crude energy (Mcal kg^{-1})	4.02	3.92	3.99

IN = *in natura* sugarcane + concentrate, AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate, ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate.
[1]Mineral mixture: zinc 1,600 mg, copper 300 mg, manganese 1,500 mg, iron 1,100 mg, cobalt 10 mg, iodine 27 mg, selenium 22 mg
[2]Neutral detergent fiber corrected for ash and protein
[3]Total carbohydrates = 100 - (%CP+%EE+%MM)
[4]Non-fiber carbohydrates = 100 – (%NDFap + %CP + %EE + %MM).
Source: Elaboration of the authors.

To obtain the hydrolyzed sugarcane, it was chopped and spread on a tarp, forming a stack. Calcium oxide suspension was poured slowly over the sugarcane, and after that, the stack was revolved for complete homogenization to assure that the fibers were hydrolyzed. The stack of sugarcane hydrolyzed under aerobic condition remained on the tarp. Whereas, sugarcane hydrolyzed under anaerobic condition was stored in screw-top drums, which avoided the contact of oxygen with the hydrolyzed sugarcane.

When reaching 15 kg of BW, lambs were treated with anthelmintic and supplemented with vitamins A, D and E, and then, confined in individual pens. The animals received a mixed diet in the bunks, allowing 10% refusals of what was supplied. Diets were delivered twice daily, at 8 and 17 hours. Lambs were weighed weekly to monitor weight gain.

At 32 kg of BW, lambs were weighed and fasted of solid diet for 16 hours. Before slaughtering, lambs were weighed again to obtain the weight at slaughter (WS) and fasting loss weight (FLW), then they were evaluated in the following morphological measurements: body length (distance in centimeters between neck base, joint and cervicothoracic tail base, first joint intercoccigea), height above (distance between the withers and distal forelimb), rump height (distance between the sacral tuberosity, on the rump, and the distal hind limb), heart girth (measured after the scapula), rump width (maximum width between the trochanters of the femurs) and chest width (distance between the sides of the scapular-humeral joint) (SEARLE; GRAHAM; DONNELLY, 1989; OSÓRIO, 1998; YÁÑEZ et al., 2004). Measurements were obtained with the lambs positioned on a flat and horizontal surface, by the same evaluator in order to minimize errors.

Body condition was evaluated according to Silva Sobrinho (2001), palpation of the dorsal vertebral column through the amount of fat and muscle found in the angle formed by the dorsal and transverse processes, assigning scores from 1 to 5, in which 1 represents an animal with lower body condition (too skinny), 2 (skinny), 3 (normal), 4 (fat) and 5 (excessively fat).

After the *in vivo* evaluations, lambs were numbed by electronarcosis with electrical discharge of 250 V for two seconds, and then slaughtered by section of the jugular veins and carotid arteries. Later, separations and quantifications of the weights of non-carcass components, in relation to body weight at slaughter was made: blood, skin, reproductive tract with bladder, kidney with perirenal fat, liver, spleen, heart, gastrointestinal tract with the esophagus, respiratory tract with trachea and diaphragm, tongue, pancreas, omental (covers the stomach) and mesenteric fat (covers the intestines), head and paws. The gastrointestinal tract was emptied to obtain empty body weight (EBW = BWS - gastrointestinal tract - gallbladder contents - contents of the bladder) to determine the true or biological dressing, which is the relationship between hot carcass weight (HCW) and EBW * 100 (SAÑUDO; SIERRA, 1986).

After evisceration, carcasses were weighed, dressing the HCW to determine the hot carcass dressing (HCD = HCW / WS * 100) and transferred to cold storage at 6 º C for 24 hours, hanging by gastrocnemius tendons, on appropriate hooks and spaced 17 cm.

After this period, cold carcass weight (CCW) was weighed, calculating the percentage of weight loss by cooling (WLC = (HCW - CCW / HCW) * 100) and commercial dressing (CD = (CCW / WS) * 100). Subjectively, conformation was determined according to the methodology of Colomer-Rocher, Delfa and Sierra (1988), attributing grade 1 (bottom), 2 (fair), 3 (good) 4 (very good), and 5 (excellent). Finishing degree or fat cover was also determined following the same methodology, attributing grade 1 (too skinny), 2 (skinny), 3 (normal), 4 (fat), and 5 (very fat). Then they took up the carcass morphological measures: carcass external length (CEL, distance between the base of the neck, cervical-thoracic joint and base of tail, first joint intercoccigea), carcass internal length (CIL, maximum distance between the front edge of the ischio-pubic and the anterior edge of the first rib at its midpoint), leg length (distance between the greater trochanter and the lateral edge of the tarsalmetatarsal joint), hind perimeter (as it involves the trochanters femurs), rump width (maximum width between the trochanters of the femurs), chest circumference (scapula after considering the largest circumference), chest width (maximum width, the greater amplitude of the ribs) and chest depth (distance maximum between the sternum and the back of the palette), according to Osório (1998) and Yamamoto (2006).

With previous determinations, the carcass compactness index (RCC $_{(kg\ cm^{-1})}$ = CCW / CIL) and leg compactness index (LCI = rump width / length of the leg) were calculated. Measurements of length, height and girth were taken with a tape measure, and the measures of width and depth, with a compass, which opening measure was recorded with a ruler.

Experimental design was the completely randomized with three treatments and eight replicates. Data were subjected to analysis of variance by PROC GLM using software SAS (2001), at 5% significance level. When significant differences were detected, means were tested by Tukey HSD range test at 5% significance level.

The statistical model used was:

$Yij = \mu + \pi i + eij$,

where Yij is the observed value of the variable studied in animal j, diet i; μ is the general mean common to all observations (constant); πi is the effect of treatment; eij is the random error associated with each observation (measurement errors, uncontrollable factors, differences between experimental units).

Results and Discussion

Sugarcane is viable because it is a tropical grass and presents a high production of dry matter and energy per unit of area. In this study, the influence of the AER and ANA conditions on the sugarcane hydrolysis regarding morphological parameters *in vivo* and in the carcass of lambs, as well as dressing of carcass and non-components was assessed.

Table 3 contains the values and coefficients of variation for the morphological measurements *in vivo* of lambs. No difference was observed in morphological means among treatments, except for rump height, which lambs fed hydrolyzed sugarcane in anaerobic condition (55.23 cm) had lower rump height than lambs fed *in natura* sugarcane (57.98 cm) and hydrolyzed in aerobic condition (59.31 cm). Means of morphological measurements were: corporal condition of 3.00, body length of 55.20 cm, height above of 57.92 cm, rump width of 20.66 cm, chest width of 20.80 cm, leg length of 51.25 cm and body compactness index of 0.57.

The mean of the rump height found for this study was 57.49 cm (Table 3), corroborating with Moreno et al. (2010) that found 58.55 cm to assess the *in vivo* morphological traits and in the carcass of lambs finished in feedlot with sugarcane and corn silage using different roughage:concentrate ratio. The commercial value of an animal to produce meat is not accounted just by its body weight, but along with other measures, such as body length, which provides the body compactness (OSÓRIO; OSÓRIO, 2005). The body compactness index of 0.57 kg cm^{-1} obtained in this study is similar to 0.51 kg cm^{-1} mentioned by Roger et al. (2010) who evaluated *in vivo* and in the carcass measures of lambs. On body condition, one seeks to estimate muscle:fat ratio, which is linked with the finishing degree of the carcass. The average body condition (3.00) in this study was lower than that found by Moreno et al. (2010) of 3.50.

Table 3. Morphological measures *in vivo* in lambs fed with diets containing *in natura* or hydrolyzed sugarcane in aerobic and anaerobic conditions.

Variable	Treatment			Mean	Pr > F	CV (%)
	IN	AER	ANA			
Corporal condition [1]	3.00	3.00	3.00	3.00	ns	12.97
Body length (cm)	53.67	57.57	54.14	55.20	ns	16.02
Height above (cm)	58.35	58.64	56.83	57.92	ns	3.03
Rump height (cm)	57.98[a]	59.31[a]	55.23[b]	57.48	*	3.76
Rump width (cm)	20.83	20.49	20.69	20.66	ns	6.86
Chest width (cm)	21.18	20.26	21.01	20.80	ns	4.42
Leg length (cm)	51.83	52.50	49.50	51.25	ns	5.03
Body compactness index (kg cm^{-1})	0.59	0.53	0.59	0.57	ns	26.38

[1] Scores from 1 to 5, that means 1 = too skinny, 2 = skinny, 3 = normal, 4 = fat e 5 = very fat
IN = *in natura* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate; ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate
Tukey test ($P < 0.05$). Different letters in rows, shown significant differences among means.
Source: Elaboration of the authors.

Results of carcass morphological measurements of lambs finished in feedlot are shown in Table 4 and difference can be observed only for leg length. Lambs fed hydrolyzed sugarcane in aerobic condition had greater leg length (32.21 cm) than lambs fed hydrolyzed sugarcane in anaerobic condition (31.07 cm). There was no difference for treatments in the variables: conformation (3.5), finishing degree (3.0), carcass external length, CEL (53.13 cm), carcass internal length, CIL (55.33 cm), rump width (21.96 cm), chest width (23.99 cm), carcass compactness index, CCI (0.23 kg cm^{-1}), and leg compactness index, LCI (0.41).

Table 4. Morphological measures in lambs carcass fed with diets containing *in natura* or hydrolyzed sugarcane in aerobic and anaerobic conditions.

Variable	Treatment			Mean	Pr > F	CV (%)
	IN	AER	ANA			
Conformation[1]	3.50	3.50	3.50	3.50	ns	14.70
Finishing degree[2]	3.00	3.00	3.00	3.00	ns	10.87
External length (cm)	53.17	53.36	52.86	53.12	ns	3.58
Internal length (cm)	55.50	55.43	55.07	55.32	ns	3.03
Leg length (cm)	31.75[ab]	32.21[a]	31.07[b]	31.67	*	2.10
Rump width (cm)	22.08	22.03	21.79	21.96	ns	4.26
Chest width (cm)	23.77	23.96	24.20	23.98	ns	3.68
Carcass compactness index (kg cm^{-1})	0.23	0.24	0.24	0.24	ns	3.36
Leg compactness index	0.41	0.41	0.41	0.41	ns	7.45

[1] Score from 1 to 5, that means 1 = bottom, 2 = fair, 3 = good, 4 = very good e 5 = excellent
[2] Score from 1 to 5, that means 1 = too skinny, 2 = skinny, 3 = normal, 4 = fat e 5 = very fat
IN = *in natura* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate; ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate
Tukey test ($P < 0.05$). Different letters in rows, shown significant differences among means
Source: Elaboration of the authors.

Difference for leg length (Table 4) was not expected, because the lambs were slaughtered with similar ages (153 days) and weights (32.0 kg). This difference between the means can be explained by the low coefficient of variation (2.10%) found for leg length, making it more sensitive to the observation between variation of data.

Values of 3.00 of fat cover, 53.13 cm of carcass external length, 55.33 cm of carcass internal length and 23.99 cm of chest width were found (Table 4). Similarly, when measuring carcass morphological traits of Ile de France lambs finished in feedlot, receiving *in natura* sugarcane, and slaughtered at 32.0 kg of BW, Moreno et al. (2010) found 3.00 cm of fat cover, carcass external length of 53.65 cm, carcass internal length of 56.30 cm and chest width of 24.12 cm. On the other hand, the results found in this study for leg length (31.68 cm) and rump width (21.96 cm) were lower than 35.69 cm for leg length and 24.05 cm for rump width (MORENO et al., 2010).

There was no difference for any quantitative traits of lamb carcasses (Table 5). The mean values were: hot carcass weight (HCW) of 13.61 kg, hot carcass dressing (HCD) of 44.88%, cold carcass weight (CCW) of 13.20 kg, commercial dressing (CD) of 43.49%, true dressing (TD) of 53.74% and loss by cooling (LC) of 3.08%. These values were lower than Mendes et al. (2008) when evaluating parameters of the Santa Ines carcass fed *in natura* sugarcane and slaughtered at 40.0 kg of BW (HCW of 20.9 kg, HCD of 47.5%, CCW of 13.20 kg, CD of 46.50%, and LC of 2.1%). Murta et al. (2010), when evaluating the quantitative measurement of carcass of lambs fed hydrolyzed sugarcane with CaO and lambs slaughtered at 30.0 kg of BW found HCW of 14.66 kg, HCD of 46.62%, CCW of 14.35 kg, CD of 45.45%, and LC of 2.09%.

Table 5. Hot carcass weight, cold carcass weight, hot carcass dressing, commercial dressing and true or biological dressing and loss by cooling of lambs fed with diets containing *in natura* or hydrolyzed sugarcane in aerobic and anaerobic conditions.

Variable	Treatment			Mean	Pr > F	CV (%)
	IN	AER	ANA			
Hot carcass weight (kg)	13.39	13.72	13.72	13.61	ns	2.42
Cold carcass weight (kg)	13.01	13.30	13.27	13.20	ns	2.70
Hot carcass dressing (%)	44.59	45.02	45.00	44.88	ns	3.14
Commercial dressing (%)	43.31	43.64	43.51	43.49	ns	3.38
True dressing (%)	53.91	53.56	53.77	53.74	ns	2.27
Loss by cooling (%)	2.88	3.07	3.27	3.08	ns	24.08

IN = *in natura* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate; ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate.
Source: Elaboration of the authors.

Slaughter body and empty body weight, and the non-carcass components dressing of lambs are shown in Table 6. For BWS there was no difference among treatments, ranging from 30.03 to 30.50 kg, whereas for EBW there was difference. Higher EBW was found in lambs fed hydrolyzed sugarcane in aerobic (25.61 kg) and anaerobic (25.52 kg) conditions when compared to those fed *in natura* sugarcane (24.84 kg). Means for weight loss fasting was 5.63% content of the gastrointestinal tract was 5.01 kg and weight gastrointestinal tract was 2.25 kg.

Table 6. Weights of slaughter body, empty body and the non-carcass components dressing of lambs fed with diets containing *in natura* or hydrolyzed sugarcane in aerobic and anaerobic conditions.

Variable	Treatment			Mean	Pr > F	CV (%)
	IN	AER	ANA			
Body weight (kg)	31.87	32.24	31.79	31.97	ns	2.20
Body weight at slaughter (kg)	30.03	30.49	30.50	30.35	ns	-
Weight loss fasting (%)	5.77	5.43	4.05	5.62	ns	27.23
Empty body weight (kg)	24.84[b]	25.61[a]	25.52[a]	25.34	*	1.62
Contents of the gastrointestinal tract (kg)	5.20	4.88	4.99	5.01	ns	10.65
Weight gastrointestinal tract (kg)	2.22	2.27	2.27	2.25	ns	8.44

IN = *in natura* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate; ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate.
Tukey test (P<0.05). Different letters in rows, shown significant differences among means.
Source: Elaboration of the authors.

There was greater empty body weight for lambs fed hydrolyzed sugarcane (in aerobic or anaerobic conditions), but no difference were observed among treatments for gastrointestinal tract contents and weight of gastrointestinal tract. It is known that the empty body weight is obtained by body weight at slaughter less contents of the gastrointestinal tract, the bladder contents and the bile contents. Therefore, it is suggestive infer that the contents of the bladder (urine) or the contents of the gallbladder (bile) varied among treatments in which the lambs were submitted. The bile salts have as main function a detergent action on particles of fat in the feed. This detergent action reduces the surface tension of particles, decreases the fat globules and assists absorption of fatty acids, monoglycerides, cholesterol and other lipids (AIRES, 1999). Table 2 shows the percentage values of the experimental diets and the ether extract content of the diet IN (2.14%) compared to diets AER (1.92%) and ANA (1.83%) is higher. This variation may have caused a greater production of bile in the lambs fed the diet IN, consequently, have reduced the empty weight. Another possibility is that these significant results for EBW (Table 6) can be explained by the low coefficient of variation (1.62%) of this parameter. Thus, the test was more sensitive in the sense of variation among treatments. Moreno et al. (2010) found 27.24 kg of EBW in lambs fed *in natura* sugarcane and corn silage, slaughtered at 32.0 kg of BW, higher than reported in this study (25.34 kg).

Skin is the most valuable non-carcass component and can reach 10 to 20% of the value of animal, followed by the liver, heart, and fat (FRASER; STAMP, 1989). There was no difference among treatments for percentage of non-carcass components (Table 7). Means for skin (9.83%), gastrointestinal tract (7.42%), head (5.43%), blood (3.98%), paws (2.65%), respiratory tract with trachea and diaphragm (2.25%), liver (1.76%), omental + mesenteric fat (0.99%), reproductive tract with bladder (0.76%), heart (0.64%), kidneys with perirenal fat (0.51%), tongue (0.24%), spleen (0.16%), and pancreas (0.15%) were found and did not differ among treatments. Evaluating dressing of non-carcass components of Ile de France lambs fed sugarcane associated with sunflower seeds and vitamin E, Lima et al. (2013) found values slightly higher: skin of 12.23%, gastrointestinal tract of 9.35%, head of 6.57%, blood of 4.60%, paws of 3.22%, respiratory tract with trachea of 3.16%, liver of 1.99%, mesenteric and omental fat of 1.01%, reproductive tract with bladder of 0.94%, heart of 0.54%, kidneys with perirenal fat of 0.45%, tongue of 0.31%, spleen of 0.20%, and pancreas of 0.17%. Silva Sobrinho et al. (2003) studied the organ production of ½ Ile de France ½ Ideal lambs, slaughtered at 30 and 34 kg of BW and found values for dressing of tongue (0.23%) and pancreas (0.15%).

Table 7. Dressing of non-carcass components in relation to body weight at slaughter of lambs fed with diets containing *in natura* or hydrolyzed sugarcane in aerobic and anaerobic conditions.

Variable (%)	Treatment			Mean	Pr > F	CV (%)
	IN	AER	ANA			
Gastrointestinal tract	7.33	7.45	7.43	7.42	ns	8.68
Blood	3.80	4.31	3.86	3.98	ns	13.03
Skin	9.62	9.98	9.89	9.83	ns	9.72
Reproductive tract with bladder	0.72	0.79	0.78	0.76	ns	26.54
Kidneys with perirenal fat	0.51	0.49	0.55	0.51	ns	10.39
Spleen	0.16	0.16	0.16	0.16	ns	12.99
Liver	1.73	1.71	1.84	1.76	ns	10.45
Heart	0.70	0.62	0.63	0.64	ns	10.83
Respiratory tract with trachea and diaphragm	2.44	2.28	2.08	2.25	ns	14.06
Tongue	0.26	0.24	0.22	0.24	ns	15.58
Pancreas	0.14	0.17	0.16	0.15	ns	23.06
Omental + mesenteric fat	1.07	0.93	1.01	0.99	ns	10.73
Head	5.35	5.55	5.39	5.43	ns	6.53
Paws	2.70	2.66	2.59	2.65	ns	5.91
Dressing of the non-carcass components	36.47	37.34	36.59	36.80	ns	3.40

IN = *in natura* sugarcane + concentrate; AER = hydrolyzed sugarcane with 0.6% of CaO in aerobic condition + concentrate; ANA = hydrolyzed sugarcane with 0.6% of CaO in anaerobic condition + concentrate.
Source: Elaboration of the authors.

Conclusion

Sugarcane hydrolyzed under aerobic and anaerobic conditions is not an important factor affecting the *in* vivo, neither the carcass measurements of the animals. The choice between supplying *in natura* or hydrolyzed sugarcane will depend on an economic analysis.

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Ethics committee and biosafety

This research is in accordance with the Ethical Principles in Animal Experimentation, and was approved by Committee of the Use of Animals, protocol number 011855/12.

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