Ruminal degradability of PREDICAL. Comparison with three forages available during the dry period in Cuba

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In order to evaluate the *in situ* degradability of PREDICAL (bagasse pith of sugar cane treated with calcium hydroxide and steam) as feed for ruminants, and compare it with the degradability of untreated bagasse pith of sugar cane, star grass (43 d of regrowth), sugar cane and *Pennisetum purpureum* cv. Cuba CT-115, two experiments of *in situ* digestibility were performed using a completely randomized design. The time of incubation of the first experiment was 48 h. In the second experiment, treatments were similar and time of incubation was extended up to 72 h. The ruminal degradability of PREDICAL in the second experiment was 58.51 % of the dry matter, and it did not differ from the degradability of a variety of forage sugar cane or the one of *Pennisetum purpureum* cv. CT-115. The estimation of the metabolizable energy contribution of PREDICAL was 8.58 MJ/kg of dry matter. *In situ* degradability and ME contribution of PREDICAL were approximately similar regarding those of the sugar cane (*Saccharum officinarum* L, variety Cuba -1616-75), recommended for forage use. After 72 h of incubation, degradability was similar to that of CT-115 and, in all cases, superior to the one of star grass (*Cynodon nlemfuensis*) under the typical conditions of dry season.

Key words: *chemical treatment, bagasse pith, forage, sugar cane*

In Cuba, the bagasse pith of sugar cane, like other fibrous by-products from sugar industry, is available during dry season, when grasses and forages become scarce and, consequently, the cattle production decreases (Martín 2004 and Villar 2010). This material is highly lignified (Pires *et al.* 2006 and Mohammed *et al.* 2013) and it should receive previous chemical treatments, designed for this purpose, for its later efficient use as animal feed (Martín 2004).

As Rodríguez *et al.* (2007) reports, the PREDICAL is a product obtained when treating the bagasse pith with calcium hydroxide and steam, with the objective of increasing its degradability thanks to microorganisms within the rumen. This product is considered as promising for ruminant diet because it does not have the pollutant properties of soil, which are present in other technologies of chemical treatment.

As part of the evaluation process of PREDICAL, the objective of this study was to compare the ruminal degradability of this product to that of the untreated bagasse pith, the sugar cane, mature star grass and *Pennisetum purpureum* cv. Cuba CT-115, which were forages available during the dry period. Besides, their contributions of metabolizable energy for ruminants are estimated.

Materials and Methods

For evaluating PREDICAL, compared to the untreated bagasse pith, mature star grass, sugar cane and Pennisetum var. Cuba CT-115, two experiments of *in situ* digestibility were performed using a completely randomized design. The time of incubation of the first experiment was 48 h and, in the second experiment, treatments were similar and time of incubation was extended up to 72 h. Each determination was carried out by triplicate and the results were processed using the statistical package InfoStat (2012). The means were compared using the multiple comparison test of Duncan (1955).

Samples of bagasse pith, untreated and treated with calcium hydroxide (PREDICAL), were used. They were taken from a pilot plant located at the facilities of the "Unión de Investigación-Producción de la Celulosa del Bagazo Cuba-9". The bagasse pith used for preparing PREDICAL was taken from the sugar mill "Pablo Noriega", located at Quivicán, Mayabeque province. A part of it was used for obtaining the product, and the rest was preserved for using it as control. An amount of 10 kg of bagasse pith and 10 kg of PREDICAL was used. After the homogenization, a kilogram of each was separated for performing the chemical characterization, and another kilogram was used for determining ruminal degradability.

Samples of forage of sugar cane (*Saccharum officinarum*, L), variety Cuba 1616-75, were taken from the material used in a process of evaluation of forage varieties of sugar cane (Molina *et al.* 1999). Samples of the remaining forages belonged to grasslands of a dairy farm from the Instituto de Ciencia Animal, in a typical red ferrallitic soil during the dry season, without irrigation or fertilization, with four years of establishment (*Pennisetum purpureum*, cv. Cuba CT-115), and more than ten years of exploitation (star grass, *Cynodon nlemfuensis*, Schum), and 95 and 43 d of regrowth, respectively.

Processing of samples. Samples were dried in an oven at 55º C for 48 h, and later, they were grounded in a lab mill for fibrous materials, with proper sieves for reaching the particle size of 2.5 mm for ruminal degradability

experiments, and 1 mm for chemical analysis.

In situ ruminal degradability. For determining *in situ* ruminal degradability, the procedure described by Kriznan *et al.* (2012) was used. Portions of 5 g of the sample were weighed, and placed into Dacron bags of 14 cm long and 8.5 cm wide, with a porosity of 48 µm. For this purpose, three crossbred Holstein x Zebu bulls were used, with liveweight of 415 ± 10 kg, which had a plastic cannula inserted in the dorsal part of the rumen, through which a bag was introduced per treatment. Animals were kept in individual pens, of 2.5 x 2.5 m and slatted floor. They were fed with forages of grasses, water and minerals at will, and 0.5 kg daily of soybean meal. Later, these bags were extracted and washed with running water until eliminating all contamination with the ruminal content of the bulls. After that, they were dried in an oven at 55º C for 48 h. The degraded material was estimated with the difference between initial and final weights of the dried bags.

Chemical analysis. Dry matter (DM), ashes, organic matter (OM) and crude protein (CP) were determined according to the techniques described by AOAC (1995). The neutral detergent fiber (NDF) and the acid detergent fiber (ADF) were quantified using the procedure of Goering and van Soest (1970). Determinations were made by duplicate and the mean of each result was taken.

Estimation of the metabolizable energy contribution. For estimating the contribution of metabolizable energy of samples, the ash content after 72 h and the content of degradable organic matter per kilogram of DM were determined in the residue of the ruminal incubation. The contribution of metabolizable energy (ME) was estimated from the supposition that 1 kg of degradable OM adds 15.06 MJ of metabolizable energy (CSIRO 2007).

Results and Discussion

Table 1 shows the chemical composition of the analyzed feeds. The fiber content of the untreated bagasse pith was high compared to the remaining forages, while the the bagasse pith treated with calcium hydroxide experienced a decrease of its content of NDF. All forages had low content of CP, except Cuba CT-115, so they should only be evaluated by their characteristics of energy carriers.

The difference of NDF and ADF contents are the result of the estimation of the content of hemicellulose of forages (Goering and van Soest 1970). The content of these two fractions in PREDICAL was similar, and it can be explained if it is considered that the effect of the treatment with calcium hydroxide, under specific conditions for the preparation of this product, consists on dissolving the fraction of hemicellulose of bagasse pith. Hence, the approximate similarity between the PREDICAL and sugar cane. In the sugar cane, because it is known, the soluble fraction is formed by sucrose. This conclusion is reached because there are no similarities between the contents of ADF of bagasse pith and the PREDICAL. The composition of CT- 115 and star grass is typical of these tropical forages (Valenciaga *et al.* 2001 and Juárez-Reyes *et al.* 2009).

Table 2 shows the *in situ* degradability of the studied fibrous materials, estimated at 48 and 72 h of incubation. The degradability of PREDICAL, at both times, was not different than the one of sugar cane, which belongs to one of the recommended varieties due to its high digestibility (Molina *et al*. 1999).

The degradation rate of fibrous components of sugar cane is extremely low (González 1995). As a consequence, its degradability after 48 h was inferior to the expected for the used variety, which is over the 50 % (Molina *et al.* 1999). Extending the incubation time to 72 h (second experiment) allowed to reach the expected values of degradability and, similarly, there was a substantial increase in the degradability of PREDICAL. In both cases, there were no differences regarding the sugar cane. Starting from the fact that hemicellulose in bagasse pith is dissolved with the alkaline treatment for obtaining the product, the fraction degrading through the incubation into the rumen is formed by cellulose. This precision is not possible in the case of sugar cane because of the information obtained in this experiment.

Table 3 shows an estimate of the content of metabolizable energy of the studied fibrous feeds. This is a preliminary result and it should be confirmed through metabolism tests in sheep. However, it gives an idea of its energy potential. The similarities of the ME content between the PREDICAL and the sugar cane was highlighted.

The energy contribution of the PREDICAL is about similar to that of sugar cane and CT-115. Its use can be evaluated as an alternative to other technologies for treating sugar cane bagasse, such as the use of sodium

Table 1. Chemical composition of fiber feeds, % on dry bases

Feed	CP	NDF	ADF	Ashes
Bagasse pith	2.7	83.0	53.9	5.7
PREDICAL	2.7	53.8	54.9	14.2
Sugar cane C-1616-75	4.3	55.3	34.1	6.3
Pennisetum Cuba CT-115	7.2	72.1	43.2	8.4
Mature star grass (*C. nlemfuensis*)	6.4	75.0	34.9	9.1

*Mean of two determinations

Table 2. *In situ* degradability of different fibrous materials, estimated in two incubation times

Treatment	48 h	72 h
Untreated bagasse pith	25.00[a]	36.48[a]
PREDICAL	45.79[b]	58.51[b]
Sugar cane C-1616-75	43.31[b]	55.85[b]
Pennisetum CT-115	57.37[c]	61.34[b]
Mature star grass (*C. nlemfuensis*)	30.46[a]	39.16[a]
SE ±	5.33*	4.85*

Means in the same column with different superscripts differ at $P < 0.05$ (Duncan 1955)

Table 3. Estimate of metabolizable energy of studied fibrous feed, times of incubation

Fibrous feed	ME (MJ/kg MS)
Bagasse pith	5.02
PREDICAL	8.58
Sugar cane C-1616-75	8.41
Pennisetum CT-115	8.79
Mature star grass (*C. nlemfuensis*)	5.56

hydroxide, urea (Pires *et al.* 2006, Chaji *et al.* 2010 and Mohammed *et al.* 2013), treatment with steam (Sabbagh Zade *et al.* 2009) and fungi fermentation (Akinfemi 2012). The low content of CP of PREDICAL demands a supplementation for ruminal microorganisms to use it efficiently (Martín 2004). This fact should be taken into consideration in future analyses on the use of this food.

It can be concluded that PREDICAL had *in situ* degradability and its contribution of ME was similar to that of the sugar cane variety Cuba -1616-75. This is one of the recommended varieties for being used as forage. With an incubation time of 72 h, the degradability of PREDICAL is similar to that of CT-115 and, in all cases, superior to that of star grass, under typical conditions of the dry season in Cuba. This is a preliminary result and it should be confirmed through metabolism tests in sheep. However, it gives an idea of the energy potential of PREDICAL.

References

Akinfemi, A. 2012. Upgrading of sugarcane bagasse by solid state fermentation with *Pleurotus sajor*-caju and *Pleurotus florida* and the impact on the chemical composition and *in vitro* digestibility. Biotechnol. Animal Husbandry 28:603

AOAC. 1995. Official Methods of Analysis. Ass. Off. Agric. Chem. 17 th. Ed. Washington, DC

Chaji. M., Naserian, A.A, Valizadeh, R., Mohammadabadi, T. & Mirzadeh, K.H. 2010. Potential use of high-temperature and low-temperature steam treatment, sodium hydroxide and an enzyme mixture for improving the nutritional value of sugarcane pith. South African J. Anim. Sci. 40(1):22

CSIRO 2007. Nutrient Requirements of Domesticated Ruminants. CSIRO Publishing, 150 Oxford Street (PO Box 1139) Collingwood VIC 3066 Australia.

Duncan, D.B. 1955. Multiple range and multiple F tests. Biometrics. 11:1

Goering, H.K. & van Soest, P.J. 1970. Forage fibre analysis (apparatus, reagents, procedures and some applications). Agric. Handbook. No. 379, USDA, Washington, DC.

González, R.1995. Contribución al estudio de los factores que limitan el consumo de forraje de caña de azúcar por los bovinos. PhD Thesis. Instituto de Ciencia animal, La Habana. 130 pp.

InfoStat 2012. InfoStat professional. Versión 1.1 Universidad de Córdoba. Estadística y Diseño- F.C.A. Córdoba. Argentina

Juárez-Reyes, A.S., Cerillo-Soto, M.A., Gutiérrez-Ornelas, E., Romero-Trevillo, E.R., Colín-Negrete, J. & Bernal-Barragán, H. 2009. Estimación del valor nutricional de pastos tropicales a partir de análisis convencionales y de la producción de gas *in vitro*. Técnica. Pec. Méx. 47:55

Krizsan, S. J., Nyholm, L., Nousiainen, J., Südekum, K.H. & Huhtanen, P. 2012. Comparison of *in vitro* and *in situ* methods in evaluation of forage digestibility in ruminants. J. Anim. Sci. 90: 3162

Martín, P. C. 2004. La alimentación del ganado vacuno con caña de azúcar y sus subproductos. Ed. Instituto de Ciencia Animal. La Habana. p. 234

Mohammed, H.A., Babiker, S.A., Abd Elnasir, M.A., Fadel, E. & Abdelrahman, M.M. 2013. Effect of Urea-treatment on Nutritive value of Sugarcane Bagasse. ARPN J. Sci. Technol. 3 (8): 834 – 838.

Molina, A., Leal, P., Vera, A., Milanés, N., Pedroso, D. & Tuero, O. 1999. Forage evaluation of sugar cane industrial varieties. *In situ* digestibility. Cuban J. Agric. Sci. 33:369

Pires, A. J. V., Reis, R. A., Carvalho, G. G. P., Siqueira, G.R. & Bernardes, T. F. 2006. Bagaço de cana-de-açúcar tratado com hidróxido de sódio. Rev. Bras. Zoot. 35:953

Rodríguez, Y., Aguilera, I., Stuart, J. R. & Islén, P. 2007. Inclusión del PREDICAL en raciones para el ganado en crecimiento-ceba en la etapa de menor rendimiento de los pastos. Segundo Congreso de Producción Animal Tropical. Instituto de Ciencia Animal. La Habana. p. 96

Sabbagh Zade, M., Dabiri, N., Fayazi, J. & Boujar Pour, M. 2009. Determination of Optimum Level of Steam Pressure Hydrolyzed Pith Bagasse in Feeding of Crossbred Beef. Res. J. Biol. Sci. 4 (7): 773

Valenciaga, D., Chongo, B. & La O, O. 2001. Characterization of Pennisetum CUBA CT-115 clone. Chemical composition and rumen DM degradability. Cuban J. Agric. Sci. 35:325

Villar, J. 2010. Alimento animal y energía de la caña de azúcar. Rev. IDICA. 43(1): 41

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