HUSBANDRY AND NUTRITION

Original

Effect of Drying Sicklebush (*Dichrostachys cinerea* (L.) Wright *et* Arm) Leaf Petioles from Two Different Plant Heights on *in vitro G*as Production

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ABSTRACT

Background: Studies of the nutritional value of *Dichrostachys cinerea* leaf-petioles are insufficient to define sample drying in various *in vitro* digestibility studies. The aim of this research was to calculate *in vitro* gas production, and provide better fit model parameters, as indicators of foliage digestibility from two different plant heights, using two drying methods.

Methods: The samples were collected at random (1 m and 2 m high), by hand, from 10 different trees, during the dry season, simulating total plant leaf browsing. Each sample was divided in two for the different drying treatments (room temperature for approximately 96 h, and 55 ºC in a stove), to constant weight. The influence of plant height and drying temperature on the volumes of *in vitro* gas produced at 24, 48, and 72 h, in cattle feces, were evaluated through simple analysis of variance of factor combinations.

Results: *In vitro* gas production from 2 m high plant leaf-petioles dried at 55 °C was significantly lower than the rest of the temperature-height combinations evaluated.

Conclusions: The better fit parameters of the equations for *in vitro* gas production from *Dichrostachys cirenea* in leaf-petioles showed their potential for ruminant nutrition, due to the high nutritional values, similar to several forage shrub-like species of leguminosae.

Key words: nutritional value, leguminosae, foliage, digestibility, *in vitro* (Source: *AIMS)*

INTRODUCTION

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Pasture is an economical and easily accessed source of foods for livestock. An abundant grassland guarantees the production of meat, milk, and other derivatives, which are necessary for human nutrition, which ensures proper sustainability and maintenance of livestock productions. The presence of sicklebush (*Dichrostachys cinerea)* in grasslands hinders quality and productivity of pasture. This becomes more important under the current conditions of the world, making the acquisition of raw materials to produce feedstuffs, like grains, a difficult task. Besides competing with the growing demands and human nutrition, grains like corn, are also being used to produce energy, in the form of biofuels (Folliero and Laya, 2008).

Sicklebush (*D.cinérea*) is originally from South Africa, though it also grows in Asia (Pakistan), and was introduced in the Americas (the United States and Cuba) by humans, at an undetermined date yet. It is a shrub or tree-like with thorny branches, from the leguminosae family. It never grows in isolation, but forming compact clusters which are impenetrable, and may grow up to 8-10 m high. In Cuba, sicklebush has been estimated to cover 1.7 million hectares, many of which are fertile lands that were previously cultivated. This species spreads quickly, so it is very difficult to eradicate (International Network of model Forests, 2017).

It is useful for animal nutrition, especially the fruits, seeds, and forage, by cattle, sheep, goats, camels, giraffes, buffaloes, antelopes, and others. Most of these animals eat the pods that fall on the ground, and consume young branches and leaves, which are rich in protein (11-18%) and minerals. The leaves and pods of the plant remain attached during the dry season, where pasture availability may be limited (Heuzé, Tran, and Giger-Reverdin, 2015).

Polyphenols have an inhibiting effect on a series of enzymes like proteases, zymogenes, lipases, α-amylases, cellulases, β-glucosidases, and ureases, which, accordingly, depress food digestibility. They also inhibit the digestion of protein in the rumen, reducing ammonia concentrations (Lasa, Mantecón, and Gómez, 2010).

Drying foliage with high polyphenol contents, like *D. cinerea´s,* may have an influence on its biological activity, and may lead to mistaken interpretations in *in vitro* digestibility studies. In that sense, this influence must be assessed for inclusion in further studies.

In this paper, in vitro gas production and the better fit model parameters are studied as indicators of digestibility of leaf-petiole of *D. cinerea* plants dried naturally and in a stove at 50 ºC.

MATERIALS AND METHODS

Sample processing

Collection, transportation, and processing of samples used in this study are described in a recently published Technical Note by Espinosa, Martínez, Pedraza, and González (2020).

In vitro digestibility

The gas production technique recommended by Menke and Steingass (1988) was used in 100 mL glass syringes (FORTUNA®, Häberle Labortechnik. Germany), modified to use recently deposited cattle feces as inoculum, which were dissolved in buffered mineral medium (b.m.m.), in a 1:4 proportion. An analytical balance was used to weigh 200 mg of the dry samples, which were then placed in the syringes. Then they were shaken softly before being placed in Luke warm bath, at 39 °C, and after, 3, 6, 24, 48, 72, and 96 h of incubation, the inocula were read. In each of the three runs, only the inoculum+buffer solution was placed in two syringes, used as target. Other two contained 200 mg of ground guinea grass, used as reference to correct the differences between runs, and three contained each sample. The calculation of better fit models and correction of experimental values were done according to Martínez, Pérez, González, and Olivera (2014). The model used was

$V = 0$ ti $t <= lag$
$V = b*\exp(-ct)$

Where:

Lag, b, and c are the parameters of the model.
V volume of gas produced in ml
t-time in hours.

The better fit of the model was done by linear programing on a spreadsheet, using Excel Solver for minimal square error.

Statistical processing

Samples were collected from two different heights (1 and 2 m), which were used as independent variables; the samples were dried at two different temperatures (55 °C, and room temperature). Three variables were used in each case.

A simple analysis of variance was performed to determine the possible influence of the variables studied on the gas volumes, at 24, 48, and 72 h, following correction. The differences between the means were determined according to the Duncan's test (1955), $p < 0.05$. STATGRAPHICS® Centurion XVI (2012) was used for statistical analysis.

RESULTS AND DISCUSSION

The results of gas production are shown in figure 2, and are similar to the ones produced by Rodríguez (2012) using graminaceae, though the 55 °C was for samples collected at 2 m, which was lower than the other temperature values and heights evaluated in the same experiment.

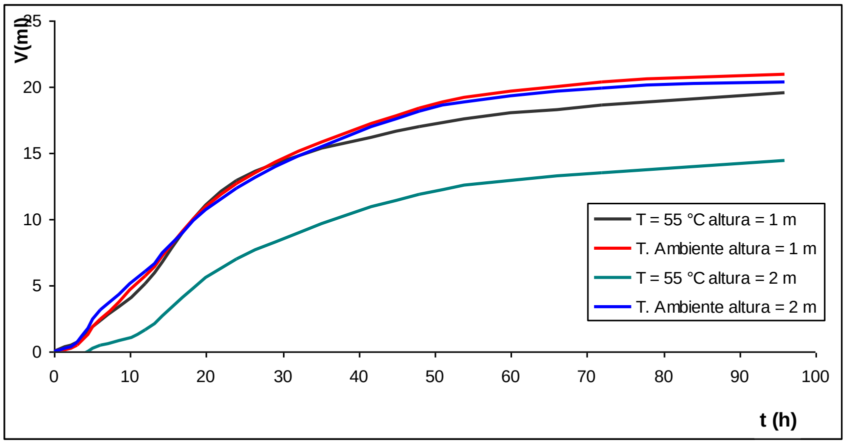

Fig. 1. Dynamics of in vitro gas production, according to the leaves of *D. cinerea* at different drying temperatures and reshooting heights.

A study done by Pedraza *et al.* (2008) of *D.cinerea* using heights of up to 153 cm, found lower gas productions than the results of this work, which may be influenced by different factors, including the strength of the inoculum used to produce gas.

By arranging groups of leguminosae to study gas production, Martínez, Olivera, Viera, and González (2009) found that in the first group (*Gliricidia sepium*, *Haematoxilum. brasiletto, Leucaena leucocephala, Stilosanthes viscosa*, *Chamaecrista lineada*, *Desmodium barbatum*), the production of gas was higher than the gas produced by the samples of *D.cinerea* evaluated in the current study.

In *D.cinerea*, the study reported high contents of antinutritional factors (Pedraza *et al.* 2008). The authors say that when PEG4000 is added, the production of gas rises significantly because polyphenols are blocked. In *D.cinerea,* this is a remarkable increase (over 50%), and it explains the limited incorporation in the diet of ruminants.

That study was done by Fernández Gálvez *et al*. (2016), based in the integral fraction of two new sugar cane cultivars used as forage, at 6, 8, and 11 months of reshooting. At 8 months, the study says that the three cultivars have reached the optimum moment for use as animal food. At this age they can be better consumed by ruminants, since the production of gas reaches much higher values (32.7 ml-52.1 ml) than the ones found in this research, considering this plant is a graminaceae. This behavior may be associated to the fact that the plant has higher contents of CP and less fiber at eight months than at 11. Furthermore, in spite of having greater fiber contents at six months, it also has higher contents of CP and soluble carbohydrates, which facilitate the process of food degradation.

A research done by Rodríguez, Pujal, Olivera, and Martínez (2008) on leguminosae, which included *D.cinerea*, concluded that the production of gas of 17.2 ml is within the ranges found in this study.

Table 1 only shows the production of gas for 72 h, since between this time and 96 h, it remains without significant change.

Table 1. *In vitro* gas production from different samples collected at different heights and using different drying methods

Temperature	Height (m)	Time (h)		
		24	48	72
T = 55 °C	1	12.9[a]	17.9[a]	19.5[a]
Room T	1	12.7[a]	18.4[a]	20.4[a]
T = 55 °C	2	11.8[b]	13.5[b]	14.1[b]
Room T	2	12.4[a]	18.2[a]	19.8[a]
SE		0.22	0.36	0.49

Unequal letters on each column indicate a significant difference (p<0.05) (Duncan, 1955). SE = Standard error

At 2 m and 55 °C, the production of gas was significantly low ($p<0.05$). This behavior may be given by the difference in the bromatological composition at higher positions (less protein) and more dry matter, which can have a negative influence on *in vitro* digestibility. This topic requires more detailed studies.

Parameter b is a measure of the food potential to deliver digestible matter into the ruminal environment, whereas c measures the speed of material degradation and lag adaptation time (Ørskov and McDonald, 1979).

Fernández Gálvez *et al*. (2016) in sugar cane cultivars, reported a lag between 2.10 and 4.57 hours, similar to the ones in the table, except for the 2 m height at 55 °C, with 8.0 hours.

The leaves collected from 2 m *D. cinerea* plants, which were dried at 55 °C, had a lower potential of delivering digestible matter into the rumen than the leaves in the other three variants. Also, this combination had the greatest *lag* phase, which may be caused by changes in its chemical composition, that make microorganic colonization more difficult. These values are coherent with the ones shown in table 2, and also require further studies.

Table 2. Better fit parameters, model suggested by Martínez, Pérez, González, and Olivera (2014)

Drying temp.	Height (m)	*lag* (h)	b (ml)	c (h^{-1})	Typical error
55 °C	1	3.3	19.5	0.046	1.3
Room T	1	3.1	21.3	0.043	1.5
55 °C	2	8.0	15.0	0.040	0.9
Room T	2	2.2	21.1	0.040	1.4

***lag*-adaptation phase b-potential gas volume c-specific growth speed.**

In three groups studied by Martínez, Olivera, Viera, and González (2009) *b* and *c* had different values. Group 1 (*G. sepium, H. brasiletto, L. leucocephala, S. viscosa, Ch. lineada, D. barbatum*) showed higher values of *b* and similar values of *c*, though a little below the results of the samples of *D. cinerea* from 1 m high, dried at 55 °C. In group 2 (*D. cinerea, P.maximun, P. purpureum, S. officinarum)*, which included sicklebush, *b* was similar (19.0 ml), and the value of *c* was lower (0.02 h^{-1}). In group 3 (*A. bilimekii* and *A. pennatula*), the value of b was close to the ones reported in the current research, regarding 2 m high plants, dried at 55 °C.

CONCLUSIONS

The better fit parameters of the equations for *in vitro* gas production from *Dichrostachys cirenea* leaf-petioles showed their potential for ruminant nutrition, due to the high nutritional values, similar to several forage shrub-like species of leguminosae.

The drying type and plant height had an influence on *in vitro gas* production from *D.cineres* leaf-petioles, particularly the samples from the 2 m high plants, dried at 55 °C, with a lower production.

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AUTHOR CONTRIBUTION

Conception and design of research: EE, SM, RP; data analysis and interpretation: EE, SM, ML; redaction of the manuscript: EE, SM, RP.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.