Fermentation parameters of kikuyu grass (*Pennisetum clandestinum*) by *in vitro* gas production technique (IVGPT)

A Marín, P Giraldo and LA Giraldo

Universidad Nacional de Colombia, Bogotá, Cundinamarca 111321, Colombia, www.unal.edu.co
Contact email: amaring@unal.edu.co

Keywords: Kikuyu grass, fermentation, methane, *in vitro*, Colombia.

Introduction

Methane (CH_4) is a byproduct of ruminal fermentation whose production is directly related to forage quality, which in turn is affected by a myriad of environmental factors. In general the quality of pastures in the tropics range from medium to poor due to a high content of lignocellulosic material of low digestibility and a low content of other components, such as soluble carbohydrates and protein (Correa *et al*, 2008). CH_4 produced by enteric fermentation from cattle rumen represents a major source of greenhouse gases (GHG). By measuring these emissions the impact of dairy production systems on the climate change can be determine.

In Colombia and in specifically in the Department of Antioquia, dairy herds are characterized by using diets based on kikuyu grass (*Pennisetum clandestinum*) supplemented with concentrates. Once in the rumen the forage /concentrate combination are used as substrate for ruminal fermentation to generate usable energy but also unusable one represented by methane production. The energy losses due to diets based on kikuyu are unknown. Thus, the measurement of its fermentation products has become an important necessity in order to achieve greater efficiency in the livestock production systems which are also environmentally friendly and economically competitive. Despite some important progress in Colombia, the potential impact of livestock on global warming is still unknown so that measuring of CH_4 emissions is a crucial imperative. In the dairy zone located in the northern part of Antioquia, where daily two millions liters of milk are produced, there are around 185,000 ha in kikuyu pasture. The overall objective of this research was to measure the parameters of fermentation and CH_4 production of kikuyu pastures from dairy systems of Antioquia, using the *in vitro* gas production technique (IVGPT).

Methods

Based on a country wide inventory of the numbers of dairy cattle and volumes of milk produced, five regions of Antioquia, Colombia (South America) were selected for the study, and within each region four farms were chosen as the data collection sites. In total, 20 samples of kikuyu grass were taken. Chemical composition for each sample was determined: matter dry (% DM) organic matter (% OM), crude protein (% CP), neutral detergent fiber (% NDF), acid detergent fibre (% ADF), lignin percentage, ash percentage, and ether extract (% EE) (Table 1).

Incubations *in vitro* were performed (IVGPT) for 24 hours from samples of 0.5 g of dry kikuyu grass and ruminal fluid collected from four cannulated Holstein cows. During the incubation, the supply of CO_2 was permanent and temperate maintained at a constant 39°C. The products of the *in vitro* fermentation measured included: gas production (mL); dry matter degradation (% DMD); pH units; ammonia nitrogen (NH_3-N); volatile fatty acids concentration (VFA); and CH_4 production expressed as mL/g of incubated dry matter (DMi) or digested dry matter (DMd).

For purposes of statistical analysis a randomized block design (RBD) was performed; and means were compared by Tukey test with significance level of 5%. GLM procedure of SAS statistical program was used.

Results and Conclusions

The mean values of the IVGPT products such as accumulated gas, dry matter digestibility, pH, ammonia nitrogen, and volatile fatty acids profile (Table 2) are comparable to those reported for kikuyu grass in Colombia (Correa *et al*. 2008) and in others countries (Tavendale *et al*. 2005). However, the acetic:propionic acids ratio was lower than those reported by Tahmasbi *et al*. (2005). The main differences were found in region 2 in relation to the other regions (P <0.05). Region 2 recorded the poorest quality of grass perhaps due to deficiencies in pasture management. As a consequence of these differences, the results of CH_4 production in these were also the highest (P<0.05). It is

Table 1. Chemical composition expressed as dry matter percentage of kikuyu grass (*Pennisetum clandestinum*) from five regions of Antioquia-Colombia (South America).

	% Ashes	% OM	%NDF	%ADF	% Lignin	% CP	% EE
Mean	9.85	90.15	62.47	27.31	2.86	19'31	3.14
min	8.31	88.00	53.87	23.28	1.66	9.95	2.20
max	12.00	91.69	70.49	32.13	4.94	24.23	4.21

Dry matter (%DM), Organic matter (% OM), Crude protein (%PC), Neutral detergent fiber (%NDF), Acid detergent fibre (%ADF), Ether extract (%EE). n=20.

Table 2. Mean values of the *in vitro* fermentation products of kikuyu grass (*Penissetum clandestinum*) after 24 hours of incubation.

	Region					
	1	**2**	**3**	**4**	**5**	**P**
Gas (mL)	99.98 ab	108.93a	95.21 b	94.83 b	103.59 ab	*
DMD (%)	57.07	58.46	51.68	54.04	53.35	N.S
pH (U)	6.52 b	6.55 ab	6.59 a	6.54 ab	6.56 ab	*
NH_3-N (ppm)	193.44 b	254.89 a	158.97 b	136.47 b	135.97 b	*
VFA Total (mmol/L)	15.21 b	19.75 a	16.06 b	16.24 b	16.04 b	*
Acetic (mmol/L)	9.72 b	12.96 a	10.39 b	10.47 b	10.36 b	*
Propionic (mmol/L)	4.42 b	5.19 a	4.43 b	4.55 ab	4.32 b	*
Butiric (mmol/L)	1.07 b	1.59 a	1.24 a	1.21 b	1.35 ab	*
Acetic:Propionic	2.20 d	2.50 a	2.36 cb	2.30 cd	2.41 ab	*
CH_4 mL/g MSi	30.80 c	72.76 a	46.12 b	40.39 bc	48.72 b	*
CH_4 mL/g MSd	54.20 c	124.64 a	89.97 b	75.36 bc	88.98 b	*

DMD: dry matter digestibility, NH_3-N: ammonia nitrogen, VFA: volatile fatty acids, CH_4 mL /g MSi: mL of methane per g of incubated dry matter, CH_4 mL /g MSd: mL of methane per g of digested dry matter; [a-d] Means with different letters between rows differ significantly *P <0.05, N.S: not significant

concluded that IVGPT is a useful tool for measuring CH_4 emissions from which decisions can be made leading to make more profitable the livestock industry and to mitigate GHG emissions produced by our livestock.

References

Correa CHJ, Pabón RML, Carulla FJE (2008) Valor nutricional del pasto kikuyo (*Pennisetum clandestinum* Hoechst Ex Chiov.) para la producción de leche en Colombia (Una revisión): I - Composición química y digestibilidad ruminaly posruminal. *Livestock Research for Rural Development* 20(Article #59. Retrieved March 30, 2013, from http://www.lrrd.org/lrrd20/4/corra20059.htm).

Tahmasbi R, Nolan JV, Dobos RC (2005) Comparison of the volatile fatty acid profiles of dry and fresh kikuyu incubated with rumen fluid in vitro. *Recent Advances in Animal Nutrition* **15**, 32A.

Tavendale MH, Meagher LP, Park NG, Waghorn GC, Attwood GT (2005) Methane production from in vitro incubation of kikuyu grass, lucerne and forages containing condensed tannins. *Proceedings of the New Zealand Grassland Association* **67**, 147-53.