Short note [Nota corta]

BIOGAS PRODUCTION AND *In vitro* CH_4 FROM EXCREMENT OF CATTLE, SHEEP, PIGS AND HEN[†]

[PRODUCCIÓN DE BIOGAS Y CH_4 *In vitro* A PARTIR DE EXCRETAS DE BOVINOS, OVINOS, CERDOS Y GALLINAS]

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SUMMARY

The aim of this research was to evaluate the effect of pig, ovine, bovine and hen excreta on biogas production and in vitro methane. Five kg of fresh excreta from cattle, sheep, pigs and hen was used. Each excreta were mixed with water at a ratio of 1: 4. Subsequently, 600 ml of the mixture was poured into bottles of 1-liter nominal capacity, sealed hermetically and kept at 39-40 °C. The total gas production and methane was evaluated. The highest ($P<0.05$) total gas production was observed in in vitro digesters with hen excreta (27.1 L gas/kg excreta). Methane production and percentage of methane in the gas produced was higher ($P<0.05$) on in vitro digesters with sheep excreta (8.3 L methane/kg of excreta and 74.7% respectively). The excreta of sheep can be used as a substrate in anaerobic biodigesters due to the potential of methane production.

Keywords: Biogas production; methane; excrement; livestock systems.

RESUMEN

El objetivo de esta investigación fue evaluar el efecto de las excretas de cerdos, ovinos, bovinos y gallinas sobre la producción de biogás y metano *in vitro*. Cinco kg de excreta fresca de bovinos, ovinos, cerdos y gallinas fue utilizado. Cada excreta se mezcló con agua a relación 1:4. Posteriormente 600 ml de la mezcla se vertió en frascos de 1 litro capacidad nominal, se sellaron herméticamente y se mantuvieron a 39 - 40 °C. Se evaluó la producción de gas total y metano. La mayor ($P<0.05$) producción de gas total se observó en los digestores *in vitro* con excretas de gallinas (27.1 L gas/kg de excreta). La producción de metano y porcentaje de metano en el gas producido fue mayor ($P<0.05$) en los digestores *in vitro* con excretas de ovino (8.3 L metano/kg de excreta y 74.7 % respectivamente). Las excretas de ovinos pueden usarse como sustrato en biodigestores anaerobios debido al potencial de producción de metano.

Palabras clave: Producción de gas; metano; excremento; sistemas ganaderos

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INTRODUCTION

The use of energy from non-renewable sources is decreasing every time, due this resource is running out. Renewable energy emerges as a solution to this global problem. One of the factors that impede its development is its cost, because fossil fuels and nuclear energy in some countries have received subsidies (Cerdá Tena, 2012). In this context, a viable alternative for the generation of energy is the use of excreta from livestock systems, as it leads to a sustainable production and friendly to the environment (Núñez Camargo, 2012).

The anaerobic digestion of animal excrements by means of biodigesters is the process by which we can obtain biogas as a source of energy and biofertilizers (Villanueva Hernández et al., 2011). Previous studies show that when mixing bovine excreta with water in a ratio 1:1 and excreta of hen with water in a ratio 1:2, 6.33 m^3 and 0.83 m^3 of biogas were obtained respectively (Recebli et al., 2015). In this sense, Canepa et al. (2014) reports that the residual biomass of bovines when mixed with water (1:1 v/v) in a biodigester and fermented for 45 days, 62.12% methane was obtained, from the total of gas produced. Likewise, Pantoja Cabrera and Parra Paz (2017) report that by incorporating excreta from pigs, organic waste (kitchen waste, waste from agricultural activities) and water (57.2, 12.8 and 30% respectively) into a biodigester, 99.3% of methane was obtained, of the total gas produced. Based on this background, the objective of this research was to evaluate the effect of excreta from pigs, sheep, cattle and chickens on the production of biogas and methane.

MATERIALS AND METHODS

Location, Collection of excreta and preparation of samples

The present experiment was carried out in the Faculty of Agricultural Sciences of the Technical University of Ambato, Querochaca campus, Ambato, Ecuador

Five kg of fresh excreta from cattle, sheep, pigs and hen was collected. Each excreta were mixed with water at a ratio of 1: 4. Subsequently 600 ml of the mixture was poured into bottles of 1-liter nominal capacity. Each bottle was hermetically sealed with rubber and aluminum cap, adaptation of the in vitro gas production methodology described by (Theodorou et al., 1994).

Gas and methane production

The bottles were incubated at 39 °C in a Water Bath to achieve the mesophilic stage, and gas production was measured with a DELTA OHM pressure transducer (Pressure Data Logger DO9704, Italy) and methane with a gas monitor GX-6000 (gas analyzer RKI Instruments, GX-6000, Tokyo, Japan) and plastic syringes at 12, 24, 36, 48, 60, 72, 84, 96, 120, 144, 168, 192 and 216 h. The data were adjusted to the equation GV $(1 + (B/t) C)^{-1}$ (Groot et al., 1996).

Experimental design and statistical analysis

A completely randomized design was used, with four treatments and six repetitions. The variables were analyzed by means of an ANOVA using the PROC GLM of the SAS. And the comparison of means was made using the Tukey test.

RESULTS AND DISCUSSION

The highest ($P<0.05$) total gas production (GV) was observed on *in vitro* digesters with hen excreta (27.1 L gas / kg excreta). The production of methane and percentage of methane in the gas produced was higher ($P<0.05$) in the *in vitro* digesters with sheep excreta (8.3 L methane/kg of excreta and 74.7% respectively) (Table 1 and Figure 1).

The results obtained in the gas production (L gas/kg of excreta) in the fermenter with hen manure was possibly due to the concentration of nitrogen and non-structural carbohydrates that contain the excrement, which benefits the production of gases such as hydrogen sulfide, carbon dioxide, nitric oxide, nitrogen dioxide and methane, the latter in low quantities (Table 1, Figure 1), these results are consistent with those reported by Palacio (2005) and Solano et al. (2011).

However, the highest methane production and proportion methane by gas produced in the digester with sheep excreta was possibly due to the fact that the nature of the excrement (encapsulated) conserved better the methane producing microorganisms with respect to the manure of cattle, these microorganisms (methanogenic Archaea) that coexist in the rumen are responsible for producing about 60% enteric methane in ruminants, and that being found in the manure of ruminants could favor the production of methane under conditions of anaerobic fermentation in biodigesters (Alvarez and Lidén, 2009) in relation to other excreta, something observed in this investigation (Table 1). These results are consistent with those reported by Sarabia Méndez et al. (2017).

CONCLUSIONS

Under the conditions of this study, sheep excreta can be used as a substrate in anaerobic biodigesters due to the potential for methane production.

Table 1. Parameters of gas and methane production from excreta from pigs, hen, cattle and sheep under *in vitro* biodigester conditions.

	Excreta				
	Pigs	Hen	cattle	Sheep	Value P
Total Gas					
GV	9,9±1,68b	27,1±0,69a	3,3±0,78c	11,1±1,65b	<0.05
B	80,5±33,54b	39,7±1.83c	164,9±47,30a	88,4±20,80b	<0.05
c	0,891±0,1562b	1,548±0,1036a	1,699±,02531a	1,505±0,2811a	<0.05
CH_4	5,1±0,55 b	5,0±0,88b	0,540±0,1141c	8,3±0,20a	<0.05
B	65,4±12,18b	84,5±22,02ab	119,4±21,62a	59,0±1,720c	<0.05
c	1,431±0,2496b	1,635±0,3972b	3,253±1,063a	4,200±0,4766a	<0.05
%CH_4/total gas	51.51b	18.4c	16.36c	74.77a	<0.05

[a,b,c] Medias con letras distintas entre filas difieren significativamente (p<0.05). GP, B y c: are the parameters of the mL gas equation or $CH_4 = GV\ (1 + (B/t)^C)^{-1}$ (Groot et al. 1996) (see text)

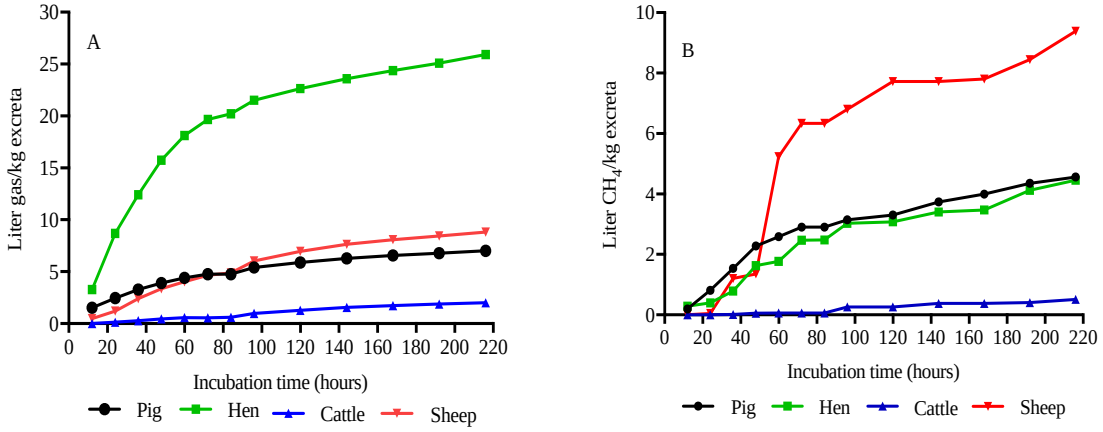

Figure 1. Biogas production kinetics (A) and methane (B) (liters/kg of excreta) from excreta from pigs, hen, cattle and sheep under *in vitro* biodigester conditions.

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