

Sustainable Agriculture through ICT innovation

Composition of biogas obtained in batch biodigesters from manure of broilers fed a diet with probiotic and exogenous enzymes**

Poster presentation

Environmental information systems/Environmental management systems
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ABSTRACT

The objective was to assess the chemical composition of biogas obtained in batch biodigesters from manure of broilers fed a diet with probiotic and exogenous enzymes. In a completely randomized design, the study included 4 treatments with manure from broilers (Cobb®), ages between 43 and 48 days, raised in cages, and fed different diets: a negative control (NC, control diet without feed additives); probiotic (PRO, the NC diet + 500 ppm of a product containing *Bacillus subtilis*); exogenous enzymes blend (ENZ, the NC diet + 20 ppm phytase+200 ppm protease+200 ppm xylanase); and a treatment combining both feed additives in the NC diet (P+E). Each treatment had 4 replicates in the batch biodigester. The manure was collected, identified and prepared (4% total solids). The volume per batch was the same (1.8 kg) for all biodigesters, with manure (0.301 kg) + water (1.499 kg). The vertical displacement of the gasometers was measured daily and the values were multiplied by their internal transversal section (0.00785 m²) to determine the biogas volume accumulated in 142 days. The gasometers were reset after each reading using the discharge valve. The biogas volume was corrected for 1 atm and 20°C. The biogas composition analyses were performed every week to determine the amounts of methane (CH₄) and carbon dioxide (CO₂), using a Finnigan GC-2001 gas chromatograph equipped with Porapak Q and Molecular Sieve columns, as well as a thermal conductivity detector. The results were given as cubic meters (m³) and percentage of CH₄, CO₂ and other gases that were produced. The data underwent variance analysis employing the *General Linear Model* procedure using the SAS® software. The data underwent variance analysis employing the *General Linear Model* procedure using the SAS® software. Averages were then compared by the Tukey test with a significance level of 5%. It was found that there was no statistical difference

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“**Composition of biogas obtained in batch biodigesters from manure of broilers fed a diet with probiotic and exogenous enzymes**”. EFITA-WCCA-CIGR Conference “Sustainable Agriculture through ICT Innovation”, Turin, Italy, 24-27 June 2013. The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the International Commission of Agricultural and Biosystems Engineering (CIGR) and of the EFITA association, and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

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($P < 0.05$) between the treatments as to the production of CH_4 , CO_2 and other gases. The treatments with additives (PRO, ENZ and E+P) resulted in a gas production (CH_4 , CO_2 and others) that was statistically similar to that of birds fed the NC diet. The poultry manure produced an excellent amount of CH_4 in relation to the other gases (NC-80.04; PRO-80.79; ENZ-81.30; P+E-79.29). It can be concluded that additives included in the diets for birds do not interfere with CH_4 production, a gas essential for clean energy production.

Keywords: Digester, methane, *Bacillus subtilis*, carbon dioxide.

1. INTRODUCTION

The Brazilian poultry production increases year after year, generating high amounts of residues. It is essential to think about management and disposal of these residues, in order to minimize the impacts that they cause mainly due to the high nitrogen and organic carbon concentrations present in this material. The alternative available in rural areas is the anaerobic biodigestion of plant or animal organic material with biogas production.

Methane (CH_4) and carbon dioxide (CO_2) are the main components of biogas, with traces of O_2 , N_2 , H_2S , etc. Biogas can be used as energy in the farm for lighting and for heating the chicks, for example. According to Lucas Junior. (1987), the methane calorific value is $9,100 \text{ kcal/m}^3$ at 15.5°C and 1 atm, its flammability occurring when mixed with air at 5 to 15%. Due to the presence of other gases besides methane, the calorific value of biogas varies between $4,800$ and $6,900 \text{ kcal/m}^3$.

Considering the increasing prices of energy inputs, the use of fossil fuels becomes extremely expensive. Considering the climate conditions and its vocation as poultry producer, biogas and other forms of energy related to biomass are important alternatives to supply energy to poultry farms in Brazil, thus contributing to a more sustainable production chain.

As feeding is an important factor in broiler production, the present study was designed to assess the composition of biogas produced with manure from broilers fed different diets containing additives (probiotic and enzymes) and treated in batch biodigesters.

2. MATERIAL AND METHODS

In a completely randomized design, the study included 4 treatments with the manure from broilers (Cobb®), ages between 43 and 48 days, raised in cages. The treatments consisted of different diets for broiler chickens containing exogenous enzymes and *Bacillus subtilis*. The diets were based on corn and soybean meal, and

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were supplemented with minerals, vitamins and amino acids to meet the nutritional requirements according to Rostagno et al. (2005) recommendations. A nutritional matrix of each enzyme was used to ensure the proper diet formulation. The added *Bacillus subtilis* is present in a commercial product currently tested in birds. Treatments were as follow: a negative control (NC, a control diet without feed additives); probiotic (PRO, the NC diet + 500 ppm of a product containing *Bacillus subtilis*); exogenous enzymes blend (ENZ, the NC diet + 20 ppm phytase + 200 ppm protease + 200 ppm xylanase); and a treatment combining both feed additives in the NC diet (P+E). Each treatment had 4 replicates in the batch biodigester.

The manure was collected, identified and prepared (4% total solids). The volume per batch was the same (1.8 kg) for all biodigesters, with manure (0.301 kg) + water (1.499 kg). The vertical displacement of the gasometers was measured daily and the values were multiplied by their internal transversal section (0.00785 m²) to determine the biogas volume accumulated in 142 days. The gasometers were reset after each reading using the discharge valve. The biogas volume was corrected for 1 atm and 20°C.

The biogas composition analyses were performed every week to determine the amounts of methane (CH₄) and carbon dioxide (CO₂), using a Finnigan GC-2001 gas chromatograph equipped with Porapack Q and Molecular Sieve columns, as well as a thermal conductivity detector. The results were given as cubic meters (m³) and percentage of CH₄, CO₂ and other gases that were produced.

The data underwent variance analysis employing the *General Linear Model* procedure using the SAS® software. Averages were then compared by the Tukey test with a significance level of 5%.

3. RESULTS AND DISCUSSION

In the analyses of gas composition, the average amounts of methane produced in the biogas burning test were determined. It was found that there was no statistical difference (P<0.05) between the treatments as to the production of CH₄, CO₂ and other gases. The treatments with additives (PRO, ENZ and E+P) resulted in gas production (CH₄, CO₂ and others) that was statistically similar to that of birds fed the NC diet. The poultry manure produced an excellent amount of CH₄ in relation to the other gases (NC-80.04; PRO-80.79; ENZ-81.30; P+E-79.29) (Table1).

It is reported by Silva (1998) that the biogas composition can vary from 60 to 70% of methane. Several authors found values within this range: using bench biodigesters operated at 35°C and with a hydraulic retention time of 30 days, Miranda (2005) found biogas with 65.73% methane; Orrico Junior (2008) obtained 66.55% methane in biogas generated in bench biodigesters operated with a hydraulic retention

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time of 29 days. In the present study, the values of biogas composition are higher than expected for all treatments when compared to the authors mentioned above.

Table 1. Averages, F and P values, and coefficient of variation of total biogas volume produced and composition of biogas produced from manure of poultry fed a diet containing probiotic and exogenous enzymes. The manure was treated in batch biodigesters.

Treatments	Characteristics					
	Volume (m ³)			Ratio (%)		
	Biogas	CH ₄	CO ₂	CH ₄	CO ₂	Other gases
NC	0.022	0.017	0.0040	79.99	18.51	1.49
PRO	0.024	0.019	0.0042	80.52	17.93	1.55
ENZ	0.023	0.019	0.0040	81.36	17.22	1.42
P+E	0.023	0.018	0.0043	79.24	18.61	2.11
F Values	0.42	0.62	0.29	1.52	1.10	2.79
P values	0.74	0.61	0.83	0.26	0.39	0.08
CV¹	10.44	10.17	13.69	1.80	6.88	22.97

¹Coefficient of variation; Averages with different letters in the same column are statistically different; NC= control diet without feed additives; PRO= NC + 500 ppm of product containing *Bacillus subtilis*; ENZ= NC + 20 ppm phytase, 200 ppm protease and xylanase; P+E= NC+PRO+ENZ.

Figure 1 shows the methane production (m³) during the entire experimental period (142 days), from the first day of gas collection (before and after burning the biogas). There were no major variations in the amount of methane present in the biogas, but a numerically higher methane production was found in the treatment that included only exogenous enzymes.

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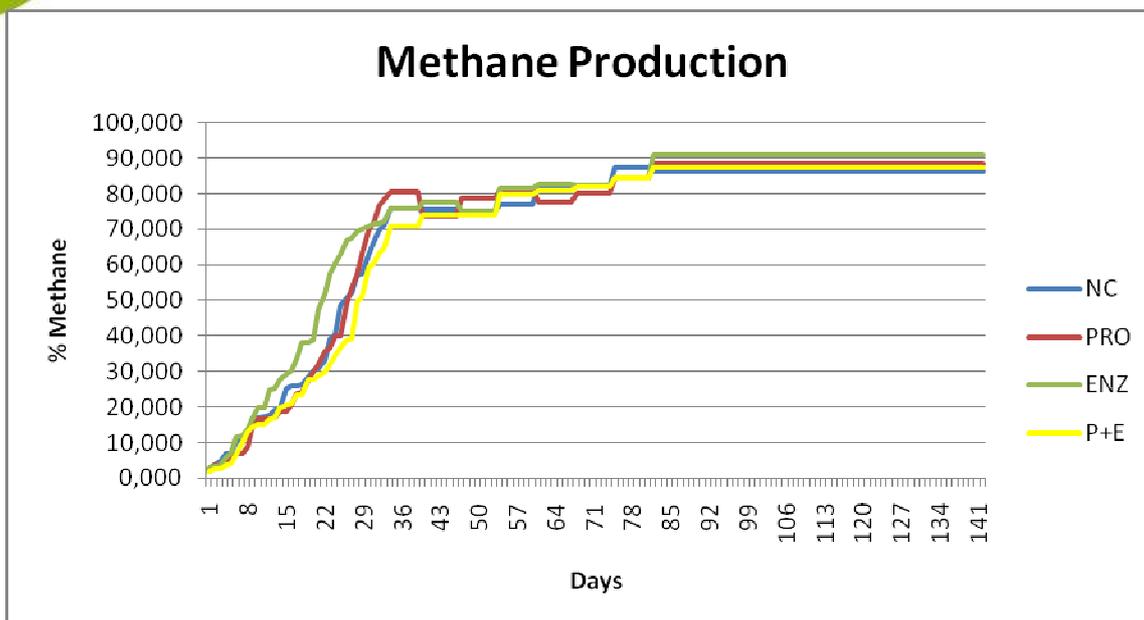


Figure 1. Methane distribution (%) in 142 days of production.

4. CONCLUSION

It can be concluded that additives included in the birds diets did not interfere with CH₄ production, a gas essential for clean energy production.

5. ACKNOWLEDGEMENTS

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