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Effect of dietary inclusion of dried or autoclaved sugarcane bagasse and vinasse on live performance and *in vitro* evaluations on growing rabbits

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ABSTRACT

The current study was conducted to evaluate the potential use of dried or autoclaved sugarcane bagasse, enriched or non-enriched with vinasse, in diets for growing rabbits, by assessing the growth and slaughtering performance, *in vitro* digestibility, degradability and fermentation parameters. A total of 110 rabbits were used, distributed in five groups with 22 animals each in a completely randomized design and fed diets containing: 100 g/kg of dried sugarcane bagasse (DB); 100 g/kg of dried sugarcane bagasse enriched with vinasse (DBV); 100 g/kg of autoclaved sugarcane bagasse (AB); 100 g/kg of autoclaved sugarcane bagasse enriched with vinasse (ABV); and a control diet, without bagasse or vinasse. The *in vitro* assays were conducted employing cecum inoculum on the same aforementioned dietary treatments. The results showed that all bagasses show high amounts of aNDF (742–900 g/kg DM), ADF (493–616 g/kg DM) and lignins (88.1–136 g/kg DM), and low CP (22.6–30.3 g/kg DM). The inclusion of vinasse increased the *in vitro* DM digestibility and *in vitro* DM degradability of the diets (0.72 and 0.67, respectively). The control diet presented higher *in vitro* DM degradability (0.68) when compared to DB (0.65) and AB (0.65), but was no significantly different to the DBV (0.67) and ABV (0.66) diets. For diets with autoclaved bagasse, vinasse inclusion increased the specific gas production rate from 4.33 to 4.74. Maximum fermentation rate was higher for ABV than for DBV diet (6.09 *vs.* 5.54 mL/h, respectively), and the autoclaving of bagasse and inclusion of vinasse increased the lag time. Bagasse autoclaving increased FCR from 30 to 51 days (2.26 *vs.* 2.44), and FCR from 51 to 72 days was reduced by inclusion of vinasse (4.84 and 5.28). There were no significant differences to live weight, ADG, ADFI and slaughter weight among the groups. Autoclaving bagasse reduced the relative liver weight and increased caecal $N{-}NH_3$ content. Moreover, the $N{-}NH_3$ of

Abbreviations: DB, dried sugarcane bagasse; DBV, dried sugarcane bagasse enriched with vinasse; AB, autoclaved sugarcane bagasse; ABV, autoclaved sugarcane bagasse enriched with vinasse; CMSC, crumbled maize with straw and cob; ADFI, average daily feed intake; ADG, average daily gain; FCR, feed conversion ratio; ivDMdig, *in vitro* dry matter digestibility; ivDMdeg, *in vitro* dry matter degradability; B, maximum amount of gas produced; C, specific gas production rate; A, decay rate of specific gas production; TMFR, time for maximum fermentation rate; MFR, maximum fermentation rate; LAG, lag time; ADF, acid detergent fiber expressed inclusive of residual ash; aNDF, Neutral detergent fiber assayed with a heat stable amylase and expressed inclusive of residual ash; DM, dry matter; AOAC, Association of Official Analytical Chemists; NDIN, neutral detergent insoluble nitrogen; ADIN, acid detergent insoluble nitrogen; $N{-}NH_3$, ammonia nitrogen; SEM, standard error mean

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the control group (3.71 mmol/L) was lower than DBV (4.64 mmol/L), AB (5.01 mmol/L) and ABV (5.11 mmol/L), but similar to the DB group (4.05 mmol/L). The results of this study revealed that 100 g/kg of sugarcane bagasse can be included in the diet of growing rabbits without adverse effects on growth performance. Additionally, autoclaving and vinasse inclusion promote higher rate and extent of *in vitro* digestion, which is reflected on the caecal activity.

1. Introduction

Previous research has already focused on the handling and disposal of waste from the biofuels industries due to the inadequate and indiscriminate manner of treatment of these effluents. With approximately 370 active refineries, 10.9 million planted hectares and capacity to produce 28 billion liters of ethanol per year (UNICA, 2016), Brazil is currently the largest sugarcane producer in the world (Demattê et al., 2004). About 12 to 13 L vinasse per liter ethanol are produced from sugarcane (Martinelli and Filloso, 2008) and 270 kg bagasse per ton harvested cane (Castañón-Rodriguez et al., 2015).

Vinasse is composed mainly of water, organic acids, sugars, and minerals (Doelsch et al., 2009), and has usually a pH of 3.5–5 (España-Gamboa et al., 2011). If applied to water or soil in a careless manner, it can become a major polluter. Ethanol production generates large volumes of bagasse, a lignocellulosic residue originating from the stalk of processed sugarcane which can be used to generate energy, fermented products and animal feed, the latter limited due to its low nutritional value. Its composition reaches values of 590–974 g/kg of aNDF, 380–620 g/kg of ADF and 100–120 g/kg of lignin. Moreover, 12–24 g/kg crude protein is present, and up to 90% of the nitrogen may be unavailable associated with the fiber (Pires et al., 2004; Carvalho et al., 2009).

Bagasse enrichment with vinasse has already been used in diets for rabbits (Ferreira et al., 2015). Still, vinasse was used in Tifton 85 hays enrichment (Coelho et al., 2016) and included *in natura* in different proportions in rabbit diets (Oliveira et al., 2013). In this context, being a non-ruminant herbivore that requires the inclusion of a minimum fiber content (De Blas and Mateos, 2010) and maintains a rich and active microbial community in its caecum (Abecia et al., 2005; Monteils et al., 2008), the rabbit becomes a strategic animal that is able to use a wide range of alternative ingredients maintaining high productive levels.

The use of fibrous sources of low nutritional value, rich in insoluble fractions of fiber, affects the rate of retention of the digesta, microbial activity, fiber fermentability and caecal turnover (Gómez-Conde et al., 2009; Gidenne et al., 2010; Rodriguéz-Romero et al., 2011), but the adequate supply of this fibrous fraction maintains mortality due to intestinal disorders below 5% (Trocino et al., 2013).

The objective of this study was to evaluate the potential use of dried or autoclaved sugarcane bagasse enriched or non-enriched with vinasse in diets for growing rabbits by assessing their growth and slaughtering performance, *in vitro* digestibility, degradability and fermentation parameters.

2. Material and methods

2.1. Study site

The study was carried out in the rabbit sector of the Experimental Farm Professor Hélio Barbosa of the Federal University of Minas Gerais (UFMG) situated in the city of Igarapé, from the state of Minas Gerais, Brazil. The animals were kept in a semi-enclosed shed

Table 1
Analyzed chemical composition (g/kg DM basis) of different sugarcane bagasses.

Items	DB	DBV	AB	ABV
Dry matter (g/kg)	910	681	912	683
Ash	12.2	15.5	12.2	15.7
Crude protein (CP)	23.8	30.3	22.6	29.1
aNDF[a]	742	900	734	884
ADF[b]	493	616	501	608
Lignin (sa)	89.9	129	88.1	136
Hemicelluloses (aNDF-ADF)	249	284	233	276
Cellulose (ADF-Lignin (sa))	403	487	413	472
NDIN[c], % CP	32.7	29.6	28.4	38.6
ADIN[d], % CP	19.6	12.6	32.9	37.6
Ether extract	4.31	5.53	7.99	8.53
Calcium	13.9	12.8	16.1	12.3
Total phosphorus	13.9	15.6	14.9	14.2

DB: dried sugarcane bagasse; DBV: dried sugarcane bagasse enriched with vinasse AB: autoclaved sugarcane bagasse; ABV: autoclaved sugarcane bagasse enriched with vinasse.

[a] Neutral detergent fiber assayed with a heat stable amylase and expressed inclusive of residual ash.
[b] Acid detergent fiber expressed inclusive of residual ash.
[c] Neutral detergent insoluble nitrogen.
[d] Acid detergent insoluble nitrogen.