

Effect of Alkali Treatment of Agave Azul *tequilana* Bagasse on the Pelibuey Lamb Intake and Apparent Digestibility

F.J. Paredes-Ibarra, J.R. Orozco-Hernandez, H. Verdin-Sanchez,
O.D. Montanez-Valdez, E. Alvarado-Loza and V.O. Fuentes Hernandez
Departamento de Ciencias Biologicas, Centro Universitario de Los Altos,
Universidad de Guadalajara, Tepatitlan de Morelos, Jalisco,
Km 7.5 Carretera Tepatitlan a Yahualica, P.O. Box 58, Mexico

Abstract: Tequila industry bagasse is an alternative feedstuff that need to be assessed as part of the lamb diet. Nine Pelibuey lambs were used in a 3×3 factorial trial to assess the inclusion of agave bagasse in the diet, untreated or 4% NaOH treated on nutrient intake and *in vivo* digestion, as well as performance and water intake. The inclusion of 25% of agave bagasse affected positively the intake of dry matter, organic matter and gross energy ($p<0.05$) and their apparent digestibility ($p<0.05$). However, neither the water intake or daily gain of weight were statistically affected by treatments ($p>0.05$). Hence, the agave bagasse can be used as an alternative feedstuffs for Pelibuey lambs.

Key words: Agave bagasse, tequilana, lamb, digestibility, performance, Mexico

INTRODUCTION

Agro-industry produces several lignocellulosic co-products that are normally used as feedstuffs of domestic animals diets, however not all animals can use highly lignified ingredients (Buxton and Redfearn, 1997). The agave agro-industry produces a 7 years old agave, which generates 30% of the head (average weight 50 kg each) as bagasse when the plant is industrialized to obtain the beverage tequila.

The waste is a lignin rich by-product that is use partially in the cardboard, furniture and as fuel in the brick industry (Iniguez-Covarrubias *et al.*, 2001). Research on the use of waste from the harvesting and industrialization of agave plant is needed since their disposal represent a serious environmental problem. On the other hand, Harada *et al.* (2001) and Fayazi *et al.* (2009) using sodium hydroxide (NaOH) have improved the feeding value of fiber rich ingredients. Little has been done to fully assess the agave bagasse as feedstuff for ruminant (Iniguez-Covarrubias *et al.*, 2001), neither the effect of alkali (NaOH) treatment (Alonso-Gutierrez, 2005) to increase the feed value of the residue for sheep feeding. Hence, the objective of the present trial is to assess the effect of agave bagasse on the performance and digestibility of Pelibuey lambs.

MATERIALS AND METHODS

Nine male Pelibuey lambs (initial average weight of 17 kg) were housed in individual metallic crates with plastic floor.

Feed and water were offered for *ad libitum* intake and measured daily. Agave bagasse was obtained locally from a tequila factory and sun dehydrated. After part of the bagasse was treated with a solution of 4% sodium hydroxide (NaOH) and hand mixed. Bagasse was stored for 10 days prior usage. A commercial lamb feed was purchased from local company. Treatments were; control (ground corn stalk), 25% bagasse either NaOH-treated or untreated. Lambs were randomly assigned to treatments. Three experimental periods of 21 days were used and the last five were use to measure intake and weight gain (the initial weight was use as co-variable for the last parameter).

Dry matter content of feed and feces was determined by drying the samples at 70°C for 24 h, organic matter was obtained by ashing in a muffle furnace at 550°C for 4 h and the gross energy was determined using an adiabatic calorimeter (Parr Industries). Neutral Detergent Fiber (NDF) was determined following the procedure (Van Soest *et al.*, 1991). Data were analyzed as a 3×3 factorial arrangement using the SAS package and using a

0.05- α to declare differences among treatments and when they existed the Duncan procedure was used to separate the means.

RESULTS AND DISCUSSION

At the start and at the end of the experiment, samples of agave bagasse were analyzed and it was observed that the NaOH treatment reduced the dry matter content (96.96 vs. 84.97%, for untreated and treated, respectively) of the diet, increased the ash and slightly the NDF content (11.01 vs. 15.25% and 49.23 vs. 55.50% for untreated and treated, respectively).

Lamb dry matter intake averaged 737.60 g day⁻¹ and was increased when the agave bagasse was included in the diet ($p < 0.05$; Table 1) but slightly reduced with the NaOH-treated. This probably due to the residual carbohydrates as pulp in the agave bagasse which is sweet, thus increasing the intake of the by-product. Iñiguez-Covarrubias *et al.* (2001) using 62% of agave bagasse in the diet reported 776 g of daily dry matter intake, which is quite similar to the observed in the present trial. The dry matter apparent digestibility was increased around 14% units with the use of agave bagasse and further augmented when this was sodium hydroxide treated ($p < 0.05$). This behavior is in line with the observation of Arisoy (1998) and Harada *et al.* (2001), who reported with agricultural residues (straw) an augmentation on the digestibility of components with sodium hydroxide. Alonso-Gutiérrez (2005) using alkaline (NaOH) treatment improved the *in sacco* dry matter disappearance of *Tequilana* Weber agave bagasse.

Water intake was also numerically higher when the bagasse was included in the lamb diet ($p > 0.05$), independently of the presence of NaOH treatment. This is contrary of the results reported by Arisoy (1998) who observed that the animal increased the drinking of water with the sodium hydroxide treatment of the cereal straw.

On the other hand, organic matter intake was 28% higher with the agave bagasse ($p < 0.05$) and when the NaOH treatment was used, the increase was only 20% compared with the control corn stalk based diet.

The intake of structural carbohydrates (NDF) was increased ($p < 0.05$) as the bagasse was included. As shown in Table 1, the energy intake was augmented when the bagasse was used ($p < 0.05$), compared with the corn stalk in the diet of Pelibuey lambs, probably reflecting the residual pulp contained in the agave bagasse. The digestibility of the gross energy was 32.2% higher with the untreated bagasse and the difference of 21% with the treated bagasse compared to control diet ($p < 0.05$; Table 1). However, the daily weight gain was lowest with NaOH-treated agave bagasse but with the

Table 1: Changes in the digestibility and intake of Pelibuey lambs

Digestibility	Control	Agave bagasse	
		Untreated	4%NaOH-treated
Dry matter Intake (g day ⁻¹)	630.03a	810.15b	772.62b
Body weight (%)	4.40a	5.10b	5.40b
Apparent digestibility (%)	46.13a	60.85b	63.72b
Organic matter intake (g day ⁻¹)	575.21a	737.81b	694.13b
Apparent digestibility (%)	49.73a	63.55b	65.33b
Neutral detergent fiber intake (g day ⁻¹)	239.16a	290.20b	283.55b
Apparent digestibility (%)	24.37a	39.98b	47.39b
Gross energy intake (cal day ⁻¹)	2116.90a	2321.90b	2358.80b
Apparent digestibility (%)	46.26a	61.16b	59.03b
Water intake (mL day ⁻¹)	1278.600	1483.300	1481.05
Daily weight gain (kg day ⁻¹)	0.111	0.143	0.095

ab: Means with different letter differ significantly ($p < 0.05$)

untreated bagasse was increased ($p > 0.05$; Table 1). Pinos-Rodríguez *et al.* (2006) using sisal bagasse either chopped or whole reported an increase of gain using ewes fed high concentrate based diet.

On the other hand, Iniguez-Covarrubias *et al.* (2001) using Pelibuey lambs reported slightly lower gains of weight (96 g day⁻¹) of the animals when 62% (dry matter basis) agave bagasse was included in the diet.

The results of the present experiment generally suggest that the bagasse obtained from the *Agave tequilana* Weber var. azul industrialization has nutritive and economic value similar to that of corn stover.

Furthermore, it has the advantage of all year round availability, whereas the corn stover availability is related to corn grain harvest.

CONCLUSION

The agave bagasse generated by the tequila industry can be use as forage for lambs when they are used in complete mixed diet.

REFERENCES

- Alonso-Gutiérrez, M.A., 2005. Valorisation de la bagasse de l'agave tequilana W. cv azul: Caractérisation, étude de la digestibilité et de la fermentation des sucres. Ph.D. Thesis, Institut National Polytechnique de Toulouse, France.
- Arisoy, M., 1998. The effect of sodium hydroxide treatment on chemical composition and digestibility of straw. Turk. J. Vet. Anim. Sci., 22: 165-170.
- Buxton, D.R. and D.D. Redfearn, 1997. Plant limitations to fibre digestion and utilization. J. Nutr., 127: 814S-818S.
- Fayazi, J., M.B. Pour, M.S. Zade and N. Dabiri, 2009. Determination of optimum level of steam pressure hydrolyzed pith bagasse in feeding of crossbred beef. Res. Biol. Sci., 4: 773-776.

- Harada, C., Y. Saito, Y. Nakamura and H. Minato, 2001. The effect of sodium hydroxide treatment of rice straw on *in situ* disappearance of hemicellulose and lignin in its cell wall. Anim. Sci. J., 72: 19-25.
- Iniguez-Covarrubias, G., S.E. Lange and R.M. Rowell, 2001. Utilization of byproducts from the tequila industry: Part 1: Agave bagasse as a raw material for animal feeding and fiberboard production. Bioresour. Technol., 77: 25-32.
- Pinos-Rodríguez, J.M., J.R. Aguirre-Rivera, J.C. García-López, M.T. Rivera-Miranda, S. González-Muñoz, S. López-Aguirre and D. Chávez-Villalobos, 2006. Use of "maguey" (*Agave salmiana* Otto ex. Salm-Dick) as forage for ewes. J. Applied Anim. Res., 30: 101-107.
- Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.