

Inclusion of Tequilana Agave Pulp in Dairy Goat Feed

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Abstract: Agave plant is the main ingredient for tequila manufacturing mainly due to sugar content of the core which is cooked before juices extraction, the solid waste (pulp) obtained may be used in animal feeding. Nine lactating dairy goats were blocked by production level and used to assess three substitution rates (0, 25 or 50%, dry matter basis) of agave pulp instead forage in the diet. Animals were individually lodged and feed *ad libitum*, fresh tap water was offered daily. The trial was 21 days long and the last week was used for sample collection, measurements of intake, milk yield and milk quality. The goats were weighted at the beginning and at the end of the trial. Feed intake averaged 2.41 kg day⁻¹ and was not affected by the level of pulp ($p>0.05$). Milk yield augmented 34% with the 50% of agave pulp in the feed ($p<0.05$) but percentage of nutrient was unaltered ($p>0.05$), however the nutrient daily production of protein and lactose was increased ($p<0.05$). Body weight and back fat were similar among treatments ($p>0.05$). Based on the finding, it could be concluded that the pulp can substitute corn stover in dairy goat without affecting animal health and performance.

Key words: Agave pulp, dairy goat, milk yield, tequila manufacturing, solid waste, animal feeding

INTRODUCTION

Certain agroindustrial by-products affect the environmental immediacy of the factories that is why the actual tendency is the sustainable use of the vegetal and animal resources (España-Gamboa *et al.*, 2011; Iniguez-Covarrubias and Peraza-Luna, 2010; Paredes-Ibarra *et al.*, 2009). However, the economical aspect of their disposal leads the constant evaluation for alternative use. The tequila industry faces such problem. In 2003, there were 146 tequila distillers that produced 97.2 millions of liters and by the 2008 increased to 231.2. The transformation of the *Agave tequilana* core into tequila provides for every liter of tequila 8-10 L of solids, these materials are especially attractive sources of nutrients for ruminants (Iniguez-Covarrubias *et al.*, 2000; España-Gamboa *et al.*, 2011). Pulp is the residue rich in fructose and glucose, formed by the stem of the plant after cooking and crushing and is available all year long (España-Gamboa *et al.*, 2011; Kategile, 2003). Nevertheless, no studies were found in the published literature of its use as small ruminant feedstuff.

MATERIALS AND METHODS

The present study was carried out in the small ruminant unit of the Centro Universitario de Los Altos of

the University of Guadalajara between March and April, 2011. The trial followed the procedures approved by the Animal Care and Use Committee of the campus Los Altos, University of Guadalajara and under continuous veterinary supervision. Nine adult dairy Saanen goats (average weight of 55 kg) were individually lodged (1.5 m²) in crates with capability of separating and of quantitatively collecting fecal output. The goats were dewormed using ivermectine. Goats were fed a totally mixed diet with 60% commercial concentrate and 40% of ground corn stover, the agave pulp was used to substitute the latter at different levels (0, 25 or 50% dry matter basis).

The experiment lasted 21 days and fifteen were given for adaptation to experimental condition and feeding, the following were used for measurements and sampling. Fresh water was always available for *ad libitum* consumption. Feed and faeces samples were dried at 65°C for 72 h in a forced air oven to determine their dry matter content.

Milk samples were obtained the 2 last days and analyzed using ultrasound (Sacco Milk Analyzer®). Back fat was measured between the 10 and 12th rib using an ultrasound equipment (Simadzu; Linear ultrasound scanner, Model SDL-32C and a probe of 7.5 mHz). The statistical analysis of data was performed establishing an alpha value of 0.05 to declare differences among

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treatments using the SAS package. When differences existed means were separated using the Duncan procedure.

RESULTS AND DISCUSSION

In the approach used here, dry matter intake averaged 2.41 kg day⁻¹ and was similar among the different levels of substitution of corn stover by pulp (2.28, 2.01, 2.92 kg day⁻¹ for 0, 25 and 50% of pulp, respectively; $p>0.05$). Nevertheless, the whole tract dry matter digestibility tended to increased numerically but showed no statistical difference among treatments (60.55, 62.68 and 72.74% for 0, 25 and 50% of pulp, respectively; $p>0.05$). This is probably due to the lowering of daily dry matter excretion of the goats, also this means lower corn stover used and that the agave pulp had nutritional potential for ruminants. Gebremariam and Machin using sisal pulp in the feeding of recently weaned lambs, reported an increase in the dry matter intake, body weight and the digestibility was quite similar to obtained in the present trial.

Augmenting the pulp level in the diet slightly increased the milk yield with the 25%, however with the use of 50% the parameter by 34% (1052, 1065 and 1427 mL day⁻¹, for 0, 25 and 50% respectively; $p<0.05$). The milk composition was unchanged by the corn stover substitution with the agave pulp ($p>0.05$; Table 1), nevertheless daily production of protein was increased (40.06, 44.55 and 51.91 g for 0, 25 and 50%, respectively; $p<0.05$). On the other hand, fat production responded quadratically to the pulp level (52.21, 41.27 and 51.48 g day⁻¹ for 0, 25 and 50% of substitution, respectively; $p = 0.068$).

Mean final body weight was 51.9 kg and was unchanged by the level of substitution of stover with the agave pulp ($p>0.05$), even though numerically showed some difference (54.23, 52.20 and 49.27 kg for 50, 25 and

0%, respectively). The variation on weight gain was higher in the goats fed the control treatment ($p>0.05$; 2.48, 2.25 and 2.03 kg, for 0, 25 and 50%). Hence, animals in the experimental diets kept their energy reserves and maintained the production.

Body fat increased 24.76% with the 25% of pulp compared to control diet but with 50% was reduced 14.55% (9.69, 12.09 and 8.28%, for 0, 25 and 50%, respectively; $p>0.05$). This observation is not in line with Bas who related the variation of body reserves with the level of feeding and production and reproduction of goats.

CONCLUSION

The results of this study show that the *Agave tequilana* pulp can successfully replace >50% of the forage in the feed of dairy goats.

ACKNOWLEDGMENTS

The researchers want to thanks the Tequilera San Antonio SA de CV and cheese manufacturer La Altena for their support of this research.

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Table 1: Milk composition from dairy goats fed agave pulp

Milk composition	Corn stover substitution by agave pulp (%)			
	0	25	50	p-values
Percentage				
Total solids	13.76	13.20	13.25	0.802
Protein	4.00	4.19	4.04	0.645
Fat	5.03	3.88	4.13	0.390
Lactose	4.72	5.12	5.07	0.379
Yield, g day⁻¹				
Total solids	142.48	140.30	169.91	0.012
Protein	40.06	44.55	51.91	0.022
Fat	52.21	41.27	51.48	0.068
Lactose	50.19	54.48	66.50	0.014