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Evaluating Bagasse-Based Ration as a Sole Feed for Goats

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Abstract

Sugarcane bagasse was used with other locally available ingredients to constitute a complete ration, bagasse-based feed (BBF) for ruminants. The effect of the feed on rumen pH and ammonia was studied. The effect of the feed on intake and live weight gain in goats was also determined in a growth trial. At the end of the feeding trial 4 goats, 2 in the treatment and 2 in the control were selected and were slaughtered for carcass evaluation. The intake of the BBF was significantly (P<0.05) higher than that of the control diet. The apparent digestibility of dry matter (DM), organic matter (OM) and neutral detergent fibre (NDF) for BBF was 76.9, 76.8 and 59.1 % respectively and was significantly different (P<0.05) from the control diet which was 68.2, 70.0 and 69.9 % respectively. There was no significant difference in the apparent digestibility of the crude protein (CP), which was on average 73.5 %. The nitrogen retention was on average 72 % of the N-intake for both of the diets. BBF did not affect the rumen pH but there was a significant increase in rumen ammonia-N. At the end of 117 days of feeding trial animals on BBF had a significantly higher (P<0.05) average daily gain (ADG) of 116 g/day compared to 82 g/ day for the control diet. The dressing percentage of goats on average was 46.8%. The legs and loin, neck, breast and shank and the shoulder represented 43%, 11%, 27% and 19% of the total carcass. A partial budget analysis was carried out and showed a cost of feed of Rs 39 for 1kg of liveweight gain for BBF compared to Rs 48 for the control diet. It is concluded that BBF has a good nutritive value and can be used as a sole feed for goats.

Key words: bagasse-based feed, digestibility, carcass characteristics

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1.0 INTRODUCTION

In Mauritius by-products of sugar cane industry namely cane tops and molasses, are commonly used as feed materials for livestock (Boodoo *et al.*, 1988). In addition, most of the bagasse generated from the industry is used in the production of electricity while a major part of molasses is transformed into ethanol (Anon, 2004). With the phasing out of the sugar protocol in the year 2007, much attention is given to alternative uses of sugarcane particularly in view of maximising the use of by-products of the cane industry such as bagasse as animal feed.

Bagasse is the term describing the fibrous residue of the sugarcane stalk after crushing and extraction of the juice. Bagasse is characterised as low quality feed for ruminants by virtue of its high content of ligno-cellulose, low crude protein (CP) and poor palatability (Brendt *et al.*, 2002). Several methods of improving the nutritive value of bagasse have been investigated by several authors (Pires, 2004, Mould et al 1998) with varying degree of success and practical applicability. For example Pires *et al.* (2004) tried to upgrade sugar cane bagasse with anhydrous ammonia and /or sodium sulphate. Sermento *et al.* (2001) investigated the use of urea for improving the nutritive value of bagasse using soybean grain as a source of urease. Alternatively, bagasse can be incorporated with other locally available feed materials of high nutrient content for the formulation of a complete ration for improving its use by ruminants. This paper evaluates the use of a bagasse-based ration formulation as sole feed for growing goats.

2.0 OBJECTIVES

The objectives were to assess the intake of the bagasse-based ration and determine its effect on live weight gain and carcass characteristics for growing goats.

3.0 MATERIALS AND METHODS

3.1 Site

The experiment was conducted at the Curepipe Livestock Research Station of the Agricultural Research and Extension Unit.

3.2 Digestibility trial

3.2.1 Animals, diets and experimental design

The bagasse-based feed (BBF) was prepared according to the formula given in Table 1.

Table 1**:** Composition of bagasse based feed

Ingredients	Percentage
Bagasse	35
Molasses	35
Wheat bran	16
Cotton seed cake	10
Common salt	0.5

Mineral mixture	0.5
Urea	3
Total	100

Ten entire male and two female goats (Anglo-Nubian Boer cross) of average age of 10 months and body weight of 20 ± 3 kg were used in a completely randomized design. Six animals were in the control and six in treatment groups. The animals in control group received maize stover *ad libitum* and were supplemented with 250 g/head/day of cotton seed cake. In the treatment group the animals received only bagasse based feed *ad-libitum.* Clean drinking water was available at all times to all animals.

The animals were housed in digestibility crates and allowed to adapt for 7 days prior to the start of the experimental period. The experimental period lasted 18 days and comprised of an adaptation period (10 days), followed by a feed intake, digestibility and nitrogen balance trial and rumen fluid sampling on the last 2 days of measurements for ammonia-N and pH determination. Rumen fluid was sampled through stomach tubes at 0, 2 and 4 hours after the morning feeding. Immediately after sampling, the pH of the rumen content was measured using a portable pH meter (Hanna® digital pH meter) and later a few drops of 50% H_2SO_4 were added to stop microbial activity. The acidified rumen fluid was then strained through 4 layers of surgical gauze and later centrifuged at 3500 x *g* for 20 min to precipitate feed particles. The supernatant was transferred into McCartney bottles and frozen at -20 °C pending analysis of ammonia-N.

3.2.2 Intake, digestibility and N retention

Feed offered and refused, output of feaces and urine, were recorded daily during the last 8 days. Samples of feed offered and refusals were taken daily and analysed for DM and N. Feaces were put in plastic bags in the freezer (-20°C) for further analysis. Urine was collected in a bucket containing 100 ml of 10% sulphuric acid to keep the pH below 3 for inhibiting microbial activity and nitrogen losses. Nutrient digestibility and N balance were calculated by standard procedures outlined for direct estimation of animal digestibility.

3.2.3 Chemical analyses

Feed samples were analysed for dry matter (DM), ash and crude protein (CP) according to the AOAC (1990) procedures. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest *et al.* (1986).

Faecal samples were ground through a 1 mm sieve and analysed for nitrogen (N), NDF and organic matter (OM). Urine samples were analysed for total N.

Rumen ammonia N (NH_3N) was analysed by direct steam distillation of 2 ml of the centrifuged rumen fluid using the Kjeldahl method for protein analysis.

3.3 Feeding trial with goats

3.3.1 Animals, diets and experimental design

Same animals and design were used as in digestibility trial (Section 3.2). The feeding trial lasted 117 days.

***3.3.2 Carcass evaluation*.**

At the end of the feeding trial (117days), four goats were selected, two from the treatment and the control group for carcass evaluation. The goats were slaughtered at the Mauritius Meat Authority. The following weights were taken: blood, eviscerated carcass, weight of pluck and gut (full and empty), different organ.

The dressed carcasses were chilled overnight at around 4^0C. The weight of the chilled carcass was taken and the carcass was separated into different cuts according to the IZ methodology elaborated by Gruszecki et al 1994. The different cuts, legs and loin (hind), neck, breast and shank, and the shoulder were weighed separately.

3.4 Partial budget analysis

A partial budget was carried out for the feeding trial of goats with feed cost as the variable factor. The cost of BBF was calculated by adding cost of different ingredients based on the level of inclusion in the mixture. The cost of fodder was based on current price of fodder.

4.0 RESULTS

4.1 Chemical analysis of feeds

Chemical composition of feeds used in the digestibility and growth trial is given in Table 2.

Table 2: Chemical composition (%DM) of the feeds used for the *in vivo* digestibility and growth trial

	Bagasse based feed	Maize stover	Cotton seed cake
DM	78	33	90.7
CP	12.9	9.7	31.3
CF	11.1	33.2	17.1
ADF	20.3	37.5	-
NDF	29.2	63.8	-
EE	1.2	2.7	-
Ash	13.3	6.81	6.6
P_2O_5	0.89	0.79	2.6
Ca	0.38	0.52	0.18

4.2 Apparent digestibility, nitrogen balance

The apparent DM and organic matter (OM) digestibility of BBF was significantly higher ($P<0.05$) than the control diet. The CP digestibility did not differ whereas the control diet had a higher NDF digestibility than BBF as shown in Table 3.

Table 3**:** Apparent digestibility % of nutrients and nitrogen retention in goats fed BBF and maize stover

Digestibility	BBF	Control	SE	Significance
DM	76.9	68.2	1.0	*
OM	76.8	70.0	0.9	*
CP	73.0	73.9	0.9	ns
NDF	59.1	69.9	1.1	**
N- retention % intake	75.8	76.8	-	ns

*Significance at 5% ** significance at 1 %

There was no significant difference in N-retention % N-intake between the BBF and the control diet.

4.2.1 Rumen pH and ammonia-N

The effects of BBF and control diets on rumen pH and rumen ammonia-N are shown in the Table 4.

Table 4**:** Rumen pH and ammonia-N on BBF and maize stover diet

	BBF	Control	SE	Significance
Rumen pH				
0 hrs	6.92	6.90	0.03	ns
2 hrs after feeding	6.45	6.60	0.04	ns
4 hrs after feeding	6.30	6.50	0.04	ns
Ammonia , mg N/L				
0 hrs	125	80	5.40	*
2 hrs	525	175	5.14	**
4 hrs	685	360	14.29	**

*Significance at 5% ** significance at 1 %

Rumen pH. There was no significant difference ($P<0.05$) in rumen pH when either BBF or control diet was fed to the goats. Sampling time as expected resulted in drop in rumen pH after 2 and 4 hrs of feeding but it was not significant ($P<0.05$) .

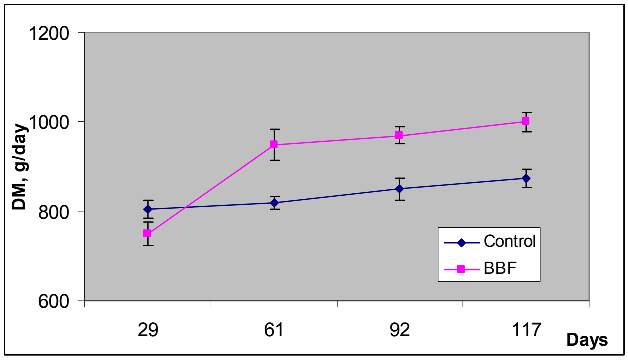
Rumen ammonia. Animals fed BBF had significantly ($P<0.01$) higher rumen ammonia levels than the control diet. Mean ammonia level four hours after feeding in animals fed BBF was 685 mg N/L compared to 360 mg N/L in the control diet. The level of ammonia concentration increased significantly ($P<0.05$) at 2 and 4 hrs post-feeding for both the BBF and control diet.

4.3 Feeding trial goats

4.3.1 Dry matter intake

The DM intake is given in Figure 1. The average DM intake was higher in the BBF than in the control group.

Figure 1**:** DM intake of BBF and control diet with standard deviation



4.3.2 Growth rate

Figure 2 indicates that the 2 groups of animals showed a similar pattern of growth curve. There was a steady growth rate for both group of animals on BBF and control.

Figure 2: Growth curve of goats fed on BBF and control

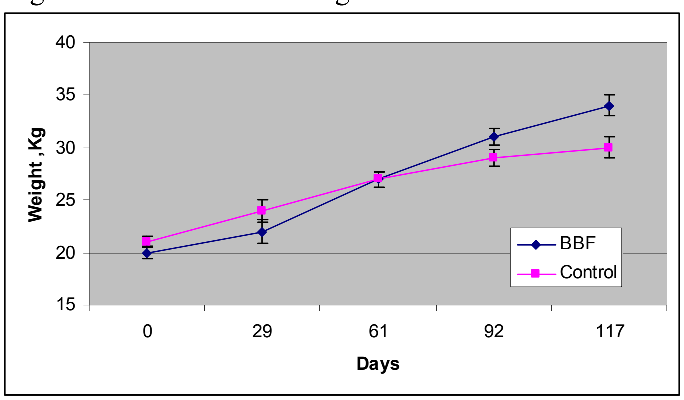


Table 5 shows the average liveweight and daily weight gain of animals both in treatment and control group. The ADG for animals on BBF diet was 116 g/ day which was significantly higher ($P<0.05$) than that in control diet which was 82 g/day.

Table 5: Average live weight and ADG of goats

	Initial live weight, Kg	Final live weight ,kg	ADG g/day
Control	21±3	30±3	82±29
BBF	20± 3	34±3	116±22

4.3.3 Carcass characteristics

Carcass characteristics and different choice cuts are given in Table 6 and Table 7.

Table 6: Carcass components and body parts of goats fed BBF and control diet

Parameters	BBF	Control
Starved liveweight(Kg)	31.4±7.9	31.3±0.9
Dressed carcass weight (Kg)	14.8±3.5	14.5±1.0
Dressing percentage (%)	47.3±0.6	46.2±1.9
Carcass length (cm)	55.5±5	55.5±0.7
Chilled carcass(kg)	14.3±3.4	14.0±1.0
% Shrinkage	2.9±0.1	3.2±0.2
Omentum and visceral fats(kg)	0.70±0.01	0.35±0.14

On average dressing percentage of goats was 46.8 %. The loss in moisture (shrinkage) was 3.1 % of the hot carcass. The legs and loin represented on average 43 %, neck 11 %, breast and shank 27 % and the shoulder 19 % of the carcass.

Table 7: Choice cuts for carcass of animals fed BBF and control diet

	BBF	Control
Chilled carcass	14.3±3.4	14.0±1.0
% of liveweight	45.9±0.5	44.0±1.7
Legs and loin % of carcass	43.0±0.7	44.4±4.8
Neck % of carcass	11.1±0.1	10.7±0.5
Breast and shank % of carcass	27.1±0.5	27.2±5.4
Shoulder % of carcass	19.2±0.4	18.4±3.0

4.4. Partial budgeting

The cost of feed to produce 1kg of live weight in goat is given in Table 8.

Table 8: Cost of production of liveweight goat

	BBF	Control
Initial live weight(kg)	20	21
Final live weight(kg)	34	30
Live weight gain(kg)	14	9

Feed consumed,(kg)	275	155
Concentrate(kg)	-	58
Price of feed (Rs)	550	435
Price per live weight gain(Rs)	**39**	**48**

The control diet cost Rs 9 more to produce 1 kg of live weight compared to the BBF diet.

5.0 DISCUSSION

5.1 Intake

The dry matter intake was higher, 30% more for the BBF compared to the control diet. The NDF of BBF was 29.2 % compared to the maize stover which was 63.8 %. The low dry matter intake of maize stover diet may be explained by the low rate of degradation and high structural fibre component of the feed which imposes a barrier to the rumen microbes. Consequently this could delay in the colonisation of the fibrous particles and hence an increase in the mean retention time in the rumen. Supplements can be considered as a means of increasing nutrient supply to animals that are unable to consume sufficient nutrients as forage (Romney *et al.*, 2000). Supplementation has a positive effect on the overall dry matter intake. The high dry matter intake of the bagasse feed was mainly due to the supplementation with molasses, cottonseed cake and urea.
The constant supply of protein in BBF encouraged voluntary intake. This supplied with more nutrients (nitrogen) to the rumen microbes, thus reducing the retention time by increasing the outflow rate stimulating the intake.
The higher weight gain on feeding BBF was associated with sufficient supply of fermentable substrate to ruminal microbes enhancing their growth and protein synthesis, subsequently improving availability of microbial protein in the small intestine. BBF presumably synchronized fermentability of individual chemical constituents (nitrogen and carbohydrate) leading to associative effects in DM intake and digestibility, hence the difference in weight gains (McDonald *et al.*, 2002).

5.2 Digestibility indices

The apparent digestibility was higher for the BBF (77%) diet compared to the control diet (68%). The supplementation of the bagasse with molasses, cottonseed cake and urea provided the required nutrients to the microbes to improve the digestibility of the diet. This agrees with Leng (1997) that supplementation of basal diet enhances the utilization of the fibrous diet and hence increases the digestibility. Castro *et al*, 1990 obtained a DM digestibility of 60.2% of raw bagasse and 54.7 % with steam treated bagasse supplemented with cereals grain.

5.3 Rumen pH

The pH values reported in this study were within the range for optimal growth of cellulolytic bacteria as suggested by Mould *et al.* (1983). Non-significant effects of BBF on rumen pH is indicative of the typical buffering capacity of the rumen when roughage diets are fed (McDonald *et al.*, 2002) The significant drop in rumen pH after feeding is indicative of active fermentation. Wanapat (1999) obtained similar results when straw was supplemented with high quality feed block containing 10% of urea.

5.4 Ammonia-N

The ammonia in the rumen fluid was higher in the BBF diet than in the control diet, expected since BBF contains urea. The results are in accordance with that of Wanapat, (1999) when rice straw was supplemented with high quality feed block containing 10% of urea. Kouch *et al.,* (2003) obtained value ranging from 467 to 1076 mg/litre of ammonia in rumen fluid in goats fed diets of mulberry, jackfruit or cassava leaves.

5.5 Weight gain with bagasse-based ration

The higher average weight gain of 116 g/ day may be attributed to higher feed and crude protein intake of the BBF compared to 82g / day in the control diet. This resulted in the optimum rumen functioning in terms of pH and ammonia level. This ration of BBF tried to balance and optimise all the requirement of rumen fermentation.

5.6 Carcass yield as affected by ration

The dressing percentage was on average 46.8% and was similar to that reported by Dadi *et al.*, 2005. Okello *et al.* (2003) reported a dressing percentage of 53%. Dressing percentage estimated on chilled carcass weight is one of the most important factors characterizing the slaughter value (Gruszecki *et al.*, 1994).
Moisture losses in carcasses observed in the study are in accordance to those found in literature (Ruvuna *et al.,* 1992). This information helps to account the weight loss of hot carcasses between the point of slaughter and after a limited storage time. The trend in meat consumption is low fat content and a shift towards choice cuts and value added products to meet the needs of consumers (Anon, 2005). The percentage of choice cuts obtained was not influenced by diets but animals fed BBF had higher percentage (0.70 kg) of fat deposition around the kidneys and the viscera as shown in tables 6 and 7.

5.7 Economic implications.

Adoption of technology depends on the cost of the technology and on- farm experimentation (Owen, *et al*., 1989). This study demonstrated that farmer will be benefiting an extra Rs 9 for producing one kg of live weight using BBF. Although, goat farmers do not purchase fodder they spend time to collect fodder and other crop residues to feed their animals. Eventually when the farmers will be heading towards professionalism, they will not have time to collect fodder and crop residues which are becoming more and more scare. The option of buying bagasse which is centrally produced can be envisaged. Alternatively bagasse- based feed can be produced and marketed.

6.0 CONCLUSION

The experiment gives adequate indication that BBF has a good nutritive value and can be used as sole feed for growing goats whilst sustaining good growth.

7.0 ACKNOWLEDGMENT

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