The Effect of Supplementation of Dried Mulberry Leaf Meal on the Growth and Carcass Characteristics of young Boer and Crossbred Boer Goats in Jamaica

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Abstract

Twelve growing male goats (6 Boers and 6 crossbred Boers), 3-4 months old with mean initial body weight of 18.29 ± 1.98 kg, were used to evaluate the effect of supplementation with mulberry leaf meal (MLM) on body weight, growth rate (ADG), body measurements, carcass yield and non-carcass components. The kids were matched by weight and randomly assigned to 2 treatment diets, T1 (100% commercial concentrate) and T2 (100% MLM) and fed in individual stalls for 140 days after an initial adjustment period of 14 days. They were each given a basal diet of pangola grass hay fed *ad libitum*. The concentrate (T1) fed animals had greater ($P < 0.001$) final body weight (36.19 vs 29.84 kg) and average daily gain (127.8 vs 82.5 g) compared with the MLM (T2) group ($P < 0.001$). Dressing percentage based on fasted body weight was 48.6 and 43.2 for T1 and T2, respectively. The differences were significant ($P < 0.05$). Mean dressing percentage based on empty body weight was 56.7 and 53.6 for T1 and T2, respectively. This difference was not significant ($P > 0.05$).There was no significant difference ($P > 0.05$) between the two treatment diets for loin eye area, 17.4 and 14.8 cm^2 for T1 and T2, respectively. For animals on T1, mean proportions of the primal cuts were 33.41, 9.7, 16.7, 29.6 and 11.0 % for leg, loin and flank, breast and foreshank, shoulder and neck, and rack, respectively. T2 had primal cuts in the proportion of 30.7, 11.1, 16.6, 28.3 and 12.0 % for similar body measurements. The diets did influence mesenteric fat deposition with T1 animals having higher ($P < 0.05$) deposits (1314 vs 357 g) than T2 animals. Neither kidney fat nor heart fat showed any significant difference ($P > 0.05$) between the two treatments. The higher energy concentrate ration did result in higher fat (mesenteric) deposition as expected.

The results suggest that growing goats will require further supplementation after 6 months of age (12 weeks on test) with a high energy ration during the finishing period to market (6–9 months). Levels of concentrate and MLM fed and the growth stage need to be studied.

Introduction

Goat production systems in Jamaica range from small-scale fully intensive cut and carry (zero grazing) systems to large-scale extensive pasture driven systems. Most goat producers in Jamaica now offer some level of supplementation to their animals. Feeding systems mainly consist of roughage in the form of grass, fed fresh or as hay, together with some commercial concentrate or agro-industrial by-product. Roughages alone are not sufficient to support optimal growth due to low levels of protein and energy (Sebsibe and Mathur, 2000). At the same time commercial concentrates based on imported corn and soyabean meal are increasingly costly, while on-farm mixes of agro-industrial by-products are seasonal in their ingredient availability and are often inconsistent in formulation.

In previous studies, Miller et al (2005) concluded that mulberry leaf meal can be used effectively as a substitute for commercial grain concentrate in the diet of growing goats. This is supported by Boschini (2002) whose evaluation of the nutritive value of the plant indicated its place as an excellent feed for high producing animals. Sanchez (2001) also found this to be true, stating that the mulberry foliage can be used to supplement poor quality forage-based diets.

The present study was conducted to evaluate the effect of supplementation with dried mulberry leaves on body weight, growth rate, body measurements, carcass yield, and non-carcass components of Boer and crossbred Boer goats in a stall-fed feeding system in Jamaica.

Materials and Methods

Management of materials and animals

The study was conducted at the Goat Research Unit, Bodles Agricultural Research Station, Old Harbour, Jamaica. Twelve intact male kids (6 Boer and 6 crossbred Boer), 3-4 months old with mean body weight of 18.3 ± 1.98 kg., were randomly assigned to 2 treatment diets (T1 and T2), each treatment with 3 Boers and 3 crossbred Boers. The basal diet consisted of Pangola grass (*Digitaria decumbens)* hay, fed ad libitum. The two treatment diets were T1 (100% commercial grain concentrate) and T2 (100% dried mulberry leaves). The animals were fed in individual pens on a 6 % body weight dry matter basis at a forage to concentrate ratio of 60:40. They each had access to trace mineralized blocks and fresh water daily.

The goats were dewormed with a Fenbendazole product and given 2 mL. injectable iron at the beginning of the adjustment period (14 days prior to starting the experiment). They were also administered a 5 day course of a coccidiostat in the drinking water. The trial started on May 2, 2005 and continued to September 19, 2005 (140 days). Kids were fed once per day at 8:30 a.m. and weighed fortnightly prior to feeding and watering to determine average daily gain (ADG). The individual weights were recorded and the feed adjusted to reflect the changes each fortnight.

A measuring tape was used to obtain the following body measurements of each animal:

- body length (point of shoulder to pin bone)
- height at withers (from base of hoof to highest point of wither)
- heart girth (body circumference immediately behind the forelegs)
- paunch girth (body circumference taken around the umbilicus)
- neck girth (circumference at base of neck)
- thigh circumference (around the middle of the thigh).

At the end of the 140 days 3 kids from each treatment group were randomly selected and slaughtered. Average age of the group was 8.5 months. The animals were fasted for 24 hours and then slaughtered by Halal method for carcass evaluation. After bleeding the carcasses were skinned and eviscerated and later fabricated into five primal cuts:

- leg
- loin
- rack
- shoulder and neck
- breast and foreshank.

Weights of the hot carcass, contents of the gastro-intestinal tract and non-carcass fat were recorded. Empty body weight was calculated by subtracting the weight of the excreta and ingesta from the fasted body weight. The loin-eye area was measured with the aid of a plastic grid (Iowa State University AS-235e September 1994) used for measuring loin eye in pork and lamb.

Chemical Analysis

Chemical analysis of the feeds was done at the Bodles Animal Nutrition Laboratory to determine crude protein (CP), ether extract (EE) and ash content. Neutral detergent fibre (NDF) was analysed using the procedure outlined by Goering and Van Soest (1970). *In Vitro* organic matter digestibility (IVOMD) was done on the various feed ingredients, using a modification of the two-stage Tilley and Terry procedure after Moore *et al (1972)*. Gross energy (GE) was determined by the Chemistry Department of the University of the West Indies (U.W. I.) using the Parr 1261 Adiabatic Bomb Calorimeter. The GE values were adjusted by a factor of 0.9 to account for ash content (zero energy) of the samples. Digestible energy (DE) value was calculated using the formula: DE = GE x IVOMD. Metabolizable energy (ME) value was then estimated using the formula: ME = 0.81 DE (Minson, 1979).

Experimental Design and Data Analysis

The study took the form of a completely randomized block design. For the growth characteristics each treatment had 6 goats/replicates (3 Boers and 3 crossbred Boers). For the carcass evaluation T1 had 2 Boers and 1 crossbred Boer while T2 had 1 Boer and 2 crossbred Boers. Analysis of the data was done with the aid of Genstat 5 Release 3.2 statistical software (Lawes Agricultural Trust 1996) using initial body weight as the covariate.

Results and Discussion

Nutritive value of experimental diets

- Chemical composition (proximate analysis)

The chemical composition of the treatment diets is shown in Table 1. The CP value (13.76%) for the mulberry leaf meal was lower than the 16.01% reported by Miller et al (2005), but higher than that for the pangola grass (*Digitaria decumbens)* hay. The difference in leaf crude protein values could be due to age of plant (Sanchez, 2001), and season of the year (Yao, et al, 2000). The ash content of the mulberry (13.07%) was higher than that of the concentrate and hay but similar to that reported by Malamsha et al (1997), Shayo (1997) and Sanchez (2001).

Table 1: Chemical composition (%DM basis) of the treatment diets.

Feeds	DM	CP	Ash	NDF	EE
Pangola hay	88.98	6.45	6.27	69.13	1.93
Mulberry leaves (dried)	90.98	13.76	13.07	24.00	4.26
Concentrate	88.02	15.31	8.33	20.00	2.07

- *In Vitro* organic matter digestibility (IVOMD)

The *in vitro* organic matter digestibility (IVOMD) of 71.58% (Table 2) for the dried mulberry leaves in the current study is consistent with that stated by Araya et al (1993) and Mendizabal et al (1993) as cited by Benavides (2001) and is indicative of it’s high digestibility. The DE of the mulberry in the current study (12.84 MJ/kg DM) was higher than the 9.41 MJ/kg DM determined by Gonzalez et al (2006), and the 11.3 MJ/kg reported by Makker and Becker (1996) as cited by Singh et al (undated). The DE value of the concentrate (14.7 MJ/kg DM) in the current study was higher than that of the mulberry (12.84 MJ/kg DM). A high energy level is essential for promoting optimal growth.

Table 3: In Vitro Organic Matter Digestibility (IVOMD), Gross energy (GE), Digestible energy (DE) and Metabolizable energy (ME) values of the treatment diets.

Feeds	IVOMD (%)	GE (MJ/kg DM)	GE (Adj.)	DE (MJ/kg DM)	ME (MJ/kg DM)
Pangola hay	44.79	15.15	16.83	7.54	6.11
Mulberry leaves (dried)	71.58	16.15	17.94	12.84	10.40
Concentrate	89.38	14.81	16.45	14.70	11.91

DE = Adj. GE x IVOMD; ME = 0.81DE

Growth performance

Growth performance of the kids on the two treatment diets is summarized in Table 3. The concentrate fed animals (T1) had greater ($P<0.001$) final body weight (36.19 vs 29.84 kg), total gain (17.71 vs 11.56 kg) and average daily gain (127.8 vs 82.57 g) compared with the mulberry leaf meal group ($P<0.001$). The ADG of 82.57 g for T2 is lower than the 121.0 g realized by Miller *et al* (2005) for goats fed mulberry at 2.0% live weight DM basis, but comparable to the 86.2 g obtained by Gonzalez and Milera (undated). The latter study only lasted for 29 days and this could possibly explain the lower ADG. However, the current study lasted for 140 days, 40 days longer than Miller et al (2005) and could suggest that the animals' energy requirement was compromised within that extended period. This is seen in Figure 1 where at 12 weeks (6-7 months of age) the growth curve for the concentrate fed (T1) animals moves upward at a faster rate than the T2 animals.

Table 3: Live weight, gain and average daily gain (ADG) of purebred and crossbred Boer goats on two treatment diets.

	T1	T2	Mean	SED	P	LSD
Init. Lwt.(kg)	17.53	19.05	18.29	1.97	0.461	4.40
Final Lwt.(kg)	36.19	29.84	33.02	1.16	<.001	2.61
Gain (kg)	17.71	11.56	14.64	1.18	<.001	2.67
ADG (g)	127.8	82.57	105.20	8.26	<.001	18.68

T1 = commercial grain concentrate supplement; T2 = mulberry leaf meal supplement
SED = standard error of the differences
LSD = least significant difference

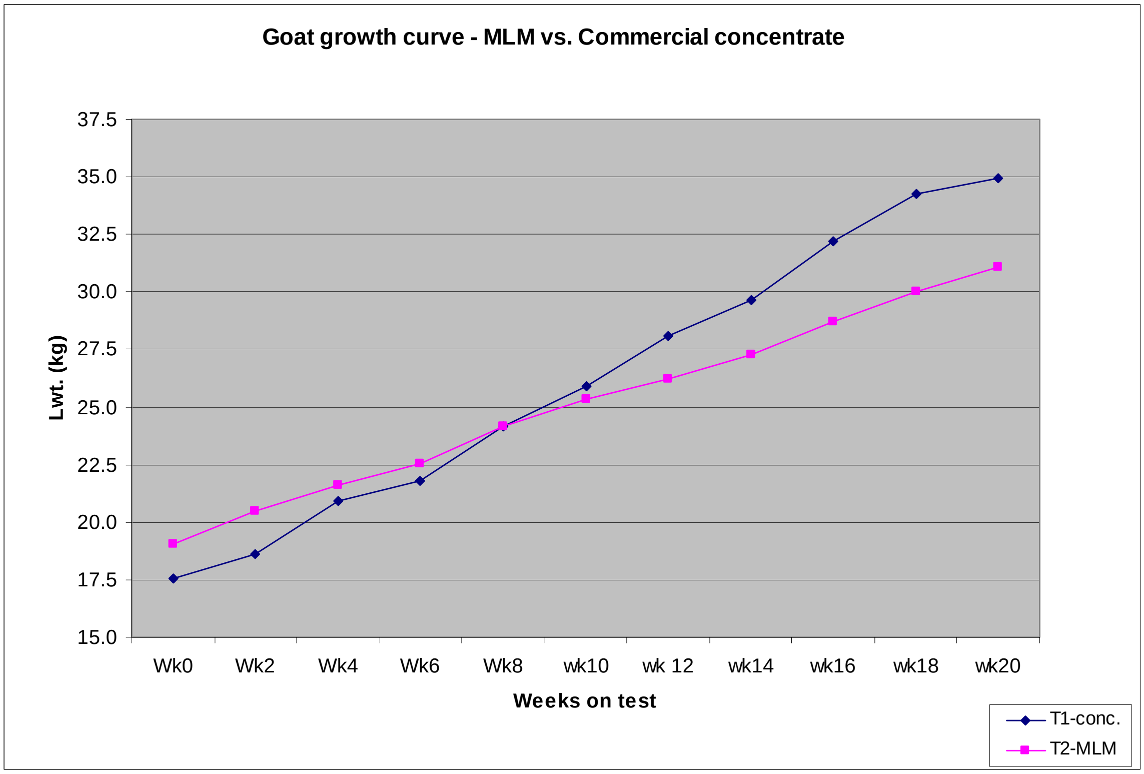

Fig. 1: Growth curve of purebred and crossbred Boer goats on two different diets (100% commercial concentrate vs. 100% mulberry leaf meal).

The kids fed the T1 diet had greater heart girth ($P < 0.05$) and thigh circumference ($P = 0.055$) than the T2 group. There were no significant ($P > 0.05$) differences between T1 and T2 for body height, length, paunch girth and neck circumference as shown in Table 4. The higher energy concentrate feed did affect thigh (33.05 vs 30.5cm) and heart girth (70.23 vs 64.98 cm) development of kids. Overall mean final body height and length measurements were similar to the Barbari kids reported by Sebsibe and Mathur (2000).

Table 4: Mean final body measurements (cm) of purebred and crossbred Boer goats on two treatment diets.

Parameter	T1	T2	Mean	SED	P	LSD
Height	61.10	57.45	59.28	1.805	0.183	4.085
Length	49.67	48.65	49.17	2.180	1.615	4.930
Heart girth	70.23	64.98	67.60	1.795	0.042	4.062
Paunch girth	84.25	83.47	83.85	1.645	1.630	3.720
TC	33.05	30.50	31.78	0.923	0.055	2.088
NC	43.63	39.70	41.67	2.153	0.255	4.867

T1 = commercial grain concentrate supplement; T2 = mulberry leaf meal supplement
TC = thigh circumference, taken at middle of thigh; NC = neck circumference, taken at base of neck.

Carcass characteristics

- Carcass weights

Initial body weight, final body weight and carcass weights along with dressing percentages and loin eye measurements of kids slaughtered from T1 and T2 treatments are given in Table 6. Empty body weight and hot carcass weight are functions of final body weight (Fehr et al (1976), cited by Okello *et al* (undated). Final body weight, hot carcass weight, fasted body weight and empty body weight were higher ($P < 0.05$) for kids in T1 than in T2. Supplementation of the browsing of indigenous tree leaves by Beetal x Sirohi kids with concentrate increased carcass weight (Paul *et al*, 1997), cited by Sebsibe and Mathur (2000). The commercial concentrate (T1) positively influenced ($P < 0.05$) dressing percentage based on fasted body weight as also reported by Sebsibe et al (2000). In a study done by Oman et al (1999) using Boer x Spanish and Spanish goats from two feed regimes (feedlot and range), the feedlot (80% concentrate) goats had heavier ($P < 0.05$) live and carcass weights than the range goats. In that study the treatment period was for 130 days post weaning and the Boer x Spanish goats had final weights of 38.2 and 20.5 kg for feedlot and range, respectively. In the current study the Boer and Boer cross kids had final weights of 35.8 and 28.6 kg for concentrate (T1) and mulberry leaf meal (T2) feeds, respectively.

- Dressing percentage

Dressing percentage based on fasted body weight (FBW) was higher ($P < 0.05$) for T1 than for T2 (48.6 vs 43.2). However there was no significant ($P > 0.05$) difference between the treatments for dressing percentage based on empty body weight (EBW). This is consistent with findings by Sebsibe and Mathur (2000). Loin eye area was not significantly affected ($P > 0.05$) by diets (Table 5).

Table 5: Carcass characteristics of Boer and crossbred kids fed two different diets.

Parameter	T1	T2	Mean	SED	P	LSD
Initial body weight (kg)	16.6	17.7	17.2	3.06	0.745	8.49
Final body weight (kg)	35.81	28.59	32.20	1.235	0.010	3.930
Hot carcass wt. (kg)	17.02	12.21	14.62	1.159	0.025	3.689
Fasted body wt (kg)	35.11	27.92	31.52	1.448	0.016	4.607
Empty body wt (kg)	30.11	22.45	26.28	1.648	0.019	5.246
Dress % on FBW	48.61	43.20	45.90	1.420	0.032	4.518
Dress % on EBW	56.69	53.55	55.12	1.439	0.117	4.578
Loin eye (cm^2)	17.40	14.80	16.10	3.92	0.553	12.48

T1 = commercial grain concentrate supplement; T2 = mulberry leaf meal supplement
FBW = fasted body weight; EBW = empty body weight (FBW – [ingesta + excreta])

Mean proportions of the primal cuts for T1 and T2 kids are shown in Table 6. These proportions are similar to that found by Sebsibe and Mathur (2000). Of the five primal cuts, only leg had any significant ($P < 0.05$) difference between T1 and T2 (5.7 vs 4.1 kg).

Table 6: Mean weight (kg) and proportion (%) of primal cuts of purebred and crossbred Boer goats under two feed regimes

Trait	T1		T2		Mean (kg)	SED	P	LSD
	kg	%	kg.	%				
Breast & foreshank	2.8	16.7	2.0	16.6	2.43	0.484	0.193	1.539
Shoulder & neck	5.0	29.6	3.5	28.3	4.25	0.576	0.071	1.832
Rack	1.9	11	1.5	12	1.67	0.715	0.618	2.276
Leg	5.7	33.4	4.1	30.7	4.90	0.292	0.012	0.929
Loin & flank	1.7	9.7	1.4	11.1	1.50	0.129	0.102	0.412

T1 = commercial grain concentrate supplement; T2 = mulberry leaf meal supplement
N.B. % of carcass is based on hot carcass weight.

The mean weight of non-carcass fat of kids fed the two treatment regimes is shown in Table 7. Fat deposition in the body of a growing goat takes place at a slower rate than in cattle or sheep and accumulates mainly as mesenteric (abdominal) fat (Piotrowski 1995), cited by Korzeniowski et al (1998), and around the heart and kidneys. The concentrate fed (T1) animals had greater ($P < 0.05$) mesenteric fat deposits (1314 vs 357 g) than those on the mulberry leaf diet (T2). There was, however, no significant difference ($P > 0.05$) between T1 and T2 kids for heart and kidney fat. Sebsibe and Mathur (2000) found that diet significantly influenced mesenteric fat deposit.

Table 7: Mean weight (g) of non-carcass fat of purebred and crossbred Boer goats under two feed regimes.

Trait	T1	T2	Mean	SED	P	LSD
Heart fat	109	27	68	45.8	0.216	197.0
Kidney fat	184	105	145	64.8	0.313	206.3
Mesenteric fat	1314	357	836	218	0.022	693.8

T1 = commercial grain concentrate supplement; T2 = mulberry leaf meal supplement

Conclusion

The concentrate fed (T1) animals grew faster after 12 weeks on test and had heavier final body weights than the mulberry (T2) fed kids. T1 animals also had heavier carcass weights and higher dressing percent based on fasted body weight. However, loin eye area and primal cuts, except for leg, were not influenced by supplementation diet. Concentrate supplementation however, caused heavier mesenteric fat deposition than did the mulberry diet. It can be concluded then that growing stall-fed goats fed a basal diet of pangola hay and mulberry leaves would require further supplementation after 6 months of age (12 weeks on test) with a higher energy ration during the finishing period to market (6-9 months). To avoid heavy mesenteric fat deposition while maintaining optimal growth, levels of concentrate and mulberry leaf meal fed and the growth stage need to be studied.

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