Full Length Research Paper

Effect of feeding varying levels of banana peelings supplemented with maize bran, cotton seed cake and *Gliricidia sepium* on the performance of lactating dairy cows

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Potential of banana peelings (BP) as animal feed for lactating dairy cows was evaluated. The cows were fed BP at 0, 20, 40 and 60% levels of their daily ration. The diets were supplemented with maize bran, cottonseed cake and *Gliricidia Sepium* to make them iso-nitrogenous. Four multi-parous cows were allotted to each of the four dietary treatments in a 4×4 Latin square design. Dry matter intake on diets with 40 and 60% BP were similar and higher (P < 0.05) than those on diets with 0 and 20% BP. Daily live weight changes did not differ between treatments. Daily milk yields ranged from 10.2 to 11.4 kg, with no significant differences between diets. Milk fat yields were 4.80, 5.54, 3.63 and 3.58% on diets with 0, 20, 40 and 60% BP, respectively; being lower on diets with higher BP levels (P < 0.05) while the other milk components were not affected by the treatments. Blood potassium reduced at the 60% BP level while phosphorus was higher and similar at the 20, 40 and 60% BP levels. Non-esterified fatty acids were lower at the 40 and 60% BP feeding levels. It is concluded that banana peelings can support moderate milk yields when accompanied with strategic supplementation.

Key words: Banana peelings, lactating cows, milk yield, dry matter intake, live weight changes, blood metabolites.

INTRODUCTION

Peri-urban agriculture is very important in sustaining livelihoods of the increasing population in cities. This form of agriculture is practised on small scale due to land limitation. Most urban and peri-urban livestock keepers in Uganda have very small land holdings of 0.25 acres and less (Ishagi et al., 2002) and so many practise zero grazing. These farmers are constrained by feed scarcity because forage is usually planted on these small plots and so many of them rely majorly on purchased feed. Alternative sources of feeds namely crop wastes can solve the problem of feed scarcity. When properly

utilized, these crop wastes represent a major animal feed resource.

Large quantities of banana peelings are produced in many parts of Uganda where the cooking type of bananas is the staple food. Ugandans are the world's greatest consumers of bananas (Nowakunda and Tushemereirwe, 2004) and so plenty of banana peelings are produced by Ugandans. Banana leaves and peelings constitute the largest proportion (48.5%) of most crop wastes in many urban and peri-urban markets of Kampala (Ssendawula et al., 1997). These banana

Table 1. Ingredients and calculated chemical composition of the experimental diets used in feeding the lactating cows.

Ingredient (%)	Diets			
	I	II	III	IV
Banana peelings	0	20	40	60
Elephant grass	65	40	15	10
Gliricidia sepium	7	8	9	3
Cotton seed cake	14	16	18	24
Maize bran	14	16	18	3
Chemical composition (% DM)				
Crude protein	15.0	14.5	13.9	13.9
Acid detergent fibre	34.6	30.5	28.6	27.1
Neutral detergent fibre	57.8	50.5	47.3	46.1
Ether extract	7.2	7.3	7.3	6.7
Ash	8. 60	8.35	8.25	8.10
Acid insoluble ash	2.30	1.73	1.48	1.36
Calcium	0.71	0.67	0.63	0.56
Phosphorus	0.57	0.56	0.55	0.51

peelings can complement grass during the wet season and act as a major feed during the dry season. Banana peelings like most crop wastes are low in protein, certain minerals and vitamins. This therefore, calls for both protein and energy supplementation if animal productivity is to be optimised as both are essential in improving utilisation of low quality feeds. Protein rich feeds like cotton seed cake, *Gliricidia sepium* leaf meal and energy rich sources like maize bran can be used to supplement banana peelings. Protein supplementation of low quality feed resources usually leads to increased milk production (Korhonen et al., 2002) and live weight gains while energy supplementation also supports milk production (Bernard and McNeil, 1991) and increases live weight gains.

Many farmers in the urban and peri-urban areas of Uganda are already using banana peelings as animal feed but they do not know how best to feed them to optimise animal productivity. Many of these farmers offer banana peelings as the sole diet because they are a cheap and readily available feed resource. Banana peelings need to be fed strategically because of the low level of protein. There is therefore need to know the optimum feeding level of banana peelings to optimise animal productivity. The purpose of this study therefore, was to evaluate the performance of Friesian lactating dairy cows offered varying levels of banana peelings supplemented with maize bran, cotton seed cake and *G. Sepium* to make iso-nitrogenous diets.

MATERIALS AND METHODS

The experiment was conducted at Makerere University Agricultural

Research Institute, Kabanyolo (MUARIK) which is about 17 km north of Kampala city. Four lactating multi-parous Friesian dairy cows weighing 476 kg on average and in early lactation with milk production level of 8 to 13 L day^{-1} were used in this experiment. The animals were housed in individual stalls and were treated against internal and external parasites before commencement of the experiment and throughout the experimental period. The animals had free access to clean drinking water and mineral block licks. Daily feed intake, live weight changes, milk yield and composition and blood metabolites were determined.

Four diets were offered to the animals in a 4×4 Latin square change over design with four periods, each lasting four weeks. The first two weeks on each diet were for adaptation while the last two weeks were for data collection. The experiment commenced two weeks after parturition. The basal feeds consisted of banana peelings (BP) offered at 0, 20, 40 and 60% (as offered) levels of the total ration in addition to fresh elephant grass (EG) harvested at about 1.0 to 1.5 m on ad *libitum* basis by offering quantities beyond the calculated levels under each treatment making a total of four diets with 0, 20, 40 and 60% BP to represent diet I, II, III and IV, respectively. Each of the basal diets was supplemented with maize bran (MB), cotton seed cake (CSC) and dry *G. sepium* (GS) balanced to contain at least above 11 to 12% CP required for moderate levels of production (ARC, 1980). The nutrient composition of the different feedstuffs and the amount of feed offered were used to calculate the nutrient composition of the diets (Table 1). Feed was offered twice daily at 07:00 and at 16:00 hours. The supplements were offered in equal portions at 6:00 and at 15:00 hours during milking. After giving the morning allowance of the supplements, BP was offered to the animals first and then EG was offered later so that the animals could consume all the banana peelings. Before adding each day's ration, the orts were removed and weighed. The daily feed intake on a dry matter basis was determined as the difference between feed offered and feed refused. Feeds were sampled fortnightly and taken to the laboratory for chemical analyses.

Milking was done twice a day at 6:00 am and at 3:00 pm and the total daily yields were recorded. Milk samples were collected during the second week of data collection on each diet, mixed thoroughly and taken to the laboratory to be analysed for protein, milk fat, total

Table 2. Chemical composition (%DM) of the experimental feeds used in feeding the lactating cows.

Proximate component	Basal feeds		Supplements		
	EG	BP	MB	CSC	GS
Dry matter	25.7	18.6	91.5	91.1	90.5
Crude protein	9.5	6.0	10.9	41.3	25.4
Acid detergent fibre	38.1	17.9	22.1	27.2	39.2
Neutral detergent fibre	67.6	31.7	31.3	40.8	48.1
Ether extract	5.2	5.6	12.9	11.6	6.4
Ash	9.2	8.0	6.3	5.8	12.6
Acid insoluble ash	2.93	0.14	1.37	0.52	1.45
Calcium	0.76	0.45	0.37	0.30	1.77
Phosphorus	0.40	0.34	0.88	1.17	0.44

EG = Elephant grass; BP = Banana peelings; MB = Maize bran; CSC = Cotton seed cake; GS = *Gliricidia.*

solids and ash. The 4% fat corrected milk yield was determined according to Maynard et al. (1979) shown as:

FCM = 0.4 M + 15 F

Where M = weight of the milk and F = the fat weight in the milk. The live weight changes (kg) of the animals on each treatment were determined by taking initial weights after the adaptation period for the animals in each treatment, and subtracting it from the final weights at the end of each data collection period.

Blood sampling and analyses

Blood samples were collected from each animal on the last day of the data collection period of each treatment. The blood samples were collected in the morning hours via jugular venipuncture into heparinised vacutainer tubes for analysis of total plasma proteins, fibrinogen, haemoglobin and the packed cell volume (PCV) or haemotocrit concentrations. The samples which were to be analysed for blood urea nitrogen (BUN), glucose, non-esterified fatty acids (NEFA), inorganic phosphate, calcium (Ca), potassium (K) and magnesium (Mg) were placed into vacutainers without anti-coagulants. After collection, the blood samples were chilled on ice and immediately taken to the laboratory, centrifuged between 4000 and 5000 rpm using a haemotocrit centrifuge to separate plasma. Plasma samples were then frozen at -20°C and later analysed for total proteins, fibrinogen, haemoglobin and PCV using procedures outlined by Zieger (1998). For the blood samples which were to be analysed for BUN, glucose, NEFA, inorganic phosphate, Ca, K and Mg, the blood was left to clot at room temperature for 30 min. The samples were then centrifuged for about 10 min at 4000 rpm and serum was then drawn off. Serum was then frozen and later analysed for the respective components.

Chemical analyses

Feed samples were oven dried at 60°C for 48 h in a forced draft oven and then ground through a 1 mm sieve for chemical analyses. Dry matter (DM), ash and nitrogen (Kjeldahl-N) in feeds and refusals as well as milk composition (CP, butterfat and total solids) were determined according to procedures outlined by AOAC (1990). Acid detergent fibre, NDF and acid insoluble ash were determined according to procedures outlined by Van Soest and Robertson (1985). Calcium was extracted by wet ashing while phosphorus was determined using ammonium molybdate using

spectrophotometer D 20. Blood total proteins, fibrinogen, haemoglobin and PCV were determined using procedures outlined by Zieger (1998). Blood urea nitrogen was determined using the modified Urease-Berthelot method and glucose was determined using the procedure for glucose GOD-PAP assay without deproteinisaton procedures outlined by Randox (1996). Inorganic phosphate was determined using ultra violet method while non-esterified fatty acids, Ca and Mg were determined using the colorimetric methods (Randox, 1996). Potassium was determined using a flame photometer.

Statistical analyses

The effects of the levels of BP on feed intake, body weight changes, blood metabolites and milk yield and composition were tested using analysis of variance (ANOVAs) of the General Linear Models Procedure (GLM) in SAS (1990) for a balanced 4×4 Latin square design using the model:

$X_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ijk};$ i, j and k = 1 ......a

Where, X_{ijk} = the kth observation on the response variable under the ith treatment; μ = Mean; α_i = Treatment effect (i = 1…4); β_j = Period effect (j = 1…4); γ_k = Animal effect (k = 1…4), and ε_{ijk} = Random error effect.

Differences among treatment means were compared using Student-Newman-Keuls test of SAS (1990).

RESULTS

Chemical composition of the feedstuffs

Chemical composition of the basal feeds (EG and BP) and the supplements (CSC, MB and GS) are presented in Table 2. Elephant grass had higher DM than BP. The supplements had similar DM content. The crude protein contents of EG and BP were 9.5 and 6.0% of DM, respectively. For the supplements, CP values ranged from 10.9 to 41.3% of DM. Banana peelings had lower ADF and NDF than EG. Among the supplements, GS had the highest ADF and NDF while MB had the least. For all

Table 3. Dry matter intake and live weight changes of cows offered the different diets.

Parameter	Diets				SEM
	I	II	III	IV	
DMI (kg)					
Basal diet	9.48[c]	10.21[c]	11.02[b]	13.25[a]	0.221
Supplement	5.61[c]	6.42[b]	7.32[a]	4.75[d]	0.013
Total	15.09[c]	16.63[b]	18.34[a]	18.00[a]	0.215
Total DMI (kg/kgW$^{0.75}$)	0.150[c]	0.165[b]	0.181[a]	0.177[a]	0.002
Total DMI (% BW)	3.22[c]	3.55[b]	3.88[a]	3.78[a]	0.046
Average body weights	468	468	473	477	4.875
Live weight changes (kg/day)	0.038	0.411	0.263	-0.275	0.402

Diets I, II, III and IV had banana peelings at 0, 20, 40 and 60 % levels, respectively. [a,b,c] Means within a row with different superscripts are significantly different (P < 0.05). SEM = Standard error of the mean. W$^{0.75}$ = Metabolic body weight. BW = Body weight.

components analysed except ether extract (EE), EG had higher contents of all chemical components than BP. For the supplements, GS had higher AIA, ash and Ca content than the other two supplements whereas MB had the highest EE while CSC had the highest P content.

Dry matter intake (DMI) and live weight changes

The daily DMI and the live weight changes of the animals are presented in Table 3. The daily basal DMI was higher (P ≤ 0.05) and similar in diets III and IV while the daily supplement DMI was highest (P ≤ 0.05) in diet III and lowest in diet IV.

The total DMI ranged from 15.09 to 18.34 kg day^{-1} with animals on diet III consuming the highest amount of DM and animals on diet I consuming the least. The total DMI of animals on diets with 40 and 60% BP was significantly higher (P ≤ 0.05) than those of animals on diets with 0 and 20% BP. Regression analysis of the results for the overall means of the average daily DMI showed a quadratic relationship in average daily DMI with increasing levels of BP in the diet. The regression equation of the response curve for the total average daily DMI was $Y = -0.0012X^2 + 0.1227X + 14.979$; where Y = the predicted average daily DMI (kg/day) and X= the level of inclusion of BP in the diets. The maximum stationary point of the curve along the best line of fit was achieved at daily DMI of 18.12 kg/day which corresponded to 51% level of BP in the study. This implies that DMI peaked at the 40% level of BP in the diets but then started declining as BP in the diets were further increased. This led to a lower stationary point of the curve compared to the intake obtained at the 40% level of BP under the conditions of this study.

For live weight changes, all the animals on the other diets gained weight except for those on diet with 60% BP. However, the live weight changes for the animals on the four diets did not differ significantly (P ≥ 0.05).

Milk yield and composition

The milk yield and composition of the lactating cows are presented in Table 4. The milk yield of the animals on the four diets was similar. Regression analysis of the results for the overall means of the daily milk yields showed a quadratic relationship in daily milk yields with increasing levels of banana peelings in the diets. The regression equation of the response curve for the daily milk yield was $Y = 0.0002X^2 - 0.0008X + 10.635$; where Y = the predicted daily milk yield (Kg/day) and X= the level of inclusion of banana peelings in the diets. The minimum stationary point of the curve was achieved at daily milk yield of 10.6 kg/day which corresponded to 2% level of banana peelings in the diets. This means that milk yield started rising from as low as 2% level of banana peelings in the diets under the conditions of this study.

Increasing the level of BP in the diets reduced milk fat content. Animals on diets with 0 and 20% BP yielded more milk fat (P ≤ 0.05) than animals on the diets with 40 and 60% BP. Milk fat in animals on diet with 60% was the lowest but similar to that of animals on diets with 40% BP. Increasing the level of BP in the diet, did not have any effect on milk protein and ash. For these particular components, there was no consistent trend as the BP in the diets was increased. The total solids were higher (P ≤ 0.05) in milk of animals on diets with 0 and 20% BP and lower but similar from those in milk of animals on the other two diets.

Blood metabolites

The effect of feeding varying levels of BP to lactating animals on blood metabolites is presented in Table 5. Except for blood K, P and NEFA, all the other metabolites were not affected by the four treatments. All the blood metabolites were in the adequate range to enable optimum animal productivity, which means that all the

Table 4. Milk yield and composition of cows offered the different diets.

Parameter	Diets				SEM
	I	II	III	IV	
Milk yield (kg)					
Daily yield	10.8	10.2	11.4	11.1	0.36
Fat corrected milk	12.0[a]	14.1[a]	9.8[b]	10.5[b]	0.78
Milk composition (%)					
Butter fat	4.80[a]	5.54[a]	3.63[b]	3.58[b]	0.302
Crude protein	2.79	2.68	2.69	2.56	0.097
Total solids	13.14[a]	12.89[a]	12.47[b]	12.62[b]	0.077
Ash	0.70	0.76	0.78	0.74	0.045

Diets I, II, III and IV had banana peelings at 0, 20, 40 and 60%, respectively. [a,b] Means within a row with different superscripts differ significantly (P ≤ 0.05). SEM = Standard error of the mean.

Table 5. Effect of feeding varying levels of banana peelings to lactating dairy cows on blood metabolites.

Component	Diets				SEM
	I	II	III	IV	
Total proteins (g/dl)	7.90	7.40	7.35	7.18	0.362
Fibrinogen (g/dl)	0.43	0.50	0.50	0.40	0.061
Glucose (mg/dl)	89.00	68.25	66.00	78.00	11.787
Blood urea N (mg/dl)	15.85	13.20	13.34	11.22	1.049
Haemoglobin (g/dl)	9.48	9.38	9.48	8.63	0.340
PCV (%)	27	28	27	25	0.813
Ca (mg/dl)	9.40	9.35	9.80	8.08	0.447
K (mmol/l)	4.60[a]	4.48[a]	4.68[a]	3.93[b]	0.094
Mg (mg/dl)	2.50	2.93	3.13	2.56	0.128
P (mg/dl)	3.23[b]	4.08[a]	4.85[a]	4.45[a]	0.330
NEFA (mmol/l)	0.26[a]	0.24[a]	0.20[b]	0.21[b]	0.007

Diets I, II, III and IV had banana peelings at 0, 20, 40 and 60%, respectively. [a,b] Means within a row with different superscripts are significantly different (P ≤ 0.05). SEM = Standard error of the mean.

treatments supplied the animals with the necessary nutrients to carry out metabolic processes effectively. Blood K concentration was higher (P ≤ 0.05) and similar at the 0, 20 and 40% levels of BP and declined at the 60% level of BP. Blood P was lower (P ≤ 0.05) in the animals on the diet without BP but increased and stabilised at similar levels for the 20, 40 and the 60% BP levels while NEFA was also lowest in animals on diets with 40 and 60% levels of BP and increased at the lower BP feeding levels.

DISCUSSION

Chemical composition of the feedstuffs and the diets

The level of crude protein (9.5%) of EG grass was lower than values obtained in other studies (Mpairwe et al., 1998; Nambi et al., 2001) but higher than 7.2% obtained

by Muinga et al. (1992). This slightly lower level of CP could be attributed to the dry season between May and August, which could have affected the grass since it is known that forage quality can be adversely affected by the dry season. The CP content (6.02%) of the BP did not differ from values reported by Nambi et al. (2001). For the GS leaf meal, the CP (25.4%) obtained was higher than (19.72%) reported by Mpairwe et al. (1998) and in the range of 20 to 30% reported by Simons and Stewart (1994). The high level of CP for the GS leaf meal used in this study could probably be attributed to good soils and to the ability of Gliricidia to withstand dry seasons (Hughes, 1987).

Dry matter intake and live weight changes

Dry matter intake increased as the levels of BP were increased. This can be attributed to the lower amounts of

the fibre at higher BP levels in the diets. Diet I with the highest amounts of fibre resulted into the lowest DMI from animals on this diet. As the levels of ADF and NDF decreased in the diets, the DMI was increased. Forages with higher levels of fibre depress intake. The DMI in ruminants is regulated by dietary density and physical fill in the gastro intestinal (GI) tract (Kawas et al., 1991). Fibre residues in the GI tract may therefore have led to the lowered consumption of this diet since it contained the highest levels of fibre. The DM of the diets also tended to increase as the level of BP was increased. This is because the supplements whose DM was very high (especially cotton seed cake) were increased to balance the protein. This could have contributed to the higher DMI of the cows on 40 and 60% BP diets. Increasing protein content in the diet may also increase DMI (Vandehaar et al., 1999) but since protein content of the diets were quite similar, the differences in feed intakes were most likely due to differences in fibre and AIA as BP in the diets was varied. Acid insoluble ash was also highest in diets I and III on which animals consumed the lowest DM. The levels of AIA could also have lowered the feed intakes of the cows.

The average daily weight changes of the cows did not vary significantly. This could be attributed to the iso-nitrogenous nature of the diets.

Milk yield and composition

Milk production did not vary significantly among the cows on the four diets. In this study, the protein content of the diets was quite similar which could be the reason why the milk yield did not vary significantly. Cows that consume more DM tend to produce more milk (Eriksson, 2003). In this experiment, milk production was slightly higher from cows which consumed the highest DM compared to those that consumed less although the differences were not significant. The FCM yield however varied significantly among the animals on the different diets in a similar pattern as the milk fat levels. The higher fibre levels in diets with lower levels of BP increased the milk fat levels and therefore the FCM yield. The FCM yield was therefore higher in the more fibrous diets and reduced as the level of BP was increased. Banana peelings are lower in fibre than EG and so the fibre levels in the diets reduced as higher levels of BP replaced EG. Milk fat is the most variable milk component (Chamberlain, 1993). The values of milk fat obtained in this study (3.57-5.54%) were high. Generally, most animals in the tropics tend to produce high milk fat because their diets are usually fibrous. Higher fibre levels in the diets as was the case with 0 and 20% BP diets usually results into production of more acetate, a precursor in milk fat production. This implies that there were higher acetate levels from animals on these diets. The high levels of milk fat obtained in this study could also have been attributed to the low amounts of milk produced as

milk fat has been reported to rise as milk yield reduces (Chamberlain, 1993).

Higher protein intake has been reported to increase Milk protein concentration in some cases but the response is not always consistent and in many cases it is difficult to separate the effect of increasing dietary protein from the effect of an increase in energy intake (DePeters and Cant, 1992). The diets in this study were balanced to supply the protein required for optimum milk performance of about 10 to 20 L. This could be the reason why the protein content in the milk obtained in this study was not very different from those obtained elsewhere (Mpairwe et al., 2003). Total solids and milk ash are the least variable milk components. The milk total solids followed a similar trend as did milk fat. The higher ($P \leq 0.05$) total solids in milk from cows on diets with 0 and 20% could have been due to the higher milk fat content from cows on these diets since all the other milk components were similar on all the four diets. Ash varies very little with different diets and has been reported at about 0.72% (Chamberlain, 1993). This could be the reason why increasing levels of BP in the diets did not affect the milk ash content. The values of ash obtained in this study are very close to those reported by the above authors and the values of total solids (11.97-12.6%) are close to the average of 12.86 in normal milk (Chamberlain, 1993).

Blood metabolites

In this study, most of the blood metabolites apart from K, P and NEFA were not affected by the varying levels of BP in the diets (Table 5). Total plasma proteins in this study ranged between 7.18 and 7.90 g/dl within the normal range of 6 to 8 g/dl reported by Zeiger (1998). This range was however lower than 8 to 10 g/dl obtained by Mpairwe (1998) but higher than that 6.0 to 6.4 g/dl obtained by Kabi (2003). There is a direct relationship between the quantity and quality of ingested protein to the formation of plasma protein (Harper et al., 1977). The concentration of total proteins in the blood of animals on all diets in this study did not differ which could have been due to the iso-nitrogenous nature of the diets. This is in agreement with the findings of Harper et al. (1977) that the quantity of ingested protein directly determines the quantity of blood plasma proteins.

Blood fibrinogen was in the normal range of 0.3 to 0.7 g/dl (Zeiger, 1998) and was not affected by the diets. The values of blood haemoglobin (8.63 to 9.48 g/dl) and the PCV (25 to 29%) were also in the normal ranges as reported by Zeiger (1998) at 8 to 15 g/dl for haemoglobin and 24 to 46% for PCV in cattle.

The blood Ca in this study (8 to 9 mg/dl) was within the normal range of 8 to 10 mg/dl (Taylor, 2007). In lactating animals, milk production starts suddenly and increases daily in early lactation. As lactation progresses, greater amounts of nutrients are needed for lactation and this results in large quantities of nutrients leaving the body to

support lactation. The body has reserves of amino acids and fat to draw upon, but not much glucose is stored in the body, and stored Ca is difficult to mobilize rapidly. Metabolic diseases can, therefore, arise in lactating animals if the diets do not supply enough glucose and calcium. If the Ca in the blood is not adequate for milk production, milk fever results.

The BUN concentration (11.22 to 15.80 mg/dl) was close to (9.00 to 15.63 mg/dl) obtained by Mpairwe et al. (2003) in crossbred cows offered either maize-lablab stover or oats-vetch hay. The results of this study indicated that BUN depends on the state of the animal. Shabi et al. (1999) also reported changes in plasma urea nitrogen depending on either the type of diet or number of meals. There was generally optimum BUN concentration for all the diets, which implies that there were efficient nitrogen metabolic transactions in the rumen.

The blood NEFA concentration in this study decreased with the increasing level of BP in the diets. The diet without BP had the highest NEFA concentration while diets with 40 and 60% BP had lower but similar NEFA concentrations.

The blood NEFA concentrations were close to those reported by Kabi (2003). Blood NEFA concentrations are also reported to vary with the state and diet of the animal. Vanderhaar et al. (1999) reported that the concentration of NEFA in plasma two hours after feeding decreased as the animals were offered diets higher in both energy and protein than the animals that were offered low energy and low protein diets.

The concentrations of NEFA in blood increases with negative energy balance (Kabi, 2003) and the values 1.2 mmol/l and above have been reported for ketotic cows (Emery et al., 1992). The values of NEFA obtained in this study (0.20-0.26 mmol/L) were below those reported for ketotic animals implying that energy in all the diets was sufficient. The concentration of NEFA in blood plasma reflects the interaction between rates of lipolysis from the adipose tissue and NEFA uptake by the liver and other tissues.

Blood Mg was not affected by the different diets while blood K and P varied as the percentage of BP in the diets was increased. Magnesium homeostasis is mainly determined by absorption from the GI tract, excretion by the kidneys and the varying requirements of the body for pregnancy, lactation and growth. Normal blood Mg ranges from 1.8 to 2.4 mg/dl (NRC, 2001). The blood Mg concentration obtained in this study was slightly above this range.

Blood K concentration at 0, 20 and 40% levels of BP was similar and decreased at the highest level of BP while blood P increased when BP was introduced in the diets. Although blood K decreased when the level of BP in the diets was increased to 60%, the lower level of 3.93 mmol/L was still in the normal range of 3.6 to 5.4 mmol/L (Wren, 2012). Blood P increased when BP was added to the diets, but the quantities were still in the normal range.

Conclusion

Although banana peelings are low in CP, Ca and P compared to EG, they can support moderate milk yields as an animal feed. Banana peelings are therefore a valuable feed resource since performance of the animals was not reduced as the level of the BP in the diets was increased. It is however important to note that BP should not be offered solely because they are low in most nutrients and under the conditions of this study, their inclusion level should not exceed 50%. Banana peelings can be used by farmers to complement on the pastures especially during the dry season when the pasture quality and quantity are greatly reduced. Substituting elephant grass with banana peelings in diets should be accompanied with strategic supplementation to be able to meet the animals' requirements.

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