Milk production by Saanen does given forage and a tree browse legume as supplements to the conventional dairy concentrate and a basal diet of Katambora Rhodes (*Chloris gayana*) grass hay.

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Abstract

The effect of substituting conventional dairy diets with tropical forage legumes Cowpea (*Vigna unguiculata)* and Sabra (*Stylosanthes scabra)* and Musasa *(Brachystegia spiciformis*) as nitrogen supplements to dairy concentrate grass on milk production and their composition were evaluated. Twenty lactating Saanen goats were allocated to dietary treatments of a mixture of maize with either a conventional 160 gCP/kgDM dairy meal concentrate as the control or the forage legume. The goats were machine milked twice daily at about 07:00 and 15:00 hours and milk yields were recorded daily for 13 weeks. Composite milk samples for each goat were taken for analyses of butterfat, lactose and protein and total solids. There were no significant differences ($P > 0.05$) in total feed intake between the treatments. The mean dry matter intake of the Katambora Rhodes *(Chloris gayana)* grass hay and concentrate diets were 381 and 405 g/d, respectively. Animals on all the treatments had deficiencies in their potential dry matter intake. There were no significant ($P > 0.05$) differences in milk yield and composition of milk constituents among the treatments. The levels of milk production achieved in this study suggest that some dairy concentrate can still be substituted with 250 g/kg forage legumes without affecting milk yield and composition in goats.

Key words: browse legume, milk, protein supplements, Saanen.

Introduction

Ruminant livestock production in Zimbabwe is dependent on the use of natural pastures (veld), crop residues, forage legumes, and browse leaves and fruits as the basic feeds throughout the year. The productivity of these animals in terms of meat, milk and other products is sub-optimal due to the low quality of these feeds, especially the veld. Dairying requires the feeding of animals with high quality energy and protein-rich concentrates to sustain satisfactory levels of milk production, particularly in early lactation. Cereal grains have been the traditional concentrates fed together with high quality roughages like silage or grass hay such as Katambora Rhodes grass *(Chloris gayana)*. However, Valentine and Bartsch (1990) reported that feeding 5 kg daily of hammer milled lupin grain compared with 5 kg of barley grain to cows in early lactation increased cereal hay intake by 20 % and milk fat production by 30 %. Nutrition has been shown to affect milk yield of goats. There was an 11.5 % difference in milk yield between Boer goats supplemented with concentrate and those not supplemented (Raats, 1988). There is a dearth of information on the effects of supplementary feeding with cheaper sources of protein to Saanen goats on milk production. There is, therefore, a need to consider milk production responses to feeding forage legumes as protein supplements in dairy rations.

The objective of this study was to assess the production and composition of milk from dairy goats whose diets were supplemented with tropical forage legumes *Vigna unguiculata* (L.) Walp. (Cowpea), *Stylosanthes scabra* (Scabra) and an indigenous browse *Brachystegia spiciformis* (Musasa) as nitrogen supplements to dairy concentrate and Katambora Rhodes grass diet.

Materials and Methods

Twenty lactating Saanen goats, with a mean body weight of 37.0 ± 0.42 kg, three days after kidding, were used. The goats were housed in individual feeding pens in a shed. The animals were vaccinated against enterotoxaemia (pulpy kidney), injected with a broad-spectrum anthelmintic (Saponiver, Caps Veterinary, Harare, Zimbabwe) and sprayed with an acaricide (Supermix, Caps Veterinary, Harare, Zimbabwe) before the start of the experiment.

New terminal shoots (leaf and young stems of less than 6 mm in diameter) of Musasa were harvested from the same trees from the end of September until November. The Cowpea and Scabra were harvested from the station in April after flowering. The forages were sun dried and then later hammer milled through a 25 mm screen before feeding.

The dietary treatments comprised a mixture of maize and either a conventional 160 gCP/kgDM dairy meal concentrate (MD) as the control or the forage legume Cowpea (MC), Scabra (MS) or Musasa browse (MB). The forages were incorporated at 250 g/kg of the conventional dairy concentrate. A common supplement that comprised an equal proportion of the three legumes (Cowpea, Scabra and the Musasa) and dairy concentrate and mixed with maize (MDCSB) was fed to the animals during the first 14 days of data collection and used as the covariate. The chemical composition of the ingredients and treatment diets are shown in Table 1. Vitamin/mineral pre-mix, limestone flour and coarse salt were incorporated into Katambora Rhodes grass hay at 2.0, 12.0 and 25.9 g/kg air dry weight, respectively. The experiment was run for 13 weeks.

Table 1: Chemical composition (g/kg DM) of Cowpea, Scabra, Musasa and Katambora Rhodes grass ingredients and Maize plus dairy concentrate (MD), maize plus Cowpea (MC), maize plus Scabra (MS) and maize plus *B. spiciformis* (MB) diets.

Ingredient	[1]DM	[2]CP	Ash	[3]NDF	[4]ADF
Cowpea	846	188	79	684	444
Scabra	873	134	69	636	512
Musasa	856	149	46	652	357
Katambora	897	29	75	881	442
MD	865	162	80	473	220
MC	864	139	70	607	220
MS	862	129	56	506	150
MB	862	122	63	835	260

[1]DM = dry matter; [2]CP = crude protein; [3]NDF = neutral detergent fibre; [4]ADF = acid detergent fibre.

After kidding, the kids were allowed to be with the does for 5 days. From day 6 to 14, all the animals were offered the MDCSD diet and milked daily. Milk production and composition and voluntary feed intake measurements from day 6 to day 14 were used for covariance analysis. At day 15 of lactation, the goats were randomly allocated to one of the four dietary treatments.

The animals were fed individually a common diet during the 7-day pre-trial period. All the does were offered a basal diet of milled Katambora Rhodes grass hay *ad-libitum*. The animals were offered the treatment concentrate according to production (0.5 kg/kg milk produced) with an allowance of 0.25 kg to provide for part of the maintenance requirements. After weighing and recording the refusals, fresh Katambora Rhodes grass hay was provided in the morning and then once or twice during the day to ensure continuous access to the basal diet. The treatment supplements were offered in separate troughs twice daily at milking at 08:00 and 14:00 hours after milking. Clean drinking water was available *ad-libitum*. The amounts of feed offered and refused were weighed daily at feeding time to determine total feed intake by difference.

The goats were machine milked twice daily at about 07:00 and 15:00 hours and milk yields recorded. Composite milk samples (25 ml) for each goat were taken three days a week during the morning and afternoon milkings.

The milk samples were preserved with a Bromo-tablet that contained 6 mg of 2-Bromo-2-nitro-propane-1,3 Dol per 20 mg of tablet (System Plus, New Hamburg, Ontario, Canada) and stored at 4 °C until analysed for butterfat, lactose and protein and total solids using a computerised Near Infrared Spectroscopy (NIRS) Bentley analyser (Bentley 2000, Meyer Services, Ontario, Canada). The concentration of solids-non-fat (SNF) was taken as the difference between total solids and fat content. The goats were weighed and body condition scores taken weekly on Thursdays at 08.00 hours by the same technician.

Oven dried and ground samples of the Katambora Rhodes grass hay, Cowpea, Scabra and Musasa that were offered as well as the refusals were analysed for nitrogen by the macro Kjeldahl method and dry matter and ash contents were determined according to standard methods outlined by Association of Official Analytical Chemists (AOAC) (1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to the method of Goering and van Soest (1970).

The feed intakes, milk yield and components and live weight and body condition scores were analysed by analysis of variance (ANOVA) using the General Linear Model (GLM) procedures of the Statistical Analysis System Institute, Inc. (SAS), (1991). The model was:

$$Y_{ijk} = +b_1C_i + D_j + e_{ijk}$$

where Y_{ijk} is the variable e.g. milk yield, protein, fat SNF composition etc, is the overall mean, b_1 is the covariance coefficient, C_I is the day 6 day 14 measurement (milk yield, composition etc) used as the covariate; D_j is the fixed effect of the diet and e_{ijk} the residual error. Multiple comparison of means was done using the Tukey's studentized range test of SAS (1991).

Results

There were no significant differences ($P > 0.05$) in total feed intake between the treatments (Table 2), although feed intake was numerically higher in the goats given Scabra and Cowpea and lowest in those fed the MB treatment. All the supplements were consumed throughout the experiment. The animals tended to eat more of the concentrate than the Katambora Rhodes grass. The mean dry matter intake of the Katambora Rhodes grass hay and concentrate diets were 381 and 405 g/d, respectively.

The average daily milk yield and composition over the 12-week period are given in Table 2. Weekly milk production means, adjusted by covariance, are illustrated in Figure 1. Over the experimental period, there were no significant ($P > 0.05$) differences in milk yield among the treatments.

There were no significant differences between treatments ($P > 0.05$) in the composition of milk constituents (Table 2). The animals on the conventional commercial dairy concentrate produced about 24.0 % more butterfat ($P > 0.05$) than the legume supplemented treatments. However, the legume supplemented rations tended to promote more lactose production in the milk than the commercial dairy diet. The Musasa treatment produced milk with a greater content of butterfat and total solids than did the Cowpea and Scabra treatments but the levels of milk protein were lower.

There were no significant ($P > 0.05$) changes in the live weight and body condition scores (Table 2) of the goats throughout the experimental period.

Discussion

The milk yield of the does was unexpectedly very low, even the animals on the conventional commercial dairy concentrate. Badamana, Sutton, Oldham and Mowlem, (1992) reported mean milk yield of about 3.2 kg per doe per day in British Saanen does fed concentrates containing 117, 152 and 185 gCP/kg DM and hay of 86 gCP/kg DM. The low milk production could be related to the low CP content of the diets. The Katambora Rhodes grass hay was very low in protein (26 g/kg DM) and the does did not eat much of it. Therefore, the concentrate input, even though the amount was restricted, must have had a large positive influence on both the energy and protein contribution in the diet.

Before the experiment the animals were left to graze poor natural pastures without any supplementation until after kidding when the dietary treatments were imposed. The nutrition of the does pre-kidding could also have influenced the milk production of the Saanen does. Poor forage to concentrate (F/C) ratio in the diets of dairy goats might cause digestive disorders and reduced milk production (Morand-Fehr and Sauvant, 1978). There was very little herbage in the grazing area by the time the trial was initiated in the dry season. Morand-Fehr and Sauvant (1978) indicated that the feeding programme before and just after parturition greatly affects milk yield in goats, not only at the beginning of lactation but during the whole period. Skjevdal (1981) reported a positive milk yield response to an increase in the digestible CP content in concentrate from 125 to 185 g/kg when given to dairy cows. The CP contents of the treatment diets were all below 140 160 gCP/kg DM and this might have had unfavourable effects on milk secretion (Morand-Fehr and Sauvant, 1978).

Table 2: Average daily feed intake, total milk yield (kg) and milk composition, mean live weight and body condition scores changes in Saanen does supplementary fed the experimental diets over a 12-week lactation period starting from week 2 to 13 of lactation

	Diet				
Trait	**MD**	**MC**	**MS**	**MB**	**SEM**
N	4	3	4	3	
Feed intake (g/d)					
Katambora hay intake	357	396	401	370	56.7
Concentrate and legume intake	389	406	464	362	230
Total intake	746	802	865	732	742
Milk yield (kg/d)					
Week 2	4.87	5.11	4.58	5.68	0.831
Week 13	1.96	2.86	2.87	1.71	1.59
Total yield (kg)	42.5	48.3	46.0	37.9	18.3
Milk composition (g/kg)					
Butterfat	61.7	48.2	49.8	51.4	5.85
Protein	33.4	33.6	31.6	29.2	4.80
Lactose	37.6	38.9	39.7	39.1	3.24
Total solids	145	132	132	135	8.62
Solids non-fat	84.5	83.4	82.2	82.9	4.04
Live weight (kg)					
Initial	33.9	35.8	35.3	34.9	1.22
Final	34.0	35.7	35.2	34.8	2.08
Body condition score					
Initial	1.88	1.95	1.85	1.91	-
Final	1.96	2.06	2.48	2.15	-

n = number of animals; SEM = standard error of means

Scabra and Musasa contain 81 and 30 g/kg Mimosine equivalent of condensed tannins (CT), respectively (Baloyi, Ngongoni, Topps, Acamovic and Hamudikuwanda, 2001.). The animals on the *B. spiciformis* treatment had lower milk production compared to the other treatments and this could be related to both the low CP content and the high amount of proanthocyanadins (PA) present, leading to a deficiency of rumen degradable nitrogen (RDN).

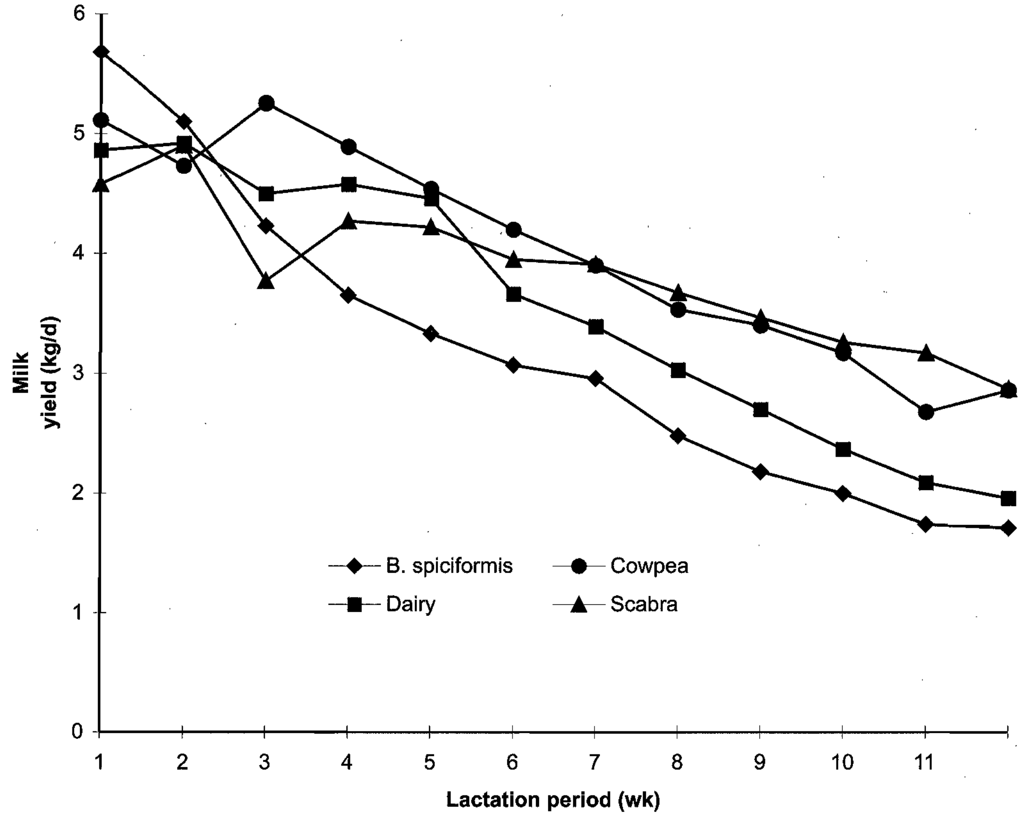

Figure 1: Milk production of Saanen does fed either commercial dairy concentrate or concentrate supplemented with Cowpea, scabra forage legumes or *B. spiciformis* browse tree legume

The stage of harvesting of the Musasa coincided with the time when the PA concentration and NDF (and possibly lignin) content had both increased. Tannins have been found to play a role in the reduction of voluntary intake through astringency (Bate-Smith, 1973) and this could have been the case with the Musasa treatment in this study. On the other hand, Scabra contains moderate levels of CT and the milk yields from this treatment were improved over the Musasa treatment. This compares with the findings of Wang et al. (1996) who concluded that ewes grazing *Lotus corniculatus* (containing 44.5 g/kg total CT/kg) increased milk yield and secretion rates of protein and lactose without affecting voluntary feed intake. The CT in the Scabra probably reduced degradation in the rumen, resulting in higher amino acid absorption from the small intestine (Waghorn et al., 1987).

Feeding excessive amounts of rumen degradable protein (RDP) such as that in Cowpea can increase the protein content of milk. Changing rumen degradability of the dietary protein for lactating cows, by substituting with undegraded dietary protein (UDP) from soyabean or cotton seed meal, does not consistently alter milk yield and protein composition or protein yield (Erasmus, 1997). Erasmus (1997) reported reviewed trials on the effect of substituting soyabean meal with protein sources high in UDP on milk protein and yield and concluded that there were positive responses to supplementation with high UDP sources in milk yield or milk protein content in only 19 % of all the comparisons. Some UDP may be indigestible, as might be the case with Musasa because of its relatively high NDF content.

Baloyi (2002) showed that cowpea has a high rumen degradability of nitrogen and it should have provided more RDP in the rumen than Scabra and Musasa forages. These forages could provide reasonable amounts of undegraded dietary protein (UDP) to the intestines. In this study, the commercial dairy concentrate probably contained sufficient rumen degradable protein (RDP). This could imply that the 250 g/kg inclusion might have been too small a proportion to show some differences in milk yield. The CT content in the Scabra and Musasa (Baloyi, 2002) could mean that the amount of RDP concentration was likely to be lower, especially in the Musasa treatment thereby limiting rumen microbial protein production.

There was higher milk protein in the milk from animals in the MD and MC diets but there was no statistical difference between the mean values of the diets on the composition. This lack of response due to differences in protein concentration of the diets is in agreement with the studies of Raats (1988) and Badamana, Sutton, Oldham and Mowlem (1992) using Boer and British Saanen goats, respectively, and other studies using dairy cows (Sutton, 1989). Changes in milk composition with changes in dietary protein quality (Erasmus, 1997) are not always obvious. Although there is a positive relationship between protein intake and milk protein content, the response is usually small. Schwab (1994) indicated that raising total dietary crude protein from 160 to 180 g/kg did not increase protein content of milk. This is probably related to either no changes or sometimes an increase in the amount of UDP relative to the microbial protein passing to the small intestines.

As found in the Musasa dietary treatment, feeding insufficient amounts of rumen degradable protein might result in decreased milk fat and ruminal ammonia nitrogen, which might not even support digestion of fibre. In general, the greater the content of fibre, the higher the levels of lignin in the fibre and the lower the digestibility and this results in low digestibility and ME value of the whole diet. Such a condition could have been the same with Musasa treatment since at harvesting there could have been inclusion of some woody material in new terminal shoots (leaf and young stems of less than 6 mm in diameter) than in leaves, that increased the NDF and also the PA content. A greater proportion of Musasa PAs is in the stems.

Conclusion

Milk production levels achieved in this study suggest that some conventional dairy concentrate can be substituted with 250g/kg forage legumes without affecting milk yield and composition in Saanen goats. Numerically higher milk yields were obtained in the Cowpea and Scabra forage legume supplemented treatments. However, more conclusive management trials to determine the appropriate inclusion levels of the legume substitute for dairy diets is required.

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