MUARIK Bulletin

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1. Manuscripts presented for publication should describe original work and are accepted on the understanding that they are not published elsewhere.

2. The articles should deal with original research, surveys, reviews, short notes, new methods and techniques. Research investigations conducted outside Uganda but with relevance to the African context will be considered.

3. Each article should be submitted in triplicate (original and 2 copies) to:

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5. Articles are arranged in well defined sections: Title, Authors' names and addresses, Abstract, Introduction, Materials and Methods, Results and Discussion, Acknowledgement (if desired), References.

6. References should be arranged in alphabetical order, by family name of the first author and year of publication. Each reference should include authors last name, initials, year of publication, title of paper, name of Journal, volume and pages, for example,

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8. Each table and figure should be presented on separate a sheet and numbered Table 1, Figure 1, etc. The number of tables and figures should be limited as much as possible.

9. Authors shall be responsible for the accuracy and originality of the articles published in the Journal.

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provide the critical nutrients (energy, protein, minerals and vitamins) that are lacking in the roughages (Mpairwe *et al.*, 1998). Maize bran has for long been used to suppliment low quality feeds and improve milk yield. Recent studies have shown that intercropping *Pennisetum purpureum* with forage legumes can increase fodder dry matter (DM) yield per unit area of land and at the same time improve the nutritive value of the fodder, which in turn improves milk yield from dairy cows (Katuromunda, 2000). Siratro (*Macroptilium atropurpureum*) is such a forage legume that has shown potential of increasing livestock productivity when it is integrated into *Pennisetum purpureum*. However the effect of supplementing Siratro and or maize bran on feed intake and milk yield and composition on crossbred cows fed on *Pennisetum purpureum* basal diets has not been investigated.

Therefore, this study was undertaken to evaluate the effects of supplementation with Siratro and maize bran on DM intake and subsequent milk production of crossbred (*Bos indicus* x *Bos taurus*) cows fed *Pennisetum purpureum* basal diets.

Materials and methods

The experiment was conducted at Makerere Univeresity Agricultural Research Institute Kabanyolo (MUARIK) which is located in the fertile Lake Victoria crescent area, about 19 km north of Kampala (0^0 28' N, 32^0 37' E) and altitude 1204 m. The climate of the area is sub-humid with moderately well distributed bimodal rainfall. During the experimental period, the annual total rainfall was 1563 mm. The mean maximum and minimum air temperatures were 17.5 and 15.0 °C, respectively. The highest and lowest relative humidity values were 87 and 63 %, respectively. The soils at Kabanyolo are deep red, highly drained red soils and are classified as Latosols.

First ploughing of the land was carried out in August 1999, just before the on-set of the rainy season and was repeated three weeks later. Planting of the fodder was done in September 1999. Siratro seeds were obtained from seed producers in Mukono District and *P. purpureum* planting material were obtained from one of the progressive farmers located within the study area. *Pennisetum purpureum* was planted on a 0.7-hectare plot at a spacing of 0.9 m between rows and 0.6 m between plants within each row. Siratro seeds were then sown in single alternate rows with *P. purpureum* immediately after planting the latter . A separate 0.7-hectare plot of Siratro alone was also established in order to ensure that enough Siratro herbage for the feeding trial is obtained. As a sole crop, Siratro was planted at a spacing of 0.5 m between hills and between rows. Three to five seeds were planted per hill. All the plots were weeded one month after planting and this was repeated eight weeks later.

Siratro herbage, both in the *P. purpureum*/Siratro mixture and sole crop was ready for harvesting after about 22 weeks from planting, while by this time *P. purpureum* was ready for the second round of harvesting. However, the feeding trial delayed for two months due to shading of leaves by Siratro during the dry spell that occurred in February 2000. The feeding trial commenced in May and lasted for three months. Siratro and *P. purpureum* fodder for feeding was harvested daily using a hand slasher and matchet, respectively. The harvested fodder was transported to the stall, chopped into pieces a matchet and then fed to cows according to assigned treatments.

Experimental design and animal management

Two Friesian (*Bos taurus*) x Zebu (*Bos indicus*) and one Jersey (*Bos taurus*) x Zebu (*Bos indicus*) crossbred cows were used in a 3 x 3 switchover Latin square design (Table 1). The animals were selected from MUARIK dairy herd and were in their first month of second lactation. Prior to the commencement of the experiment, their weights were taken using a heart girth tape measure and their mean live weight was 465 ± 93 kg. This was repeated at the end of every two weeks until the experimental period was over. The cows were housed individually in well-ventilated stall-feeding units. They were drenched with Levamisole hydrochloride (Nilzan) and sprayed with Delnav acaricide to control worms and ticks, respectively.

Diets and feeding management

At the commencement of the experiment, the diets were assigned to the cows randomly. The amount of Siratro fed was in accordance with the amount fed by smallholder farmers. The feeder-troughs were filled with *P. purpureum* fodder twice a day at 7.30 a.m. and at 5.00 p.m. to ensure *ad libitum* feed supply to the animals. Siratro and maize bran were given to the animals in the morning before giving them *P. purpureum*. The experimental diets were maintained for a period of 28 days, which included 14 days of adjustment to the diets and 14 days for data collection. Fresh, clean tap water was availed daily to the animals *ad libitum*.

Sampling and measurement

Feed and feed refusal samples, each weighing 0.5 kg were taken daily during the last two weeks of each period and kept in a fridge at 0 °C. At the end of each period, the feed samples were bulked together, mixed thoroughly and a composite sample weighing 0.5 kg taken. Similarly, feed refusal samples were bulked, mixed and a composite sample weighing 0.5 kg taken. The composite feed and feed refusal samples were oven-dried at 60 °C to a constant weight.

Chemical analysis

The dry feed and feed refusal samples were ground to pass through a 1 mm sieve and subsequently analysed for CP and ash using the AOAC (1990) procedures, for NDF by the Van Soest and Robertson (1985) method and *in-vitro* organic matter digestibility (IVOMD) by the Tilley and Terry (1963) technique. Calcium (Ca) and phosphorus (P) contents were determined by first digesting the samples with a tri-acid mixture of sulphuric, perchloric and nitric acids (1.5:2:3). Then Ca was assayed using an atomic absorption spectrometer and P content was determined using the ascorbic acid procedure (Okalebo, 1985). Gross energy of feed (GEF) was determined by complete oxidation of sample in presence of oxygen in an adiabatic bomb calorimeter (AOAC, 1990). Metabolisable energy of feed (MEF) was estimated from the digestibility of organic matter in the dry matter (DOMD) using the formula, MEF = 0.15 DOMD % MJ kg^{-1} DM (MAFF, 1987) and the ME intakes were then calculated.

Milk yield and composition

The animals were hand-milked twice a day, in the morning at 7.00 a.m. and in the afternoon at 4.30 p.m. throughout the experimental period. Milk yield values were converted to 4 % fat corrected milk (FCM) yield and recorded. In the last week of each feeding period, milk samples of each cow were

Table 1 Design for the feeding experiment.

Animals	Feeding periods		
	1	2	3
1	PSM[y]	P	PS
2	PS	PSM	P
3	P	PS	PSM

[y]Treatments: Each animal received each treatment once.

P Animals fed *ad-libitum Pennisetum purpureum* fodder only.

PS Animals fed *ad-libitum Pennisetum purpureum* supplemented with 4 kg day^{-1} of Siratro.

PSM Animals fed *ad-libitum Pennisetum purpureum* supplemented with 4 kg day^{-1} of Siratro and 2 kg day^{-1} of maize bran.

taken daily in the morning and afternoon, bulked into one sample and analysed for the butter fat content using Gerber method (British Standards Institute, 1989).

All the data collected were subjected to statistical analysis using the analysis of variance (ANOVA) procedure for a Latin square design of the MSTATC computer software package to determine the treatment effects on feed intake and milk yield and composition. Means for the different parameters were separated using the least significant difference procedure at 5 % level of significance.

Results and discussion

Chemical composition and IVOMD of experimental feeds

Chemical composition of the feeds used in the experiment is presented in Table 2. Mean DM, CP and NDF contents of *P. purpureum* were 22.9, 10.2 and 65.3 %, respectively. The CP content was greater than the limiting CP level (7 %) for ruminant production, but lower than the level (11-12 % CP) required for moderate levels of production (Forbes, 1986). These values were close to those reported by Fernandes and Deshmukh (1988) but higher than those reported by Saamanya (1996) and Kabirizi *et al.* (2000). The differences in these values could be attributed to the age at cutting, season of the year and site differences (Sanchez, 1982; Saamanya, 1996).

Siratro contained 18.6, 20 and 55 % DM, CP and NDF, respectively. The CP content of Siratro was twice that of *P. purpureum* and the NDF of Siratro was lower than that of *P. purpureum*, indicating that Siratro was better in nutritive quality compared with *P. purpureum*. However, the DM content of Siratro was lower than that of *P. purpureum*. Maize bran had the highest DM content as expected and was slightly higher in CP content than *P. purpureum* and very low in NDF. IVOMD was highest in maize bran due to its low NDF content and lowest in Siratro due to the presence of tannins, which protect the protein in Siratro from enzymatic breakdown (Norton and Poppi, 1995). Phosphorus (P) content was higher in Siratro and least in maize bran while calcium (Ca) content was higher in Siratro and lowest in *P. purpureum*.

Table 2. Chemical composition (% DM basis), IVOMD and energy content of the feeds used.

Parameter	Feeds		
	P. purpureum	Siratro	Maize bran
Dry matter	22.90	18.64	86.00
Organic matter	91.25	92.60	92.48
Crude protein	10.22	20.00	12.26
Neutral detergent fibre	65.31	54.97	24.00
Ash	8.75	7.40	7.52
IVOMD	74.48	62.14	87.24
DOMD	67.96	57.54	80.68
Calcium	0.27	1.02	0.48
Phosphorus	0.22	0.25	0.18
GEF (MJ Kg^{-1} DM)	19.16	17.04	18.10
MEF (MJ Kg^{-1} DM)	10.20	8.63	12.10

DOMD = Digestible organic matter in the dry matter; GEF = Gross energy of feed;
MEF = Metabolisable energy of feed = 0.15 x DOMD % (MAFF, 1987).
IVODM = *In vitro* dry matter digestibility

Feed intake by lactating dairy cows

The effects of supplementing *P. purpureum* basal diet with Siratro and maize bran on dry matter, CP, energy and mineral (Ca and P) intake are presented in Table 3. Supplementation with Siratro alone and a combination of Siratro and maize bran significantly ($P<0.05$) improved both the *P. purpureum* and total DM intake by lactating cows. When daily total DM intake was expressed on per unit metabolic body weight, there was a significant ($P<0.05$) difference between the unsupplemented and supplemented diets. The significant ($P<0.05$) increase in DM intake with supplementation could be attributed to the high CP content of Siratro and maize bran, as compared to that of *P. purpureum*. An increase in CP content in the diet could have resulted in improved availability of nitrogen to the rumen microbes (Bamualim *et al.*, 1984). This in turn could have increased the rate of digestion and clearance of DM from the rumen (Bonsi *et al.*, 1994). Thus supplementation with Siratro and maize bran could have increased the amount of amino acids that were absorbed from the diet which could have also stimulated the increase in DM intake (Osuji *et al.*, 1995). The low DM intake values obtained when sole *P. purpureum* diets were fed to the cows could be attributed to coarseness and chemical composition of *P. purpureum*. In addition, low CP levels could not provide enough nitrogen that would stimulate microbial activity, which would in turn lead to higher rate of digesta breakdown.

Supplementation of *P. purpureum* basal diets with Siratro and a combination of Siratro and maize bran significantly ($P>0.05$) improved the total CP intake, as compared with the unsupplemented diets. The CP intake was higher with Siratro and maize bran supplementation (1.55) than when Siratro alone was provided (1.41). Both supplements were richer in CP and had lower NDF than *P. purpureum* fodder. Thus, they were able to supply more CP required by the rumen microbes and also the dairy cows as by-pass CP.

Supplementation significantly ($P<0.05$) increased the metabolisable energy (ME) intake of the lactating cows, as compared with the unsupplemented basal diets. But there were no significant ($P>0.05$) differences among the supplemented diets. The highest ME intake among the supplemented diets (147.1 MJ head^{-1} day^{-1}) was obtained when *P. purpureum* basal diets were supplemented with a combination of Siratro and maize bran. The unsupplemented diets provided 87.7 MJ head^{-1} day^{-1}, which was lower than the estimated daily ME requirement (95 MJ head^{-1} day^{-1}) of a lactating cow weighing 400 kg and producing 8-12 kg milk of 4 % butter fat (MAFF, 1987). The DE intake followed the same trend as the ME intake. The gross energetic efficiency for milk production of the supplemented diets was not significantly ($P>0.05$) different from that of unsupplemented diets. This probably could be due to the fact that the animals received sub-optimal amounts of energy from both the supplemented and unsupplemented diets. Consequently, the gross energetic efficiency values for milk production for supplemented and unsupplemented diets were very low.

Supplementation significantly ($P<0.05$) increased the intake of Ca and P, as compared to the unsupplemented diets (Table 3). The differences in the mineral intakes could be attributed to the higher Ca concentration in the supplements as compared with the *P. purpureum* basal diets (Table 2). The Ca:P ratio was significantly ($P<0.05$) higher in the supplemented than in the unsupplemented diets. Also, the Ca:P ratios of the supplemented diets were significantly ($P<0.05$) different from each other. The estimated Ca and P requirements of dairy cattle weighing 400 kg and producing 8-12 kg milk of 4 % butter fat are 36.6 and 27.4 gms head^{-1} day^{-1}, respectively (NRC, 1989). Thus, the results of this study indicated that the intake of Ca and P was adequate only for the supplemented diets. Also, the estimated Ca:P ratio intakes were above the recommended range (1-2:1). But it has been reported that ruminants are able to tolerate high Ca:P ratios without detrimental effects (NRC, 1989).

Milk yield and composition

Results of the effect of supplementing *P. purpureum* basal diets with Siratro and maize bran on daily milk yield and butter fat content are presented in **Table 4. Supplementation of *P. purpureum* with Siratro alone (PS) and in combination with maize bran (PSM) significantly (P<0.05) increased FCM yield. However, supplementation of *P. purpureum* basal diets with a combination of Siratro and maize bran had no significant (P>0.05) advantage in milk yield over the *P. purpureum*-Siratro diet. Supplementation yielded 1.75 kg day^{-1} more FCM milk than the unsupplemented basal diets. The increase in milk yield when *P. purpureum* basal diets were supplemented with Siratro alone and a combination of Siratro and maize bran could be attributed to the high CP and Ca contents in the supplements.** Sole *P. purpureum* basal diets provided minimal quantities of CP (0.87 kg day^{-1}), ME (87.7MJ head^{-1} day^{-1}) and minerals (Ca and P).

Supplementation had no significant (P>0.05) effect on the butter fat content of the milk and the fat content in the milk of unsupplemented diets was almost equal to that in the milk of the supplemented diets. This could be attributed to better utilisation of dietary fibre contained in the *P. purpureum* diets from which, precursors for mammary lipid synthesis are derived (Susmel *et al.*, 1995). Mean daily changes in body live weights of the lactating cows were not significantly (P>0.05) different and all the treatments exhibited negative body weight changes (Table 4). Daily body live weight losses were greatest when the cows were given the *P. purpureum* basal diets alone. Losses in live weights of the

Table 3. Daily dry matter, crude protein, energy and mineral intake of lactating cows fed P. purpureum basal diets supplemented with Siratro and maize bran.

Parameter	Treatments			SEM	F-test
	P	PS	PSM		
Dry matter (kg day^{-1})					
P.purepureum	8.83a	12.17b	11.69b	0.51	*
Siratro	-	0.82	0.82	-	-
maize Bran	-	-	1.73	-	-
Total	8.63a	12.99b	14.24b	0.74	*
Total (g DM/kg $BW^{0.75}$)	90.83a	137.02b	144.62b	10.61	*
Crude protein (kg day^{-1})					
P.purepureum	0.87	1.25	1.18	-	-
Siratro	-	0.16	0.16	-	-
maize Bran	-	-	0.21	-	-
Total	0.87a	1.41b	1.55b	0.09	*
Energy (MJ head^{-1}day^{-1})					
[Y]ME	87.70a	131.03b	147.08b	6.80	*
DE	106.97	159.73b	179.37	8.16	*
[b]GEE of DE utilisation for milk production (%)	15.8	14.5	12.6	0.91	NS
Minerals (g head^{-1} day)					
Calcium (Ca)	23.22a	40.98b	48.14b	3.90	*
Phosphorus (P)	18.91a	28.69b	30.85b	1.61	*
Ca:P ratio	1: 2:1a	1: 4:1b	1: 6: 1	0.02	*

SEM = Standard error of mean; BW = Body weight; $BW^{0.75}$ = Metabolic body weight;
DE = Digestible energy; GEE = Gross energetic efficiency;
NS = Non-significant (P>0.05); * = Significant (P< 0.05).
[Y] Multiplication factor for converting DE to ME = 0.82 (ARC, 1984).
[b] Percent GEE of DE utilisation for milk production was calculated using 3.14 MJ kg^{-1} (0.75 Mcal kg^{-1}) as the estimated energy content of 4 % FCM (Close and Menke, 1986).
Thus,

$$\text{GEE of DE utilisation for milk (\%)} = \frac{\text{Energy content in the milk (MJ kg}^{-1}\text{)} \times 100}{\text{Digestible energy intake (MJ head}^{-1}\text{ day}^{-1}\text{)}}$$

Table 4. Daily milk intake, butterfat content and changes in body weights of crossbred lactating cows fed ad-libitum Pennisetum purpureum diet supplemented with Siratro and maize bran.

Parameter	Treatments			Mean	SEM	F-test
	P	PS	PSM			
Mikl ouput (kg day^{-1})	5.4	6.9	7.3	6.6	-	-
FCM milk output (kg day^{-1})	5.5a	7.3b	7.2b	6.7	0.31	*
Butterfat content (%)	4.1	4.3	3.9	4.1	0.32	NS
Changes in body wieghts (kg day^{-1})	-0.8	-0.2	-0.7	-0,6	0.23	NS

NS = Non-significant (P>0.05); * = Significant (P<0.05).
Means within the same column followed by different lettersare significantly different at P<0.05.

animals during the experimental period indicated that milk yield was, in part, at the expense of the animals' body weights. These cows had just delivered and energy requirements are highest during

Conclusion

The results of this feeding trial experiment have indicated that unsupplemented *P. purpureum* is nutritionally poor and thus does not provide adequate nutrients to crossbred lactating cows for milk production. However, when supplemented with small quantities of Siratro alone and a combination of Siratro and maize bran, the intake of crude protein and energy and milk yields are significantly (P<0.05) increased. Therefore, Siratro would serve as a cheap locally produced supplement alternative to purchased concentrates, especially under smallholder dairy production systems.

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