Ethiop. J. Agric. Sci. 20:161-167 (2010)

Milk Yield and Quality of Crossbred Dairy Cows Fed with Different Levels of Vetch (*Vicia dasycarpa*) Hay and Concentrate on a Basal Diet of Fresh Cut Napier Grass (*Penissetium purpureum*)

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Abstract

This study was conducted to examine the effect of different levels of vetch hay (**Vicia dasycarpa**) *supplementation on feed intake, milk yield and milk composition of 50:50 Boran-Freisian crossbred dairy cows fed a basal diet of napier grass* (**Penissetium purpureum**). *Five crossbred dairy cows at an early stage of lactation with average milk yield of 6 – 8 liters/cow/day and body weight of 390 ±15 kg (mean±STD) were arranged in a 5*5 latin square design. In the first 4 treatments, napier grass was fed* **ad libitum** *as basal diet, while in T5 (the control diet) native hay was the basal diet. In treatment 1, 2 and 3 vetch hay was supplemented at 20% (2.4 kg), 30% (3.6 kg) and 40% (4.8 kg) replacement of the total daily DM intake, respectively. In T4 and T5 concentrate mix (55% wheat bran, 43% noug seed cake* (**Gizotia abysinica**) *and 2% salt) was supplemented at the rate of 0.5 kg per liter of milk produced. Total dry matter intake differed among treatments in the order of T4>T3=T5>T2>T1. Milk yield was greater for concentrate supplemented treatments compared with the vetch supplemented ones, and was similar (P>0.05) among the different level of vetch supplemented groups. Milk fat and protein were not affected (P>0.05) by treatments. In general this study indicated that optimum milk production (8.81 liter/cow/day) can be obtained with the use of napier grass supplemented with 2.4 kg/cow/day vetch hay dry matter.*

Introduction

Rapid human population growth in Ethiopia has led to an unprecedented increase in cultivation of food crops, which in turn has reduced availability of land for forage production. Consequently, most ruminants on smallholder farms rely heavily on low quality native pasture and crop residues for major part of the year with little protein, energy and mineral supplementation (Lanyasunya et al., 2005). It is these factors that have heavily contributed to their current poor performance on smallholder farms as evidenced by low milk yield and poor reproductive performance. This amounts to a severe economic drain for resource poor smallholder farmers. It has however, been realized that these losses can be minimized through the use of locally available recommended improved forage crops to increase animal productivity.

Forage legumes could be among the alternative feed resources and more appropriate options to produce quality feed supplements in the tropics. Many cultivated forage crops have been tested in the highlands based on their herbage yield, quality and adaptation to the different production systems. A number of improved forage crops have now been identified as suitable crops for increasing the quantity and quality of forage produced in smallholder farming systems including oats, napier grass, vetch, and species that could be grown around the homestead to overcome the feed problem such as fodder beat and browse trees. Different vetch species are widely grown for both livestock and soil fertility improvement (Chowhurry, et al., 2001), and are well known group of legumes with high crude protein content.

The value of vetch forage as protein supplements for ruminant livestock is also widely recognized. As a green manure cover crop vetches have gained popularity for their reputed beneficial ability to fit well into cereal rotations and grass pastures. These aspects of vetch forage are particularly relevant to smallholder farmers to complement both livestock and crop production**.** Indeed, many past research studies have recommended use of protein rich legume forages as the most feasible option to increase overall animal productivity. However, so far there was no any recommendation on the level of vetch hay supplementation on a basal diet of fresh napier grass. This study was therefore, conducted with the purpose of identifying the most appropriate level of vetch hay supplementation to crossbred dairy cows for optimum milk production and milk quality.

Materials and Methods

Experimental feeds and animals

This study was conducted during the rainy season from June to September 2008 at Holetta Agricultural Research Center located at (99^{O}N latitude; 38^{O}E longitude). The experimental site lies at 2400 meters above seas level. The average minimum and maximum air temperatures are 6 and 22 degree Celsius, respectively. The experimental feeds used were fresh napier grass (*Penissetium purpureum*), native hay, vetch (*Vicia dasycarpa*) hay and concentrate mixture. Adapted napier line (accession number14984) was established at Holetta Agricultural Research Center on-station farm in four hectares of land. Fertilizer (DAP) at the rate of 100 kg/ha was applied during the year of establishment in 2006. After establishment, the land was partitioned into five parts and managed in such a way that it reaches to be harvested at a height of one meter. The napier grass at the stage of one meter height was harvested every morning, chopped and offered to lactating cows. On the other hand vetch was planted in June, 2007 and harvested at the end of October the same year. Vetch was used as a supplement at different levels. Native hay from natural pasture at the on-station farm of the center was harvested and stored in early November 2007. The major species of the hay were *Andropogon, Hyperrnenia, Cyperacea* and *Trifolium*

species. The concentrate supplement used was a mixture of wheat bran (55%), noug seed (*Gizotia abysinica)* cake (43%) and Salt (2%).

The experimental animals were 50:50 Boran-Fresian crossbred dairy cows selected from Holetta Agricultural Research Center based on their milk yield (6 to 8 liters per day). The animals were at early stage of lactation and of similar parity (second parity). They had average body weight of 390 ± 15 kg (mean± STD). The cows were checked for major contagious diseases and drenched with antihelmintic and sprayed against external parasites periodically.

Treatments and feeding trial

Five cows were used in a 5*5 Latin square design. Each cow was kept in a separate pen in a well ventilated barn. The five treatment diets were fresh napier grass fed *ad libitum* supplemented with 2.4 kg of vetch hay/day (T1), 3.6 kg of vetch hay/day (T2), 4.8 kg of vetch hay/day (T3), concentrate mix fed at the rate of 0.5 kg/liter of milk/day (T4), and native hay supplemented with concentrate mix fed at the rate of 0.5 kg/liter of milk/day (T5). The experiment lasted 105 days and consisted of 5 periods of 21 days each. In each period animals were allowed 7 days of adaptation to the experimental feeds followed by 14 days of actual data collection. Throughout the experimental period animals had free access to water and mineralized salt block. The mineral block which was purchased from Hawassa and composed of table salt, molasses, lime, copper sulphate, zinc sulphate, manganase sulphate, cobalt sulphate and ground bone meal. Feed intake was determined as the difference between feed offered and that of refused.

Chemical analysis

Feed samples were taken daily, bulked on a weekly basis, oven dried at 65^{o}C for 72 hours and ground to pass through a 1 mm sieve screen for laboratory analysis. Dry matter (DM), ash, and crude protein (CP) were determined according to the procedures described by AOAC (1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the methods of Van Soest and Robertson (1985). Milk yield was recorded daily in the morning and evening. Pooled milk samples (100 ml) from each cow were collected every other day for seven days in each period. Milk samples were analyzed for milk fat by Gerber method (AOAC, 1990) and crude protein according to the procedure outlined by Pyne (1932). In-vitro dry matter digestibility was determined according to the procedures described by Tilley and Terry (1963). Metabolizable energy (ME) was estimated from in-vitro digestibility parameter according to AFRC (1993), ME= 0.0157*DOMI, where DOMI is digestible organic matter intake.

Statistical analysis

The data was analyzed using the general linear model of Statistical Analysis System (SAS, 2001). Treatment means were separated using least significant difference test.
The model used for the analysis of data was

$Y_{ij}= \mu + t_i + p_j + e_{ij}$
Where, Yij= the dependent variable
μ = over all mean,
t_i = effect of i^{th} treatment,
p_j = effect of j^{th} period,
e_{ij}= random variation

Result and Discussion

Chemical composition and *in-vitro* digestibility of experimental feeds

Chemical composition and *in- vitro* digestibility of experimental feeds are presented in Table 1. Within the basal diets fresh napier grass had high content of total ash, CP and IVOMD than native hay. The NDF and ADF content were high in native hay. The supplemental fed used were concentrate mixture and different levels of vetch hay. CP content was high in concentrate mixture than vetch hay. There was negligible difference in IVOMD between the two supplements. The total ash content of vetch hay was high compared to native hay. In case of fiber component, NDF content was low in vetch hay where as the ADF content was low in concentrate mixture.

Dry matter and nutrient intake

There was significant difference ($P<0.05$) in total DM and CP intakes between the different treatments (T4>T3=T5>T2>T1) (Table 2). Greater ME intake was encountered in T4 and T3 followed by T2 and then T1 and T5. Within the different level of vetch supplemented groups, CP and ME intakes increased as the level of vetch in the diet increased. There was significant difference ($P< 0.05$) observed in the intake of the basal diet among concentrate and vetch supplemented groups but basal diet intake was similar ($P>0.05$) among vetch supplemented group. The total dry matter intake and total nutrient intake in this study was higher than reported by Mpairwe (1998) and NARO/NAARI (1996/97).

Table 1. Chemical composition and in-vitro dry matter digestibility of napier grass, natural pasture hay, vetch (*Vicia dasycarpa*) hay and concentrate mixture used in the experiment.

parameters	Fresh Napier grass	Native hay	Vetch hay	Concentrate * mixture
DM (%)	19.10	91.70	85.00	91.00
Ash (% DM)	16.89	5.13	10.00	7.13
Crude protein (% DM)	9.10	5.90	14.00	22.00
Neutral detergent fiber (% DM)	63.41	73.80	39.39	44.34
Acid detergent fiber (% DM)	39.81	45.40	35.71	26.03
IVDMD (%)	61.85	51.57	68.48	67.50

DM= dry matter; IVDMD = *In-vitro* dry matter digestibility
* = a mixture of wheat bran (55%), noug seed (*Gizotia abysinica)* cake (43%) and Salt (2%)

Table 2. The effect of different supplementation of vetch and concentrate mix on dry matter and nutrient intake of dairy cows

Treatments	Basal diet DMI(kg/day)	Total DMI (kg/day)	DMI (% LW)	Total CPI (kg/day)	Total MEI (MJ/cow/day)
T1	9.68c	12.63d	3.17	1.29d	118.96c
T2	9.69c	13.33c	3.34	1.39c	126.13b
T3	9.55c	13.96b	3.40	1.49b	132.76a
T4	10.46a	14.39a	3.63	1.88a	135.64a
T5	9.93b	13.87b	3.38	1.51b	116.75c

[abc] , Means within column with different superscripts are significantly different (P<0.05);
CPI = crude protein intake; DMI = dry matter intake; %LW = percent live weight; MEI = metabolizable energy intake; T1= Napier grass basal diet + 20% of their dry matter intake supplemented from vetch hay; T2 = Napier grass basal diet + 30% of their dry matter intake supplemented from vetch hay; T3 = Napier grass basal diet + 40% of their dry matter intake supplemented from vetch hay; T4 = Napier grass basal diet + concentrate supplementation at the rate of 0.5 kg per liter of milk; T5 = native hay basal diet + concentrate supplementation at the rate of 0.5 kg per liter of milk

Milk yield and milk composition

There was significant difference (P<0.05) in milk yield between vetch supplemented and concentrate supplemented groups (Table 3). Among the different level of vetch supplemented groups there was no significant (P>0.05) difference in milk yield. There was no also significant difference (P>0.05) in milk fat and protein content among treatments. Average milk protein and fat content were 5.04% and 4.65% respectively. The milk yield and milk composition of the present study showed no beneficial advantage due to increasing levels of vetch supplementation. In the present study, cows under napier grass (fresh cut) basal diet and supplemented with 2.4 kg DM vetch hay, produced milk yield of 8.81 kg/cow/day. In a similar study NARO/NAARI (1996/97) obtained milk yield of 9.8 liter/day on a basal diet of napier grass supplemented with lablab hay. Mpairwe (1998) also obtained a milk yield of 8.5 kg/cow/day with lablab supplementation on a basal diet of maize lablab stover. In the current study a milk yield of 9.69 kg/cow/day was obtained when napier grass was supplemented with concentrate mixture. In a similar study in Tanzania, 60 kg of fresh napier grass supplemented with 4 kg of maize bran supported a milk yield of 10 lt/cow/day (Kavana, 2008). Khalili et al. (1992) also demonstrated significant increase in milk yield of crossbred cows fed oat-vetch hay and supplemented with increasing level of concentrate.

Table 3. The effect of different supplementation of vetch and concentrate mix on milk yield and milk composition

Treatments	Milk yield (kg/ day)	Milk protein %	Milk-fat%
T1	8.81c	4.89	4.50
T2	8.76c	5.14	4.51
T3	8.80c	4.94	4.75
T4	9.69a	5.08	4.79
T5	9.36b	5.16	4.71

[abc,] Means within a column with different superscripts are significantly different ($P<0.05$); T1= Napier grass basal diet + 20% of their dry matter intake supplemented from vetch hay; T2 = Napier grass basal diet + 30% of their dry matter intake supplemented from vetch hay; T3 = Napier grass basal diet + 40% of their dry matter intake supplemented from vetch hay; T4 = Napier grass basal diet + concentrate supplementation at the rate of 0.5 kg per liter of milk; T5 = native hay basal diet + concentrate supplementation at the rate of 0.5 kg per liter of milk

Milk protein and milk fat content was higher in the present study than reported earlier by Mpairwe (1998) and NARO/NAARI (1996/97). The higher milk protein and milk fat concentration could be due to the high protein intakes of cows in the current study. This indicated that with the use of good quality basal diet supplemented with forage legume it is possible to improve both milk yield and milk composition of crossbred dairy cows. Based on the earlier (Mpairwe 1998 and NARO/NAARI 1996/97) and present study, improved forage legumes have been proven to support considerable levels of dairy production under smallholder farmer's condition.

Conclusion

This study indicated that optimum milk production (8.81 liter/cow/day) can be obtained with the use of napier grass *ad-libtum* supplemented with 2.4 kg DM vetch hay/cow/day.

Different improved forage crops were adopted and disseminated under smallholder farmers condition as suitable crops for increasing the quantity and quality of milk produced. Supply of concentrate feeds in most rural parts of Ethiopia is highly limited. This is mainly due to poor infrastructures and accessibility, inadequate availability of concentrate feeds and agro industrial byproducts, and high costs. Under this situations production of forage crops is generally more appropriate and feasible for most smallholder farmers. Considering this potential, it is recommended to use improved forages for optimum milk production under smallholder farmers dairy production system.

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