

Effect of Forage Sorghum on Milk Production

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ABSTRACT

The effect of forage sorghum on dairy production was studied, using eight multiparous mid-lactating Holstein-Friesian crossbred cows, based on days in milk, lactation number and milk yield. They were divided into two treatments using a group comparison, with four animals in each group. Animals in Group 1 were provided with fresh sole forage sorghum, at 60 d defoliation after planting, and in Group 2 were fed fresh forage sorghum with lablab legumes at the same age as in Group 1. All cows were also supplemented with 45-50% of total daily dry matter intake with meal concentrate of 17.39% CP, twice daily at milking times of 05:00 and 15:00. The results revealed that cows fed fresh forage sorghum mixed with lablab legumes had significantly higher roughage daily dry matter intake, total daily dry matter intake, %BW of total daily roughage dry matter intake and %BW of total daily dry matter intake than Group 2 ($P<0.05$). The actual milk yield and 4% fat corrected milk, milk composition, blood glucose and blood urea nitrogen in the morning and afternoon feeding in both treatments were not significantly different. However, this study suggested that the higher nutritive value of forage sorghum intercropped with forage legume could increase dairy production.

Keywords: forage sorghum, lablab legume, dairy cow, milk production

INTRODUCTION

Forage sorghum, *Sorghum bicolor* (L.) Moench, a fast growing crop, can provide alternative roughage for dairy production in terms of fresh-cut feeding, grazing and silage feeding for ruminants (Skerman and Riveros, 1990). In general, its first cut will be at 60 d after planting with continuous defoliation after 45 d of regrowth for 3- to 5- times after the first cut (Stuart, 2002). However, the quality of forage sorghum at the first cut is apparently low, in particular with the protein content (4-6%), which is lower than the normal

requirement for cattle (Hennessy, 1980). In such cases, a tropical legume, such as *Lablab purpureus*, which is an annual tropical legume with high protein content up to 20%CP, is introduced to improve sorghum quality by means of intercropping with forage sorghum (Jones, 1972; Whiteman, 1980). The current study was designed to compare the nutritive quality of forage sorghum on its own and using it in combination with lablab, in association with the assessment of dairy performance and some blood metabolites in lactating cows fed with the different roughage mixtures.

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MATERIALS AND METHODS

The 1-ha experimental site for the commercial forage sorghum crop was located at the Muaklek Research Station of the Dairy Farming Promotion Organisation of Thailand, Muaklek, Saraburi, Thailand (14° 50'N, 101°10' E; altitude 220 m). The soil type was clay loam of moderate fertility (Wang Saphung Series) and the mean annual rainfall was 1,192 mm.

Experimental design and treatments

Two groups of cows were studied using a group comparison design.

In Group 1, four cows were housed, stanchion-restrained on rubber flooring, in individual stalls with dimensions 1.2 m wide × 1.8 m long, in an open-sided barn and fed with 1-2 inch chopped forage sorghum. The stalls were located in a barn with a tile roof and dimensions 80m long × 12m wide × 10.5m high, with the long axis oriented east-west.

In Group 2, four cows were managed as for Group 1 in the same barn, but provided with 1-2 inch chopped lablab mixed with forage sorghum.

The cows were all crossbred animals (more than 75% Friesian × local *Bos indicus*), all in their 2nd-3rd lactation and at 92 d of lactation when the experiment began. The cows were balanced for these factors across the two groups, and account was also taken of their live weight and previous milk production. A pre-experimental period of 2 weeks was allowed for the cows to adapt to the changed management conditions and for preliminary milk production data to be collected. The experiment was conducted over a period of 45 d during September and October 2007.

All cows were individually fed a commercial meal concentrate (90.01% dry matter (DM), 17.39% CP) according to their current milk production (adjusted weekly) at the rate of 1 kg of

concentrate per 2.5 kg of milk, divided between the morning and afternoon milkings. This was fed immediately prior to milking and all meal was consumed. In addition, clean water from an individual automatic bowl and a mineral block were freely accessed in each stanchion.

Forage sorghum management

Two months prior to the start of the experiment, commercial forage sorghum was planted on a well-prepared seedbed within 0.75 ha in single rows spaced at 30 cm with 10 cm between each plant. The remaining 0.25 ha was lablab intercropped with the forage sorghum with lablab in single row strips at 30 cm spacing (10 plants per 30 cm row length). The lablab intercropped with forage sorghum was then top-dressed with 156 kg/ha N:P:K (15:15:15) fertilizer, while urea was applied on the sole forage sorghum at 180 kg/ha after 30 d from planting. Sprinkler irrigation was applied when necessary to ensure optimal soil moisture conditions for forage sorghum growth. At age 60 d, both types of forage sorghum were mechanically harvested at 15-20 cm above the ground and chopped into pieces 1-2 inches long. The chopped feed was cut fresh daily and provided *ad libitum* to the test animals.

Animal measurements

The mean roughage intake of both groups was individually measured as the difference between the daily herbage offered and the residual uneaten herbage.

Roughage samples were analyzed for dry matter (DM) content, Kjeldahl nitrogen (Tecator system 1002), neutral and acid detergent fiber (NDF and ADF; Goering and Van Soest, 1970) by a VELP Scientifica (Type FIWE, Fibre Tech, Italy).

Milk yield was individually recorded at each milking and a composite sample of morning and afternoon milk for each cow was analyzed at weekly intervals for fat, protein, lactose and solids-non-fat (SNF) using a Milkoscan Tester. The yield

of 4% FCM was calculated by the formula of Walker *et al.* (2001) shown in Equation 1:

$$\text{FCM (kg/cow/d)} = \text{milk yield (kg/cow/d)} \times [0.4 + 0.015 \times \text{fat content (g/kg)}] \quad (1)$$

Liveweight was recorded before the experiment began and at fortnightly intervals thereafter. Individual cows were examined daily for health condition.

A technique (Blowey *et al.*, 1973) to assess the nutritional status of dairy cows in relation to production was applied on September 19, 2007. To accommodate that technique, morning supplementation was delayed until after milking on that day only. Individual jugular venous blood samples (Vacutainer) were collected at 07:30, immediately after the morning milking but before supplementation, and again before the afternoon milking (5 h after morning supplementation). Heparinised samples were centrifuged and stored at -20°C before being analyzed for plasma urea nitrogen (BUN; Tiffany *et al.*, 1972) and plasma glucose (Slein, 1963).

Meteorological recordings

Meteorological readings were taken daily at 14:00 for maximum and minimum temperatures and indoor relative humidity. Maximum and minimum temperatures and relative humidity under indoor conditions during the experiment were $26.83 \pm 1.47^{\circ}\text{C}$, $23.38 \pm 1.78^{\circ}\text{C}$ and $73.42 \pm 4.50\%$, respectively.

Statistical analysis

Differences between treatment means were compared using a t-test, according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Climatic conditions

The study occurred under normal indoor conditions between the end of the rainy season and the beginning of the cool season in Muaklek district (Meteorological Department, 1998). The climatic data during the experimental period indicated that the maximum air temperature in the experimental barn slightly exceeded the acknowledged upper critical temperature of 26°C for Friesian cattle (Johnson *et al.*, 1961). Thus, it might be expected that the experimental cows in the study were subjected to mild levels of heat stress in the afternoon, possibly causing lower intake and consequent reduction in milk production (Johnson, 1987).

Pasture quality and intake

Due to the urea application on the sole forage sorghum at 180 kg/ha 30 d after plating, the protein content of the sole sorghum forage was increased to 8.17% (Table 1) and had a nitrogen level sufficient for sorghum growth (Hedges *et al.*, 1989), which was adequate to meet the normal requirements of ruminal protein for cellulolytic bacterial activity (Hennessy, 1980). The high dry matter content in both sorghum groups occurred due to plant maturity at first defoliation 60 d after planting (Whiteman, 1980). In addition, *Lablab purpureus*, when intercropped with forage sorghum, could improve sorghum protein content from 8.17 to 9.48%. This was associated with the relatively high protein level of *Lablab purpureus* (Thurbon *et al.*, 1970) which meant better quality roughage for the animals.

Table 1 Nutritive values of the roughage types used in the experiment.

Items (%)	Sorghum	Sorghum-lablab mixed
DM	30.15 ± 0.24	30.22 ± 0.50
CP	8.17 ± 2.31	9.48 ± 0.23
NDF	65.70 ± 0.06	64.67 ± 0.74
ADF	44.41 ± 2.26	44.74 ± 1.03

While the data in Table 2 suggests that cows fed on the sorghum–lablab mix consumed significantly greater forage than the group fed solely on sorghum (8.27 ± 0.72 kgDM/head and 6.66 ± 0.72 kgDM/head, respectively), it was probably the higher protein content in the sorghum–lablab mixed roughage that activated cellulolytic bacteria producing faster fiber digestion (Church, 1979). Hence, the crude protein level of the pasture had a marked and beneficial effect on animal intake (Chacon and Stobbs, 1976). Subsequently, total dry matter intake per bodyweight of the cows fed on the sorghum–lablab mix was significantly higher than that of the group fed solely on sorghum ($P < 0.05$). However, there was no statistical difference in the meal concentrate intake between both groups as they had similar actual milk yield.

Milk production, liveweight change and blood metabolites

Actual milk and FCM yields for the

different groups fed either sorghum or the sorghum–lablab mix did not differ significantly throughout the experimental period with means of 15.10 and 15.72 kg/d, and 15.08 and 15.94 kg/d, respectively (Table 3). However, this represented an increase from the group fed normal quality roughage (about 15.1 kg/d) to those fed better quality roughage (15.9 kg/d).

Better quality roughage can support milking performance (Humphrey, 1991) and also produce greater liveweight gains (Table 4) during mid lactation (Chilliard *et al.*, 1989). Any differences in milk composition were small, as indicated by Table 3 and based on milk quality standards (National Food Institute, 1987).

BUN and blood glucose concentrations for the two groups are shown in Table 4. Blood urea nitrogen and glucose levels did not differ significantly between the two groups.

Blood glucose concentrations at the morning and afternoon feedings were above the normal range of 42.5–45.4 mg% (Payne *et al.*,

Table 2 Daily dry matter intake (DMI) of roughage and meal concentrate between dairy cows fed on different roughage mixes.

Items	Group fed solely sorghum	Group fed sorghum–lablab mixed
Roughage DMI (kg)	$6.66^a \pm 0.50$	$8.27^b \pm 0.72$
Concentrate DMI (kg)	6.78 ± 0.60	6.95 ± 0.63
Total DMI (kg)	$13.44^a \pm 0.83$	$15.22^b \pm 0.75$
% BW total DMI	$3.10^a \pm 0.17$	$3.52^b \pm 0.16$

^{a, b} means within a row with different superscripts differ significantly ($P < 0.05$).

Table 3 Milk production and composition between dairy cows fed on different roughage mixes.

Items	Group fed sorghum sorghum–lablab mix	Group fed
Actual milk yield (kg/d)	15.10 ± 1.59	15.72 ± 1.70
4 % FCM (kg/d)	15.08 ± 1.45	15.94 ± 1.87
Milk composition (%)		
Milk fat	4.00 ± 0.30	4.09 ± 0.11
Milk protein	3.19 ± 0.09	3.10 ± 0.09
Lactose	5.52 ± 0.13	5.41 ± 0.24
Solid not fat	9.32 ± 0.25	9.06 ± 0.45

Table 4 Liveweight change between dairy cows fed on different roughage mixes.

Items	Sorghum fed group	Sorghum-lablab mixed fed group
Initial weight (kg)	435.25 ± 32.60	429.75 ± 20.04
Final weight (kg)	441.50 ± 30.56	436.50 ± 27.00
Body weight change (kg)	6.25 ± 3.30	6.75 ± 8.22

Table 5 Mean of blood glucose and blood urea nitrogen concentration between dairy cows on different roughage mixes.

Items	Sorghum fed group	Sorghum-lablab mixed fed group
Blood glucose (mg %)		
morningAM feeding	70.49 ± 5.52	63.56 ± 8.92
afternoonPM feeding	71.67 ± 3.34	69.28 ± 3.19
Blood Urea nitrogen (mg/%)		
morning AM feeding	8.96 ± 1.65	10.47 ± 2.11
afternoonPM feeding	12.04 ± 1.05	13.18 ± 1.84

1974), indicating an adequate energy supply to all cows (Rook and Line, 1961). The morning blood urea nitrogen concentrations in both groups were within the normal range of 6.3-25.5 mg% (Wannapat, 1990) and both afternoon contents were under 12.3-17.8 mg% (Rowlands *et al.*, 1977). These results indicated that the group fed on the sorghum-lablab mix showed higher eating activity (higher dry matter intake, Table 2) than their counterparts, which would be expected to elevate blood urea levels.

CONCLUSION

Forage sorghum can be an alternative feed to compensate for pasture during feed shortage periods. In addition, tropical legumes, such as *Lablab purpureus* intercropped with forage sorghum, showed potential to improve roughage quality, inducing higher daily dry matter intake and higher milk production, which in turn was associated with greater live weight gain.

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