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Effect on Milk Production in Thailand of Silage from Forage Sorghum and Forage Sorghum with *Lablab purpureus*

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ABSTRACT

The experiment was designed to determine the quality of silage from forage sorghum and from forage sorghum mixed with lablab legume on dairy production, using eight multi-parous mid-lactating Holstein-Friesian crossbred cows, based on days in milk, lactation number and previous milk yield. The cows were divided into two treatments using a pair comparison, with four animals in each group. Animals in group 1 were provided with forage sorghum silage while those in group 2 were fed silage from forage sorghum mixed with lablab legume. All cows were also individually fed a commercial meal concentrate of 89.01% dry matter and 19.46% CP, twice daily at milking times of 0500 and 1500 hours. The results revealed that fresh yields of forage sorghum and forage sorghum intercropped with lablab legume were 1,319 and 1,374 kg.ha^{-1}, respectively. However, the better nutritive values of forage sorghum with lablab legumes were found to produce higher values of % body weight change, total daily dry matter intake, actual milk yield, 4% fat corrected milk, blood glucose and blood urea nitrogen but they were not significantly different. However, the higher nutritive values of forage sorghum mixed with forage legume can possibly increase dairy production.

Key words: forage sorghum, lablab legume, silage, dairy production

INTRODUCTION

In Thailand, the number of dairy cows has substantially increased over the past decades, but the main feeding systems for these cows have shown little change (Tudsri and Sawasdipanit, 1993). Where pasture production is low and has low nutritive value, it can be improved by supplementing feeding with a forage legume. 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 three to five times after the first cut (Stuart, 2002). However, the quality of forage sorghum at the first cut is apparently

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low, particularly its protein content (4–6%), which is lower than the normal requirement for cattle (Hennessy, 1980). In such cases, a tropical legume, such as lablab (*Lablab purpureus*) which is an annual tropical legume with a high protein content (CP) up to 20%, is introduced to improve sorghum quality by means of intercropping with forage sorghum (Jones, 1972; Whiteman, 1980). Milk production from lactating cows fed fresh forage sorghum and the mixture of forage sorghum with lablab legumes was reported by Prasanpanich *et al.* (2010). Since forage sorghum is a highly nutritious multi-cut hybrid fodder (Tudsri, 2005), it could be ensiled to meet the fodder needs during feed shortage. Therefore, the purpose of the present study was to compare the effects of silage made from sole forage sorghum with silage made from forage sorghum mixed with lablab legume on dairy performance during mid lactation with a special reference to blood metabolites.

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) on a soil type described as clay loam of moderate fertility (Wang Saphung Series) with a mean annual rainfall of 1,192 mm.

Forage sorghum management and silage production

Commercial forage sorghum and lablab legume (*Lablab purpureus* L., cultivar Highworth) were planted on the experimental site with a firm, fine seedbed before planting and was subdivided into six paddocks, each of approximately 0.16 ha. Three paddocks for sole forage sorghum planting were drilled in rows (30 × 10 cm) at a seeding rate of 18.75 $kg.ha^{-1}$ on 19 and 26 June and 3, 10, 17 and 24 July 2009 while the forage sorghum-lablab intercropping using forage sorghum at 12.50 $kg.ha^{-1}$ and a seeding rate of lablab at 21.88 $kg.ha^{-1}$ were established in the remaining areas. The site was topdressed using 187.50 $kg.ha^{-1}$ N:P:K (15:15:15) fertilizer on the planting date and at 30 d after planting in the forage sorghum-lablab intercropping while urea was applied at 187.50 $kg.ha^{-1}$ to the forage sorghum at 187.50 $kg.ha^{-1}$ on the planting date and at 30 d after planting. Sprinkler irrigation was applied when necessary to ensure optimal soil moisture conditions for better pasture growth. Both crops were harvested at 60 d after sowing for silage. The fresh yields of forage sorghum and forage sorghum intercropped with lablab legume were 1,319 and 1,374 $kg.ha^{-1}$, respectively. During silage making, both crops were mechanically harvested at 15–20 cm above the ground and a decreasing particle size by a locally manufactured machinery chopper (chop length 1–3 cm). Crop materials were manually packed and ensiled in black plastic bags (25 kg per bag) for 30 d and then provided *ad libitum* to the test animals.

Animals and diet

Eight Holstein-Friesian crossbred cows (93% Holstein Friesian and 7% *Bos indicus*) were used with an average weight of 458 kg in mid lactation at 123 d after calving based on the first to third lactation number and a milk yield of 18 $kg.d^{-1}$ prior to the commencement of the experiment. The cows were assigned into two groups with four animals in each group under a group comparison design. Group 1 was given forage sorghum silage (FS), while group 2 was fed forage sorghum mixed with lablab silage (FSL). All cows were housed and individually stanchion-restrained on a rubber mat floor (Siam United Rubber Company Limited, Thailand).They were fully fed different silage types *ad libitum* and also supplemented with meal concentrate (89% dry matter; DM, 19.5% CP), according to their current milk production (adjusted weekly) at the rate of 1 kg of meal concentrate per 2.5 kg of milk, twice daily at milking (at 0500 and 1500 hours). The meal concentrate supplement was fed twice daily during the morning and afternoon milking with an equal amount each time. In addition, clean water from an individual automatic bowl and a mineral block were available and freely accessed at each stanchion. A preliminary period of 2 wk was allowed to introduce all animals to the feeding adaptation with an experimental duration of 42 d from 23 November 2009 to 3 January 2010.

Measurements

Live weight was measured at the beginning and the end of the experiment. Feed intake was determined as the difference between feed offered and refused feed that was collected daily. During the feeding trial, after opening the silage bags, silage samples were analyzed for DM content (AOAC, 1990), Kjeldahl nitrogen (AOAC, 1990; Tecator 1002; Sweden) and for neutral and acid detergent fiber (NDF and ADF; Goering and Van Soest, 1970) by a VELP Scientifica (Type FIWE; Fiber Tech; Milan, Italy).

The DM percentage of roughage and meal concentrate was used to calculate daily dry matter intake (DMI). 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) contents by a Milkoscan Tester (LactoStar® Item No.3510; Funke Gerber; Berlin, Germany). The yield of 4% FCM was calculated according to Walker *et al*. (2001) as shown in Equation 1:

$$\text{FCM (kg per cow per day)} = \text{milk yield (kg per cow per day)} \times [0.4 + 0.015 \times \text{fat content (g.kg}^{-1})] \quad (1)$$

A technique (Blowey *et al*., 1973) to assess the nutritional status of dairy cows in relation to production was applied on the last day of the experiment. To accommodate that technique, morning feeding was delayed until after milking on that day only. Individual jugular venous blood samples were collected at 0730 hours immediately after morning milking, but before feeding, and again before the afternoon milking (3–4 hr after morning feeding). Heparinized samples were centrifuged and stored at -20 ºC before being analyzed for plasma urea nitrogen (Tiffany *et al*., 1972) and plasma glucose (Slein, 1963). All data of experimental treatments were statistically analyzed using a *t*-test according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Silage quality and animal intake

As legumes have higher protein content than pasture, the mixture of legume in any pasture should increase the nutritive values in the pasture (Whiteman, 1980). Due to mixing lablab with the forage sorghum, the quality before ensiling of this combination was higher than sole forage sorghum, with values of 17.95 and 9.64%, respectively. After the ensiling process, silage from lablab intercropped with forage sorghum still had more protein content than from sole forage sorghum silage, with values of 9.36% in the FS silage and 15.95% in the FSL silage (Table 1). This study indicated that the higher protein content in FSL was possibly associated with the high protein content in the intercropped lablab. The CP content in both silages was kept above the minimal range needed for the normal requirements of the ruminal protein level for cellulolytic bacterial activity (Hennessy, 1980). Critical dietary crude protein concentration below 7% CP would depress voluntary intake (Milford and Minson, 1967). NDF and ADF levels in both silage types were similar and would be a predictor of voluntary DMI by ruminants (Church, 1979).

However, there is substantial evidence that NDF alone is inadequate as its filling effect varies with particle size, particle fragility and the rate and extent of NDF digestion, retention time in ruminal and total chewing activity (Teimouri *et al*., 2004). Forage sorghum mixed with lablab silage had a better nutritive quality (lower NDF and higher CP) than FS silage in the present study which was attributed to the higher proportion of legume in the FSL silage than in the FS silage alone. The supplemental CP likely increased the rate of digestion, passage rate and intake. In addition, the benefits of using protein-rich fodders as good quality roughage would improve the energy and protein intake, feed efficiency, availability of minerals and vitamins, rumen function and generally enhanced animal performance (Poppi and Norton, 1995; Nyambati *et al*., 2003). Hence, a greater CP content in the FSL silage had a marked effect on animal intake expressed as the percentage DMI per body weight (Table 2; Chacon and Stobbs, 1976).

Milk production, live-weight change and blood metabolites

Cows fed the FSL silage produced more actual milk and 4% FCM than those fed on the FS silage group, but the increase was not significant at the 0.05 level. (Table 3). Milk composition in this experiment under the normal standard of milk composition by Thai Agricultural Commodity and Food Standard (2004) was not affected by treatments. About 50% of the total dry matter intake is roughage intake affecting normal milk composition (McDonald *et al*., 1988).

In both groups, all cows gained weight during the experiment (Table 4) but the increase was not significant at the 0.05 level.. Better quality roughage in terms of protein and energy contents can support milking performance (Humphreys, 1991) and also more live-weight gain during mid lactation (Chilliard, 1989).

The blood glucose (BG) and blood urea nitrogen (BUN) concentrations between dairy cows fed different silage types are shown in Table 5. BG concentrations at the morning and afternoon feedings were in the standard normal range from 50–71 mg% of plasma glucose levels

Table 1 Nutritive values of silage made from forage sorghum (FS) and from forage sorghum mixed with lablab legume (FSL).

Parameter	FS silage (% dry matter)	FSL silage (% dry matter)
DM	19.13±0.30	18.35±0.66
CP	9.36±0.82	15.79±0.22
NDF	66.41±3.20	59.21±6.99
ADF	42.20±4.60	38.30±1.29

Each value is mean ± SD.

DM = Dry matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber.

Table 2 Dry matter intake (DMI) of roughage and meal concentrate between dairy cows fed on silage made from forage sorghum (FS) and from forage sorghum mixed with lablab legume (FSL).

Parameter	FS Silage (kg dry matter)	FSL Silage (kg dry matter)
Roughage DMI	5.87±0.88	5.64±0.65
Concentrate DMI	6.11±1.42	6.03±1.66
Total DMI	11.98±1.90	11.67±1.76
% DMI per body weight	2.47±0.34	2.75±0.51

Each value is mean ± SD.

(Robert and Prasse, 1988) in dairy cows indicating an adequate energy supply to all cows (Rook and Line, 1961). BUN concentrations between dairy cows fed different silage types in both treatments were within the normal range of 6.3–25.5 mg% (Wanapat, 1990). These results could indicate that good quality roughage plus supplementation provided to animals during the dry season should provide the daily CP and energy requirements for milk production.

CONCLUSION

Silages from both sole forage sorghum and forage sorghum mixed with lablab can be utilized as good quality roughage without any negative effect on dairy production. In addition, a tropical legume such as *Lablab purpureus* intercropped with forage sorghum shows potential to improve the roughage quality and produce higher milk production associated with greater live-weight gain.

Table 3 Milk production and composition between dairy cows fed on silage made from forage sorghum (FS) and from forage sorghum mixed with lablab legume (FSL).

Parameter	FS silage	FSL silage
Actual milk yield (kg.d^{-1})	16.76±4.63	17.02±3.96
4% FCM (kg.d^{-1})	15.28±4.14	15.97±4.84
Milk composition (%)		
Fat	3.42±0.63	3.53±0.59
Protein	3.16±0.15	3.19±0.11
Lactose	5.11±0.11	5.12±0.12
Solid not fat	8.52±0.30	8.54±0.19

Each value is mean ± SD.
FCM = Fat corrected milk.

Table 4 Live-weight change between dairy cows fed on silage made from forage sorghum (FS) and from forage sorghum mixed with lablab legume (FSL).

Parameter	FS silage	FSL silage
Initial weight (kg)	487.00±69.83	429.50±49.96
Final weight (kg)	497.75±73.73	444.00±48.50
Body weight change (kg)	10.75±20.52	14.50±15.35

Each value is mean ± SD.

Table 5 Blood glucose and blood urea nitrogen concentrations for dairy cows fed on silage made from forage sorghum (FS) compared to forage sorghum mixed with lablab legume (FSL).

Parameter	FS silage	FSL silage
Blood glucose (mg %)		
Morning feeding	51.75±3.59	54.25±2.87
Afternoon feeding	57.00±5.35	60.00±4.76
Blood urea nitrogen (mg %)		
Morning feeding	16.00±0.82	16.25±0.96
Afternoon feeding	21.00±2.16	22.00±5.29

Each value is mean ± SD.

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