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Effects of Sorghum Stover as Replacement Basal Diet on Milk Yield, Live Weight and Dry Matter Intake of Friesian Cows in Botswana

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Abstract : Thirty-four lactating Friesian cows were allocated to two groups. At the beginning of lactation two cows were paired according to parity, weight and date of parturition. One group was randomly allocated to stover-based diet (SBD) and another to grass-based diet (GBD). The basal feeds (stover or grass) were given on ad lib basis. Lucerne and dried brewers grain were fed on group basis in the drylot. Dairy meal was given individually according to milk yield at rate of 500g/litre after the first 8 litres. Daily intake of Lucerne, brewers grain and the basal feeds were significantly different ($P<0.001$) between the treatments. SBD group consumed more of Lucerne and brewers grain while GBD consumed more of grass. However, no difference ($P>0.05$) in take of dairy meal was observed between the treatments. Stage of lactation was found to influence daily intake of Lucerne, brewers grain ($P<0.001$) and the basal feeds ($P<0.05$). Mean body weights and body condition score at the end of lactation were found to be similar ($P>0.05$) between the treatments. SBD cows produced more milk ($P<0.001$) than GBD cows (14.7 vs 13.7kg/d/cow respectively). Mean fat, protein and solid-not-fat content were also similar ($P>0.05$) between the treatments. Based on the similarities of body weight, body condition score and milk composition between the treatments and the high milk yield by SBD, sorghum stover can thus be used to feed fat cows during lactation. This will stimulate mobilization of body fat. However, since energy intake would limit milk yield in the long run, a high-energy feedstuff such as silage need to be introduced to maintain high milk yield. Too much reliance on body condition as a buffer to overcome nutrition shortcomings, such as the case with stover fed cows, would lead to reduced milk yield in cows with insufficient body reserves.

Key words: Friesian, Stover, Body condition, Body fat, Lactation

Introduction

Botswana imports a high proportion (80%) of its fresh milk and milk products requirements from neighbouring countries. An increase in milk production by local farmers will save the country's foreign reserves, improve economic activities of the communities and provide nutrition at household level. Besides the shortage of supply of dairy animals in the country, lack of feed is also a constraint to milk production. There is, however crop residues left in farmers' fields after grain harvesting which could be used as a source of roughage for ruminants (Mosienyana 1980). It is therefore important that management of dairy cows for sustained milk production involves utilization of these feed resources.

Feed management of dairy animals should not allow animals to become obese. Problems associated with fat dairy cow include less tolerance to heat stress, reduced oestrus activity, dystocia, ketosis and low milk production. Studies in Britain (Jones and Garnsworthy 1989 and Garnsworthy and Huggett 1992) have shown that when fat cows are given a high-energy carbohydrate or a high fat diet they mobilise less fat reserves for milk production. It was also found by Garnsworthy (1989), Garnsworthy and Jones (1993) that changing carbohydrate source from starch to fibre altered partitioning of nutrients away from body reserves to milk production. Dairy cows at Sebele Research Station were observed to have high body fat and susceptible to heat stress This experiment was designed to test if sorghum stover could be used as a basal diet like grass hay for milk production. The second objective was to test if sorghum stover could be used a source of fibre for the promotion of fat mobilization by milking cows.

Materials and Methods

Thirty-four lactating Friesian cows weighing approximately 670 kg and with an average condition score of 3.5 (1 = thin, 5 = fat) were included in the experiment. At the beginning of lactation two cows were paired according parity, weight and date of parturition. One cow was then allocated to one group while the other to another group. One group was randomly allocated to stover based diet (SBD) and another to grass based diet (GBD). Since cows did not give birth at the same time, the day of introduction of the diet was designated day 1 for every pair. Stover and grass were given on *ad lib* basis. Sorghum stover was chopped using a motorised chaff cutter (RIIC, Kanye) before feeding and the grass hay was offered in the long form. All the animals were offered the same amounts of lucerne and dried brewers' grain on group basis in the drylot and refusal measured. A dairy meal was given

individually according to milk yield in the parlour. Amount of the dairy meal given catered for changes in weight and condition score. The dairy meal was mixed on farm. The diets were formulated to supply maintenance requirements plus 18kg milk/day with a loss of 0.5kg/day during early lactation. The diets were formulated to be as isonitrogenous and isoenergitic as possible.
Cows were fed concentrate (85% sorghum, 4% blood meal, 2.1% urea, 7.9% dicalcium phosphate 0.5% salt, 0.5% mineral-vitamin premix) at a rate of 500 g *per* kg of milk produced above 8kg/day in the parlour. Feeding of roughages and brewers' grain was done once a day at 8.00am. The animals were milked by machine twice daily at 5.30 am and 3.45 pm.

Measurements : Body weights and condition score were done at the start of the study and thereafter fortnightly. Condition score was done according to procedures described by Parker (1989). Feed consumption was estimated by measurement of feed offered and feed refused five times a week. Daily milk yield was also recorded.

Chemical Analysis : Feeds were sampled at the start of the experiment and thereafter weekly. Weekly samples of feeds were bulked and sub-samples send to the laboratory on a monthly basis. Dry matter (DM) was determined by drying the samples at 60°C for 48 hours. Crude protein and minerals, calcium (Ca) and phosphorous (P) were analysed according to methods of AOAC (1985). Acid detergent fibre (ADF) was determined following methods of Goering and Van Soest (1970). Dry matter digestibility was done according to Tilley and Terry (1963).
Milk samples were taken weekly and analysed for fat concentration using the Gerber method, solid-not-fat using the density hydrometer method and crude protein according to AOAC (1985)

Statistical Analysis : Data was analysed by General Linear Models (GLM) procedure (SAS Inc.1990). Effects of treatment and that of lactation stage on feed intake, milk yield, liveweight and body condition score were tested. Treatment effects were also determined for milk composition.

Results

Diets : There was a significant ($P<0.001$) difference in intake of lucerne, brewers' grain and the basal diets (grass or stover) between SBD and GBD. In each case SBD animals consume more lucerne and brewers' grain while GBD group ate more grass. Intake of dairy meal was similar ($P<0.05$). Therefore total dry matter and nutrient intake for SBD animals was higher than those of GBD group.
Mean body weights and condition score at the end of lactation were also similar ($P>0.05$) between the groups (Table 4). SBD cows produced more milk ($P<0.001$) than GBD cows. Weekly mean fat, protein and solid-not-fat content were similar ($P>0.05$) between the groups (Table 4).

Discussion

There was a significant difference in feed intake between the two groups, SBD eating more roughages than GBD. Intake of fibrous feeds is usually low due to problems of rumen capacity, high retention time and heat stress. Low intake of dairy meal may be due to the substitution effects of brewers' grain. Muller *et al.* (1994) reported that overall feed intake of Friesian cows was not affected by heat stress basically because intake during the night was not influenced by heat stress. This leads to compensation of daytime inactivity, which resulted in overall normal feeding activities. In the present study normal intake may be attributed to similar phenomenon observed made by Muller *et al.* (1994).
The crude protein concentration for both groups were similar to those predicted from values for raw materials given in Macala *et al* (1995) and Pelaelo (1994). However the GBD cows had lower protein intake. Highly degradable nitrogen from lucerne (Pelaelo 1994) and urea which result in more ammonia in excess of microbial requirements will be excreted as urine and has no use to the animal.
The metabolizable energy concentration for both groups were lower than those predicted from values for the raw materials given in Macala *et al.* (1995). The deficit was in the order of 9.4% for SBD and 13.9% for GBD cows. SBD cows also had additional energy available from body condition loss during early lactation (Fig. 1). According to McNamara *et al.* (1986) improvement of dairy productive efficiency must also take into account the contribution of adipose tissue metabolism in support of lactation. During early lactation SBD cows lost 1.2 condition scores while GBD lost 0.8. This tendency of condition score to drop (indication of lipolysis) at early lactation by SBD could possibly be associated with ketosis observed in two animals and one animal in GBD.
Both calcium and phosphorous were lower than predicted. This could affect milk production and fertility. Phosphorous is important in energy metabolism and calcium forms part of milk minerals. Fibre intake ADF was the same for both groups but higher than recommended (21%) by NRC (1989). The fibre content of the diet of dairy cattle is inversely related to its energy content. This may possibly explain the low energy intake observed in both groups of animals.

Table 1: Chemical composition (% DM) of the experimental diets

Variable	DM	IVOMD	CP	ME[1] (MJ/kg)	Ca	P	ADF
Grass	93.7	46.4	3.0	7.0	0.37	0.15	45.34
Stover	93.2	52.9	3.3	8.0	0.43	0.11	42.6
Lucerne	95.5	51.5	15.8	7.8	0.82	0.19	50.7
Dairymeal	94.9	82.9	22.5	12.5	2.12	1.61	5.5
Brewers' grain	94.9	56.2	19.3	8.5	0.45	0.38	22.1

[1]Estimated from In Vitro Organic matter Digestibility by formula; ME = 36IVOMD

Table 2: Average daily dry matter intake of the diets by cows

Parameter	SBD	GBD	SE	Level of Significance
Lucerne (kg)	6.0	5.5	0.05	***
Brewers' grain (kg)	4.1	3.4	0.05	***
Basal diet (kg)	3.1	3.7	0.07	***
Dairy meal (kg)	3.1	2.9	0.07	NS

P<0.001 = ***, P<0.01 = **, P<0.05 = *, P>0.05 = NS

Stage of lactation had a significant effect on the intake of lucerne and brewers' grain (P<0.001), and basal diets (P<0.05).

Table 3. Average nutrient intake *per* day by SBD and GBD cows

Group	Parameter	Dry matter (kg)	CP (g)	ME[1] (MJ)	Ca (g)	P (g)	ADF (g)
	Lucerne	6.0	949.2	46.6	49.2	11.4	3040.8
	Brewers' grain	4.1	790.5	34.8	18.5	15.6	907.7
SBD	Stover	3.1	101.1	24.8	13.3	3.4	1320.6
	Dairy meal	3.1	697.2	38.8	65.1	49.6	169.9
	Total intake	16.3	2538.0	145.0	146.1	80.0	5439.0
	Lucerne	5.5	870.1	42.7	45.1	10.5	2787.4
	Brewers' grain	3.4	655.5	28.9	15.3	12.9	752.8
GBD	Grass	3.7	112.5	25.9	13.7	5.6	1665.0
	Dairy meal	2.9	652.2	36.3	60.9	46.4	158.9
	Total intake	15.5	2290.3	137.8	135.0	75.4	5364.1

[1]Estimated from *In Vitro* Organic Matter Digestibility (IVOMD) by formula: ME = 3.6 x IVOMD

Table 4: Mean body weight, condition score, daily milk yield and milk composition of SBD and GBD cows.

Parameter	SBD	GBD	SE	Level of Significance
Body weights (kg)	627.6	625.4	14.6	NS
Condition score[1]	3.1	3.1	0.11	NS
Milk yield (kg/day)	14.7	13.7	0.11	***
Fat	3.9	3.7	0.10	NS
Protein	2.8	2.8	0.05	NS
Solid-not-fat	9.2	9.2	0.06	NS

[1] Scoring: 1= thin, 5 =fat

P<0.001 = ***, P<0.01 = **, P>0.05 = NS

Milk yield was lower than predicted by the diet formulation. Based on the original formulation specification of 600kg cow yielding 18kg milk/day and losing 0.5kg/day during early lactation, theoretical daily requirements for ME were estimated to be 160MJ. Since the observed yields were relatively low compared to the predicted values, the predicted energy requirements must have been inaccurate, leading to an underestimation of actual requirements (Moorby *et al.* 1996) or the diets were deficient in the required amounts of nutrients. There was however a significant differences in milk yield between the two groups, SBD and GBD. Milk yield was significantly high in cows given sorghum stover indicating that differences in effects between stover and grass promoted differences in milk production. Though both groups consumed lower amounts of energy than required, differences in body condition loss at early lactation may further explain the difference observed in milk yield. The milk curve (Fig. 2) shows that SBD cows reached peak milk yield later (3 weeks) than the GBD cows which reached the peak at week 7. It is important that cows reached the peak as early as 4 weeks and the peak be maintained as long as possible. However SBD cows were more persistent in milk production.

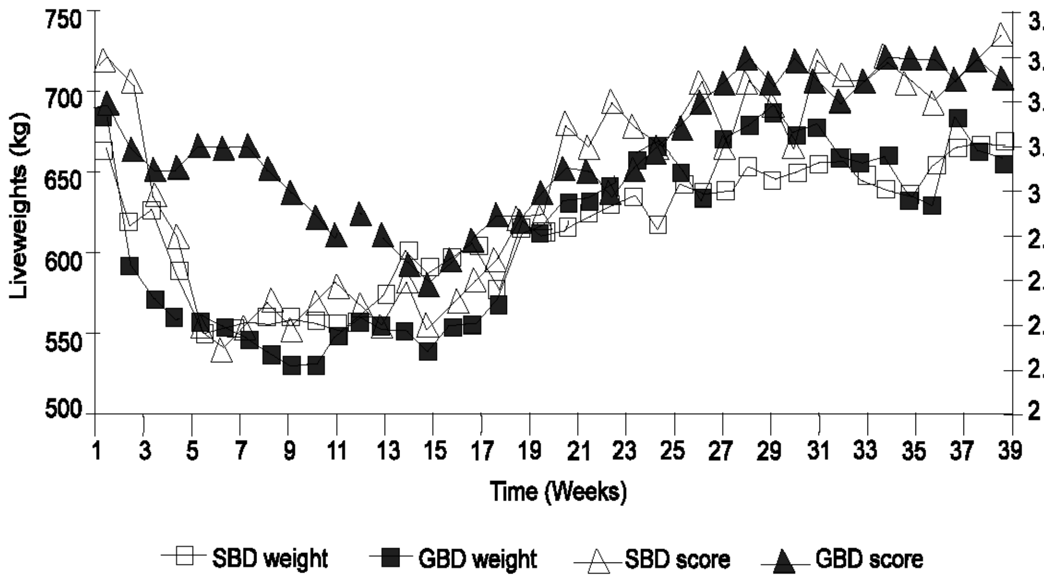

Fig. 1: Bi-weekly liveweight and body condition score of SBD and GBD animals

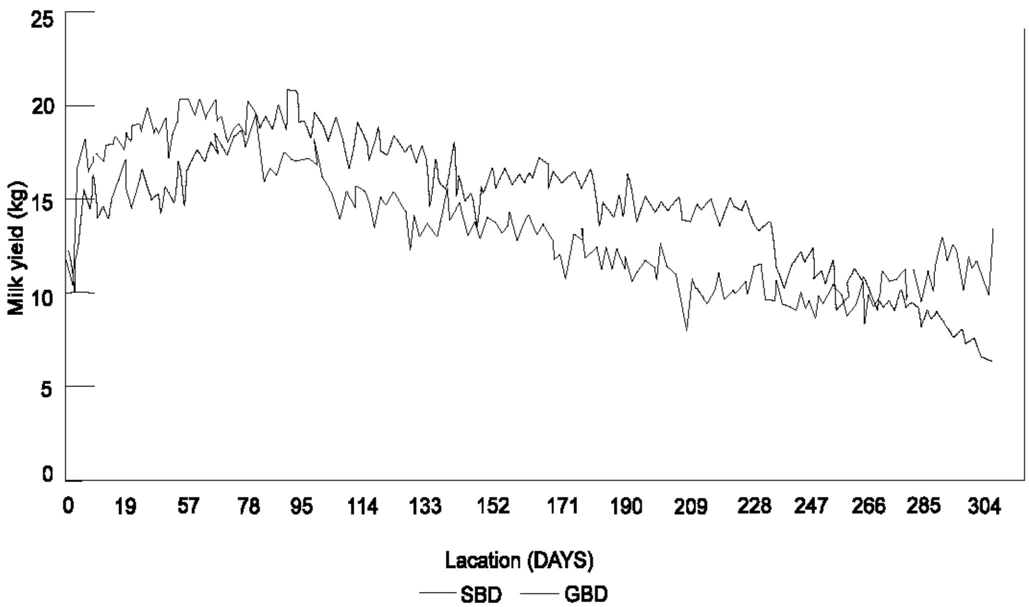

Fig. 2: Daily milk yield of SBD and GBD cows

In the present study the delay in reaching the peak early by GBD cows may be attributed to the low quality of the diets offered. In the present experiment, SBD cows milk curve decline slower than that of GBD cows thus explaining the difference in milk yield between the two groups.

Fat percentage for GBD was within the expected range for Friesian cows (3.3 to 3.7 %, McDonald *et al.* 1988). These values were found to be higher than those reported by Muller *et al.* (1994) for Friesians under shade and non-shade conditions in South Africa. According to Eastridge *et al.* (1988) milk fat depression may occur when cows receive a diet containing 40% or less forage. In the present experiment the proportion of forage for SBD animals was 55.8% and for GBD was 59.4% hence milk fat percentage was normal. The slightly higher fat value for SBD may be due to mobilization of body reserves at the start of lactation to support milk production. Some of the mobilized fatty acids were thus used for milk fat synthesis.

For all the groups milk protein was lower than the expected range for Friesian cows (3.2 to 3.4 %, McDonald *et al.* 1988) and was also lower than values reported for sub tropical conditions of South Africa by Muller *et al.*

(1994). According to Moordy *et al* (1996) carbohydrates form can be important in milk protein synthesis, whereby starch concentrate supplements to forage based diets increase milk protein content in comparison to fibrous supplements. Fibrous feed and less starchy components result in less propionate from the rumen thus increasing utilization of amino acids for gluconeogenesis. If this is what happened in the present experiment then less amino acid were available for incorporation into milk protein. It is the quality and quantity rather than quantity of protein alone, which is important for milk protein. If the quality of protein was low regardless of sufficient intake, then the availability of the required amino acids for milk synthesis would be compromised.
Body weights decreased sharply during early lactation (Fig. 1) but started to increase from approximately week 10 for SBD and week 7 for GBD cows. Body condition followed a similar trend as the body weight except for GBD animals where condition score was above liveweight during early lactation. A study by Wildman *et al.* (1982) showed that efficient producing cows maintained a mean score of 2.5 for the lactation cycle whereas inefficient producers average 3.3. In the present study it is likely that at the start of lactation SBD cows were more efficient in mobilizing fat stores for milk production. However the overall mean body weights and condition score for both groups were similar. This indicates that sorghum stover could be used to feed fat cows during early lactation to stimulate them to mobilize body fat for milk production. Since the of supply energy intake from stover was lower compared to grass, a higher energy feedstuff like silage may need to be introduced after the animals have mobilized their body reserves in order to maintain high milk yield. According to Jones and Garnsworthy (1989) too much reliance on body condition as a buffer to overcome nutrition shortcomings would lead to reduced milk yields in cows with insufficient reserves.

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