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Comparing the Performance of Sorghum Silage with Maize Silage in Feedlot Calves

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Abstract: Sweet sorghum and maize were cultivated, in research station where the agronomic parameters recorded and the forage harvested and ensiled when the seeds were at dough stage. At the second step, 32 yearling male calves with 229±1.2 kg initial weight, were used to assess their fattening performances with two types of silages (sorghum and maize), using a completely randomized design with four diets where maize silage was substituted with sorghum silage in the amount of 0, 33, 66 and 100% of diets I, II, III and VI, respectively. The sorghum seed required ha^{-1} was much lower (4 vs. 30 kg ha^{-1}) than that of the maize as well as the number of irrigations (8 vs. 11). However, the amount of forage yield per hectare was relatively similar for both crops. During the 120 days of feeding trial, average daily gain were 1037, 1068, 1010 and 1157 g for the diets I, II, III and VI, respectively which were not significantly different ($p<0.05$). The average dry mater intake was 7.50, 7.56, 7.74 and 8.06 kg, feed conversion ratio 7.23, 7.07, 7.66 and 6.59, respectively that were not significantly different ($p<0.05$). It conclusion, feeding performance of the sorghum silage was similar to the maize silage with the advantages of agronomy parameters.

Key words: Finishing calves, maize, sorghum, silage

INTRODUCTION

Since many years, sorghum has created much interest as, fresh forage or silage crop for beef cattle. It resist drought, yield high tonnage and adapt to a variety of soil types and fertility levels. The chief interest in growing sorghum for silage is that it can produce a given unit of Dry Matter (DM) with a low water requirement. The potential of whole-plant DM yields typically range from 10 to 20 tons ha^{-1} however hybrid selection is important to achieve optimum agronomic performance (Ishin *et al*., 1985; White, 1989; Sonon *et al*., 1996). The amount of dry matter produced per acre, however, is a faulty measure of production for livestock feeds (Smith *et al*., 1984; Sonon and Bolsen, 1994).

Several reports indicated that there is a considerable potential in sorghum forage production and ensiling for dairy and beef cattle nutrition (Bolsen *et al*., 1983; Aydin *et al*., 1999; Kumai *et al*., 1986; Martins *et al*., 1999; Lundeen, 2000). Sweet and forage sorghum due to high potential of preserving sugar in the stem are considered as silage forage (Ishin *et al*., 1985; Tjandraatmadja *et al*., 1991). Research works indicated that different cultivars of this forage crop may be ensiled with good fermentation and silage quality (Smith *et al*., 1985 ; Borges *et al*., 1999). Quality forage sorghum silage is a useful feed for dairy and beef cattle. According to Grant *et al*. (1995) using of sorghum silage in the diet of lactating cows resulted a similar performance of milk yield when fed up to the 65% of the diet dry mater. Lundeen (2000) compared brown midrib forage sorghum silage with isogonics standard sorghum silage with alfalfa silage or maize silage in rations of lactation cows and reported that brown midrib sorghum silage resulted in milk yield similar to that observed when maize silage was used. Using of silage as a considerable portion of diet in beef production studied and it was found that there is potential for increasing the returns to beef production by putting effort into increasing the quality of silage (Nissi *et al*., 2000). In feedlot diets for growing cattle, sorghum silage can be used in a considerable amount of the diet. Results of feedlot studies using silage have been variable, with some studies exhibiting an improvement (Freckle *et al*., 1985; Young, 1998), whereas others have found no effect (Rojas-Bourrillon *et al*., 1987) on total DM digestibility and animal performance. In a study where sorghum silage compared with maize silage in the ration of Angus and Hereford calves, the digestibility and protein efficiency were higher in sorghum diets (Adewakun *et al*., 1989). Restle *et al*. (1997) fed bulls and steers in a feedlot for

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193 days, from weaning to slaughter at 14 months of age with different roughage: concentrate ratio from 70:30 to 40:60 where the roughages were sorghum silage, chopped sugar cane and oat hay. The average daily gain and feed conversion ratio were 1.23 and 5.8 for bulls but 1.09 and 6.8 for steers, respectively. However it must be recognized that both the agronomic performance and nutritive value of forage are significantly influenced by the variety of the plants and stage of maturity at harvest (Smith *et al*., 1984; Harrison *et al*., 1996; Sonon *et al*., 1996; Sutton *et al*., 2000).

Since last decades in Iran, some studies have been conducted on several varieties of sorghum for adaptation and selection in dry zones and recently some of them have been adapted and may be introduced in farming system but still, more work is needed to determine their biological and economical performance from farming to feeding stages. More research is needed to clarify if these types of sorghums show additional benefits above and beyond those of forage maize and whether economic animal production dictate major ration component shifts. Thus, the objective of the present study was to document the agronomic performance of forage sorghum silage and compare it with forage maize silage in the diet of finishing calves.

MATERIALS AND METHODS

Forage production and ensiling: A six hectare farm was divided into two identical parts where one part considered for maize and the other one for sorghum cropping in *Golpayegan* research station. Sweet forage sorghum cultivar (*Sufra*) was obtained from the research station of Isfahan University and planted at the end of May under moderate dry area conditions. The amount of seed used was 4 kg ha^{-1} and the agronomy period prolonged up to 120 days when the forage was harvested and ensiled. Similar works has been done for maize planting and harvesting but the amount of seed and irrigation times were higher for maize (30 kg and 11 times, respectively) than for sorghum forage crop (4 kg and 8 times, respectively). Both crops were harvested and ensiled when the seeds were at mead-dough stage and the agronomic data including fresh forage yield and whole-plant DM were recorded. After 90 days, silages were opened and samples taken to evaluate DM and chemical composition including: Crude Protein (CP), Crude Fibre (CF), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Calcium (Ca), Phosphorous (P) and pH as well.

Feeding trial: Thirty two yearling Holstein male calves with initial live weight of about 229±7 kg were selected from a dairy cattle farm and transported to the research station where they housed for 15 days adaptation to the experimental conditions. Then the animals were randomly divided into 4 equal groups so that the average body weights were 230.3±14, 228±15, 230.4±14 and 229.4±12 kg for the groups I, II, III and VI, respectively.

Table 1: Formulation and composition of the experimental diets (DM basis)

	Diets			
Feeds (%)	I	II	III	VI
Sorghum silage	0.0	13.3	24.7	40
Maize silage	40	26.7	13.3	0.0
Alfalfa hay	10	10	10	10
Roughage (kg)	50	50	50	50
Barley	24.5	24.5	24.5	24.5
Wheat bran	12	12	12	12
Sugar beet pulp	7	7	7	7
Cotton seed meal	5.3	5.3	5.3	5.3
Urea	0.4	0.4	0.4	0.4
Calcium carbonate	0.5	0.5	0.5	0.5
Common salt	0.3	0.3	0.3	0.3
Concentrate	50	50	50	50
Total	100	100	100	100
Compositions of the diets				
Metabolizable energy (Mcal kg^{-1} DM)	2.63	2.59	2.55	2.51
Crude protein (g 100 g DM)	135.3	135.5	135.5	135.6
Crude fibre (g 100 g DM)	215	212	213	211
Calcium (g 100 g DM)	5.47	5.27	5.58	5.89
Phosphorous (g 100 g DM)	4.33	4.33	4.31	4.31

Four diets were formulated to meet NRC (1989) nutrient requirements of the animals where the silage contributed 40% of the diets dry matter. The maize silage was used in an amount of 40% of the diet I, whereas it was substituted with 33, 66 and 100% of sorghum silage in diets II, III and VI, respectively (Table 1).

The forage portion of the diets consisted of silage and alfalfa hay and concentrate included: barley grain, wheat bran, sugar beet pulp, cotton seed meal, urea and mineral supplements. Concentrate ingredients, were prepared and combined every week. Roughage and concentrate were mixed daily and offered *ad libitum* as Total Mixed ration (TMR) four times per day. Quantities of forage and concentrate were adjusted regularly to maintain desired ratios of forage to concentrate. Orts were weighed daily, composite monthly and analysed for DM to calculate dry matter intakes.

The total body weight gain and average daily gain were calculated from the body weight changes obtained from monthly individual weighing of the animals. Feed conversion ratio was estimated based on the dry mater intake per kg of live weight gain.

Statistical analyses: For the agronomy traits and forage production no statistical analyses was done but the data obtained from feeding trial was analysed for parametric statistics, including analyses of variance in a simple completely randomized design experiment, using GLM procedure of SAS (1998) and tested for significance, using Duncan multiple range test.

RESULTS AND DISCUSSION

Agronomy study: The fresh forage yield was 80 ton with total DM of 19 ton ha^{-1} for sorghum but 85 ton of fresh forage and 19.3 ton of DM for maize crop that were relatively similar in DM yield. However, the amount of seed and water used for irrigation were lower (4 kg of seed and 8 times of irrigation) for sorghum than that of maize (30 kg of seed and 11 times of irrigation) production. The findings in this experiment were in agreement with the results reported by other workers. Lower water demand, adaptation to a variety of soil types and fertility and high tonnage yield of sorghum has been reported by Smith *et al.* (1984) and Sonon and Bolsen (1994). Patras and Popescu (1986) evaluated irrigated land for successive fodder crops and reported that successive crops yielded up to 19.7 t DM ha^{-1} and yields were in the order silage maize, hybrid sorghum×Sudan grass, maize for green fodder and Sudan grass, respectively.

Silage characteristics: The DM content and pH were 24±0.3 and 3.78±0.07 for sorghum silage; 22.7±0.5 and 3.70±0.06 for maize silage respectively that were not significantly different between the two silages. Crude protein, NDF, ADF, Ca and P were 7.9, 61, 34, 0.24 and 0.15% in sorghum silage and 8.1, 56, 28, 0.23 and 22% in maize silage (DM basis) that were relatively similar between the two silages.

The DM content, pH and chemical composition of the silage could be affected by type of forage, agronomic factors, stage of harvesting and ensiling management (White, 1989; Tjandraatmadja *et al.*, 1991; Young, 1998; Rodriguez *et al.*, 1999). Mohanta and Pachauri (2005) ensiled two varieties of forage sorghum and found that pH was 3.8 and 4.2 and the percentage of NDF, CP and TDN were 65.5 and 67.2; 5.24 and 7.43; 55.3 and 68.3 that were significantly different between the tow varieties.

According to Kumai *et al.* (1986) DM content was between 26.6-36.2% in sorghum silage where the forage harvested in different stages. Fisher and Lessard (1987) reported that the DM, CP and ADF contents were 32.5, 8.0, 27.0 and 22.4, 10.6, 40.7% for maize and sorghum silage respectively. The sweet sorghum in this experiment used as forage crop and planted relatively with high seeding density which could resulted in higher fresh forage yield but lower DM. The average pH value obtained in this experiment is in accordance with results of Linden *et al.* (1987) who ensiled sorghum forage for periods up to 155 days and reported that pH levels declined to 3.9-4.0 within a few days. Sweet forage sorghum due to high potential of preserving sugar in the stem is considered as silage forage (Ishin *et al.*, 1985). Research indicated that different cultivars of this forage crop may be ensiled with good fermentation and silage quality (Borges *et al.*, 1999).

Feeding trial

Body weight changes and daily gain: As it is shown in the Table 2, there were no significant differences among the animals on different diets for initial and final body weight. The final live weight of the animals was between 352 to 368 kg that is normal weight for the Holstein calves. It has been reported that the yearling Holstein male calves may reach to 350 kg of body weight in a short fattening period of about 4 months (Angelov *et al.*, 1987; Restle *et al.*, 1997). However, the live weight of male calves may be affected by the type of the animal, environmental factors and feeding management system (Meat and Livestock Commission, 1991; Somyos, 1992; Valvasori *et al.*, 1998).

It was observed in this study that the diet contained maximum amount of sorghum silage resulted a significantly ($p<0.05$) higher body weight gain during the first and second months but no differences was observed during the other months of the experiment. The average total body weight gain was respectively 124.4±6.4, 128.3±8, 121.3±5 and 138.9±7 kg for the treatments I, II, III and VI that were not significantly different. On the whole, no statistically variation was obtained among the calves in different treatments, although the final body live weight of the animals on diet VI which received 40% sorghum silage was numerically higher than that of the maize silage diet (368 vs. 354 kg).

During the first and second months of the experiment, the average daily gain was significantly ($p<0.05$) highest in treatment VI and lowest in treatment I. Meanwhile, during the third and fourth months, no significant differences were obtained between the treatments. Although the highest numerically amount of daily gain (1158 g day^{-1} against 1038, 1098 and 1010 g day^{-1}) was obtained in calves received diet VI but the differences was not statistically considered. Therefore, inclusion of different portions of sorghum silage instead of maize silage did not affect the daily gain of the animals (Table 3).

Table 2: Effect of diets on the body weight gain (mean±SD.) of calves

	Treatments				
Parameters	I	II	III	VI	SEM
Initial weight (kg)	230.3±14	228±15.2	230.4±14	229.4±12	7.12
weight gain (kg)					
First month	27.4±1.3^{b}	32.9±3.3^{ab}	32.9±2.5^{ab}	36.1±3.4^{a}	1.4
Second month	29.1±2.3^{b}	30.9±1.7^{ab}	28.9±0.7^{b}	36±2.4^{a}	0.97
Third month	31.6±2.5	31±3	29.8±1.3	31±2.7	1.26
Fourth month	36.4±2	33.5±4	30.1±1.1	35.6±2	1.3
Whole period	124.4±6.4	128.3±8	121.3±5	138.9±7	3.55
Final weight (kg)	354±19	353±21	352±16	368±16	9.1

Means with the different superscripts within a row are significantly ($p<0.05$) different. Standard error of mean = SEM

Table 3: Effect of diets on the daily gain (mean±SD) of calves

	Treatments				
Parameters	I	II	III	VI	SEM
First month	913±122[b]	1096±109[ab]	1097±234[ab]	1023±114[a]	46.7
Second month	970±77[b]	1030±158[ab]	963±67[b]	1026±228[a]	32.2
Third month	1053±87	1033±104	993±95	1033±95	43.5
Fourth month	1213±66	1117±136	993±124	1187±183	43.5
Whole period	1038±151	1096±203	1010±117	1158±172	29.6

Means with the different superscripts within a row are significantly ($p<0.05$) different

Table 4: Average daily feed intake (based on the kg of dry mater)

	Treatments			
Parameters	I	II	III	VI
First month	6.65±0.40	6.49±0.45	6.70±0.42	6.73±0.44
Second month	7.32±0.3	7.43±0.33	7.80±0.35	8.04±0.40
Third month	7.70±0.45	7.85±0.44	8.07±0.44	8.55±0.48
Fourth month	8.41±0.31	8.47±0.31	8.39±0.43	8.90±0.23
Whole period (kg day^{-1})	7.50±0.76	7.56±0.81	7.74±0.75	8.60±0.91
(%) of Body weight	2.57±0.22	2.60±0.28	2.65±0.28	2.88±0.30
g kg^{-1} of Body weight	106.2±9.6	107.3±11.5	109.6±10.6	119.6±12.7

According to Lundeen (2000) when brown midrib forage sorghum silage was compared with maize silage in rations of lactation cows; the milk yield was similar in both of the groups. Thus the results suggest that brown midrib sorghum silage has the potential to replace maize silage in diets fed to lactating cows that are in agreement with the other reports. Adewakun *et al.* (1989) compared maize silage with sorghum silage in the diet of Angus and Hereford male calves and reported that sorghum silage was considered a suitable substitute for maize silage for growing calves. Valvasori *et al.* (1998) reported that where sorghum silage or sugar cane silage supplemented with cottonseed meal fed to Holstein calves, daily weight gains was higher with sorghum silage than with sugar cane silage (0.601 kg vs. 0.378 kg). In an experiment done by Angelov *et al.* (1987), 3 groups of Holstein-Friesian calves were fattened up to 450, 500 or 550 kg live weight on complete ration contained 50% maize silage, 30% concentrate and 20% meadow hay. The mean daily gain was 1.114, 1.107 and 0.994 g, respectively. For growing calves finished on the grass silage system, with initial weight of 111, 137 and 119 kg and feeding period of 375 days of the Hereford×Friesian, Continental×Friesian and Friesian-Holstein breed types, average daily gain were 1.06, 1.15 and 1.03 kg, respectively (Meat and Livestock Commission, 1991).

Feed intake: As is shown in the Table 4, there was no significant variation among the treatments for DM intake during the different months as well as the whole period. Calculating of dry matter intake as percentage of live weight or g kg^{-1} of metabolic body weight did not show any significant difference between the treatments.

Table 5: Feed conversion ratio (kg of DM intake per kg of weight gain)

	Treatments			
Parameters	I	II	III	VI
First month	7.19±0.44	5.93±0.41	6.12±0.39	5.59±0.36
Second month	7.55±0.31	7.22±0.32	8.11±0.36	6.70±0.33
Third month	7.06±0.41	7.35±0.41	7.87±0.43	7.9±0.45
Fourth month	6.94±0.26	7.59±0.28	8.46±0.43	7.50±0.19
Whole period	7.19±0.42	7.02±0.74	7.64±0.99	6.96±0.96

Therefore, substitution of maize silage with different levels of sorghum silage did not affect the voluntary DM intake. These results are similar to those reported by Schwartzkopf *et al.* (2004) where they found that DMI was between 2.59 to 2.625% of body weight for crossbreed feedlot calves from 234 to 310 kg of live weight. Restle *et al.* (1997) reported an average intake of 109 g kg^{-1} of metabolic body weight for steers fed different roughage: concentrate ratios from 70:30 to 40:60 where the roughages were sorghum silage, chopped sugar cane and oat hay. Fisher and Lessard (1987) studied the intake and digestibility of corn, rye and sorghum-Sudan grass silages in lactating cows and found that DM intake of the silages and milk yield were similar when cows fed corn and sorghum-Sudan grass silage but rye silage diet reduced intake and milk yield.

Feed efficiency: As is shown in this Table 5, the total means of FCR were from 6.96 to 7.64 and were not significantly different among the treatments. Some reports has shown that feed conversion ratio may be from 6.8 to 7.76 in feedlot calves fed rations including sorghum silage. Restle *et al.* (1997) fed the steers different roughage: concentrate ratios (70:30 to 40:60) from weaning to slaughter at 14 months of age where the roughages were sorghum silage, chopped sugar cane and oat hay. The feed conversion ratio was 6.8 that are similar to the results of diet VI in this experiment. A feed conversion ratio of 7.76 reported by Valvasori *et al.* (1998) who studied the performance of sorghum silage based diet in calves. In a feedlot trial from 10 weeks to yearling of Holstein Friesian crossbred male calf fed different amount of concentrate, feed conversion ratio was reported between 6.32 to 6.8 (Somyos, 1992). However, the feed conversion ratio could be affected by the roughage: concentrate ratio, type of the feeds, age and breed type of the animals.

CONCLUSIONS

Substitution of maize silage with sorghum silage at different levels, showed a similar result in feeding of finishing calves and there was no difference in the performance of the animals fed either maize or sorghum

silage up to 40% of the total dry mater intake. Therefore inclusion of sorghum into the forage crop farming system allows the farmer to obtain a more economic product, particularly where water is the first limiting factor.

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