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EFFECT OF DIETARY CORN SILAGE REPLACEMENT WITH SORGHUM SILAGE ON PERFORMANCE AND FEED COST OF GROWING STEERS

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ABSTRACT: *This experiment conducted to assess effects of dietary corn silage (CS) replacement with sorghum silage (SS) on performance of growing Steers. 32 steers (182.3 ± 5 kg BW) randomly, in a CRD, allocated to 4 treatments of eight replicates. A diet of 60% hay (experimental part) plus 40% concentrate including barley, wheat bran, and soybean meal were fed for a period of 120 day. Hay included 40% of the same grass silage + 60% of different levels of SS and or CS, alone or in combination. SS was replaced with CS in steer rations with ratios of 0% (T1), 33% (T2), 66% (T3) and 100% (T4). Animals were weighed every week and information such as food intake (FI), daily weight gain (DWG) and food conversion ratio (FCR) were recorded in each replicate group and the body weight (BW) presented as a average of growth performance at the end of trial. Dietary CS replacement with SS significantly improved performance traits (P > 0.05), when SS was solely replaced in hay part of diet. The higher FI and lower FCR were observed in fattening bulls fed dietary group 4 (100% SS replaced in diet). Groups fed 33% SS (T2) did showed the higher DWG in compared to other groups. It is concluded that, the diet supplemented with 66 and or 100 % sorghum silage in 60% of hay portion, seem to be capable of improve performance accompanying with economic advantage in product prices.*

ORIGINAL ARTICLE

Key words: corn silage, sorghum silage, performance, carcass yield, Steer

INTRODUCTION

Sorghum grain is the principal grain used to finish cattle in some regions of the Iran and probably other Asian countries. It usually sells for less per pound than corn in Western countries such as the United States and can be a cheaper source of nutrients than corn for beef cattle rations but yet not be a better buy for cattle rations. Sorghum grain can be silage like corn grain. But the cost of sorghum silage, have no significant difference with the cost of corn silage.

Most studies have shown corn to have a higher feed value than sorghum grain for beef cattle. The protein and starch in sorghum grain are usually not as digestible as that in corn. Sorghum grain tends to vary more than corn in protein content and feed value because of cultural practices, soil fertility, and variety. Because, seed hardness of sorghum grain is high digestibility can be decreased that is linked to variety. Varieties with a floury type endosperm were higher in digestibility than those with a corneous-type (hard-type) endosperm.

Sorghum grain silage will not produce as many pounds of beef per acre as corn silage will on land suited to corn production. Tonnage of silage will be less per acre with sorghum grain and it will take more pounds of it to produce a pound of beef gain compared to corn silage. A study conducted by Al-Suwaiegh et al. (2002) documented that steers fed either corn or sorghum wet distillers grains, fed at 30% of the ration DM, had increased efficiency of gain. About varieties that are grown for grain yield, was averaged 1000 kg in hectare. Some researchers expressed forage sorghum yield between 50 to 60 tons per hectare (McCullough et al, 1981).

Hough et al (2002) reported that the rations containing corn silage reduced feed intake in heifers fattened compared with sorghum and silo due to reduced palatability of the diet because of the shape and appearance of corn

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silage. Moreover, it is likely to reduce feed intake in the presence of products resulting from fermentation in the silo that had a negative impact on eating diets based on corn silage (Tauqir et al, 2009). On the other hand, one of the causes of increased feed intake in diets based on sorghum silo can be related to high glucose in the stem and leaves of sorghum sugar by microorganisms that are used to reduce pH of silo below 4 and thus cause increasing the quality of the silo and on the other hand glucose of silo can increase palatability silo sorghum compared to corn silage (Ishin et al, 1985).

Therefore, an experiment was performed to assess effects of replacing corn silage with sorghum silage in diet on performance and feed cost of growing Steers.

MATERIAL AND METHODS

Farming and silo operations

After preparing the ground (any two pieces of land area 5.1 acre, located in 10 km West Gotvand city) to provide nutrients for plant growth than fertilizer N, P and K levels, respectively 250, 100 and 100 kilograms per hectare were used. After full growth and the emergence of plant seeds, forage sorghum and corn grain in dough stage using a chopper machine harvested and then accurately weighted using digital scale 60-ton and transmitted to animal farm and saved within separate silos with the dimensions of 3.1×5×15 then used the tractor to remove the remaining air inside the provender and the silos that quite compressed in order to prevent water penetration. In order to prepare laboratory samples, some of forage maize and sorghum into separate plastic bags 30 kilo grams (15 pieces) was silo.

Animal and housing

32 male calves of about 9 months old and the average weight of 182 kilograms were purchased from villages around the city of Dezful Shushtar and moved into research farm. Steers quarantined for 10 days for health operations, such as Colin afferent test, blood sampling for brucellosis disease and internal parasites, serve anti-parasitic drugs, disinfect livestock against ectoparasites and vaccination against common diseases in the area was conducted. In order to increase accuracy in measuring traits, 32 solo roofed status dimensions 4 × 2 meters with separate manger and watering with conditions almost identical in terms of light, air flow and other environmental factors were used. Calves in the four groups of eight head were randomly allocated in solitude positions. In order to habituate animals to test desired rations, the usual period for 15 days was applied. After weighing the animals, the main phase of the trial began for a period of 120 days. Weighing cattle performed at the beginning and end of each month and once after 12 hours of deprivation of food and water to obtain weight gain resulting in various stages of the trial course and also conducted for utilization from a new weight for the determination of lower DMI.

Feeding and performance calculating

Diets were formulated according to NRC (1989) related to cattle calves of the heavyweight strain and were fed to different experimental groups. Chemical composition of foods used in the experiment based on 100 percent dry matter is given in Table 1. Diets ingredients and composition is shown in Table 2. DMI was included from forage and concentrate in two parts and with a ratio of 55: 45. A diet of 60% hay (experimental part) plus 40% concentrate including barley, wheat bran, soybean meal, urea, calcium carbonate; mineral-vitamin premix and salt were fed for a period of 120 day. Hay included 40% of the same grass silage + 60% of different levels of SS and or CS, alone or in combination. SS was replaced with CS in steer rations with ratios of 0% (T1), 33% (T2), 66% (T3) and 100% (T4). Animals were weighed every week and information such as food intake (FI), daily weight gain (DWG) and food conversion ratio (FCR) were recorded in each replicate group and the body weight (BW) presented as a average of growth performance at the end of trial, then two steers per treatment were slaughtered after 12 hours dietary deprivation.

All diets in terms of energy and protein concentrations were similar. Dry matter intake, two meals daily in the morning and afternoon was weighed in a certain amount so that uniformly mixed were fed to animal, free choice. The next morning and before daily feeding, the remaining food of the manger was daily collected and weighed to calculating DMI. During the 15 day of habituate period and 120 days of the main trial period, clean and safe drinking water and rock salt lick blocks were provided for animals, *ad-libitum*.

Weighing calves once every month with a 12 hours retrieving food was done before every morning feeding and the results were calculated for each 30-day periods. Rate of weight gain per calf during each period with the weight difference between the beginning and end periods were determined. Average daily gain during each period by the following formula was calculated. Feed conversion ratio (FCR) by the amount of feed consumed per unit of live weight was calculated every 30 days as well as in total of the experimental period was marked by the following equation. FCR= Dry matter intake in each course (kg) / same period the amount of weight gain (kg).

Feed and live weight prices calculation

Forage sorghum and corn planting costs for the silo and also food and diets prices per kilogram or per 100 percent dry matter (RLS) were calculated. Although, because of fluctuations in cost of one kilogram of live animal weight and one kilogram of feed intake (RLS) in the market is difficult to estimate the exact cost, the most common prices in

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different regions of Shushtar province were supplied and calculated. Unit cost is based on Iranian rial (IRR). For example for converting costs: 1 united state dollar (USD) in 2010 = 10500 ± 500 IRR.

Table 1 - Chemical composition of foods used in the experiment based on 100 percent dry matter

Diet ingredient	Dry matter	Protein	Cell wall	Cell wall without hemicellulose	Calcium	Phosphorus
corn silage	28.8	7.8	48.9	29.6	0.22	0.2
sorghum silage	25.9	7.38	54.6	38.7	0.21	0.15
Dried lucerne	89.2	17.2	43	32.3	1.4	0.27
Barley	90.3	10.8	22	9	0.05	0.3
Wheat straw	89.5	15.25	43.2	17.1	0.12	1.1
Soybean meal	89.3	42	23.1	12	0.35	0.63
Urea	100	280	_____	_____	_____	_____
Calcium carbonate	100	_____	_____	_____	39.39	_____
Vitamin & Mineral supplement	100	_____	_____	_____	_____	_____
Salt	100	_____	_____	_____	_____	_____

Table 2 - Composition and components used in diets fed tested buffalo calves

Diet ingredient (%)	Treatments			
	1	**2**	**3**	**4**
Corn silage	0.0	7.80	48.9	29.6
Sorghum silage	40.0	7.38	54.6	38.7
Dried Lucerne	15.0	17.2	43.0	32.3
Barley	55.0	55.0	55.0	55
Wheat straw	21.0	21.0	21.0	21
Soybean meal	15.3	15.3	15.3	15.3
Urea	7.2	7.2	7.2	7.2
Calcium carbonate	0.4	0.4	0.4	0.4
Vitamin & Mineral supplement	0.4	0.4	0.4	0.4
Salt	0.3	0.3	0.3	0.3
Diet ingredient	0.4	0.4	0.4	0.4
Concentrate (kg)	45.0	45.0	45.0	45.0
Calculated nutrient content				
Metabolizable energy (Mcal/kg DM)	2.42	2.4	2.37	2.35
Crude protein (%)	14.37	14.32	14.26	14.21
Dry matter (%)	65.48	65.10	64.69	64.31
NDF (%)	38.91	39.70	40.45	41.21
ADF (%)	22.25	23.36	24.57	25.79
Ash	5.90	6.07	6.23	6.39
Calcium (%)	0.50	0.55	0.60	0.60
Phosphorous (%)	0.40	0.39	0.38	0.38

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Statistical Analysis

The data obtained from research using Excel software were calculated. All data by statistical software SAS (2001) using the following statistical model analysis (Yij = μ + Ti + εij) were compared. Yij = view about the treatment i and replicate j, μ = population mean, Ti = fixed effect of treatment I, εij = experimental error effect.

Effect of initial weight as Covariance in the model considered for final weight traits according to below statistical model: FWij = μ + Ti + b (IWij) + εij. FWij = (final weight) related to treatments i and replicate j, μ = population mean, Ti = fixed effect of treatment i, b (IWij) = initial weight of treatments i and replicate j, εij = experimental error effect. For significant differences (P < 0.05), means were compared by the Duncan test.

RESULTS AND DISCUSSION

Daily dry matter intake, Daily weight gain, Feed conversion ratio (FCR)

Comparison of results related to effect of substituting different levels of sorghum with corn silage to increase the final weight of steers is given in Table 3. Results showed that replacement of sorghum silage with corn silage significantly decreased the final weight (P<0.05), so that treatment 4 (contains maximum sorghum silage) had lowest live weight with a significant difference compared to other treatments. Comparison of the mean showed that replacing corn silage with sorghum silage significantly affected feed intake (P<0.05), so that highest FI was observed in treatment 4.

Results showed that during the first month of trial, rate of overweight group 2 significantly higher than the first and fourth groups (P<0.05). During the first month of study, calves fed containing diets sorghum silage compared with the control diets had greater daily weight gain. In the second month of feeding replacement diets to animals, highest weight gain rate was numerically related to T1 and T3 however between both treatments the difference was not significant. During the third month overweight rates in T2 was significantly higher than T3 and T4. The lowest weight gain was related to T4. Results during the fourth month of trial were almost similar results of third month. Overall the highest and lowest weight gain was related to the second and fourth treatments, respectively. From the results in this study it is detected that replacing corn silage with sorghum silage up to 66% could not significantly affected the average daily weight gain of calves, but when replacement level reached to 100 %, significant decrease in WG was observed.

Results related to the effect of substituting different levels of sorghum with corn silage on feed conversion ratio of fattened calves tested in different months is given in Table 3. During the first month, the highest feed conversion ratio was observed in treatment 4 (6.66) that except T1 significantly differenced with values of T2 and T3 (P<0.05). The lowest FCR (5.93) observed in group 3 (animals fed 66% CS) with a significant difference with groups 1 and 4. In throughout trial period (four months) the highest FCR in a numerical fashion was related to the treatment 4 (100% CS) and the lowest FCR was related to T2.

All treatments received different levels of corn silage (treatments 1, 2 and 3) were not significantly different, but had significant difference in comparison with treatment 4 (P<0.05).

Performance

According to Table 3, although increasing replacement of sorghum silage with corn silage in steer diets up to 66% (T3) had not significant effect on body weight but dietary SS replacement by 100% level (T4) significantly increased DMI and decreased FCR accompanying a significant decline in body weight.

The cause of reduced feed intake can be inverse correlation NDF concentration of diets and feed intake noted. Previous research conducted with sorghum and corn silage silo showed the highest negative correlation between NDF concentration and dietary intake related to rations based on corn silage is (Nichols et al, 1998). Hough et al (2002) reported that the rations containing corn silage reduced feed intake in heifers fattened compared with sorghum and silo due to reducing palatability of the diet because of the shape and appearance of corn silage. Moreover, it is likely to reduce feed intake in the presence of products resulting from fermentation in the silo that had a negative impact on eating diets based on corn silage (Tauqir et al, 2009).

On the other hand, one of the causes of increased feed intake in diets based on sorghum silo can be related to high glucose in the stem and leaves of sorghum sugar by microorganisms that are used to reduce pH of silo below 4 and thus cause increasing the quality of the silo and on the other hand glucose of silo can increase palatability silo sorghum compared to corn silage (Ishin et al, 1985). The difference between the results of different studies can be due to species and breed of animal experiments, physiological maturity stage, the physiological form and amount of nutrients, conditions and testing different varieties and other environmental factors is used (Manhanta and Pachauri, 2004; Nichols et al, 1998).

High fiber according to the silo sorghum is expected to increase its level in the diet increased feed intake and thus weight gain is increasing, but factors such as high fiber, lignin and tannin in sorghum increased silo food passage rate of gastrointestinal tract and digestibility are reduced (Gnsrm, 1373), which eventually would be reduced daily gain in treatments of sorghum silage (t3 and T4).

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Table 3 - Effect of replacing different levels of corn silage with sorghum silage on performance (mean ± standard error)

Parameters	Treatments			
	1	2	3	4
Average initial weight	185.40 ± 3.21[a]	178.00 ± 2.91[a]	187.20 ± 4.20[a]	177.80 ± 3.80[a]
Average final weight	302.41±4.86[a]	301.7 ± 5.43[a]	303.88 ± 5.25[a]	290.87 ± 4.10[b]
Feed intake				
First Month	5.61 ± 0.75[b]	5.76 ± 0.96[ab]	5.36 ± 0.10[b]	6.01 ± 0.10[a]
Second month	6.11 ± 0.85[c]	6.44 ± 0.11[b]	6.54 ± 0.11[ab]	6.84 ± 0.11[a]
Third Month	6.86 ± 0.99[b]	7.12 ± 0.12[ab]	6.78 ± 0.12[b]	7.25 ± 0.11[a]
Fourth Month	7.42 ± 0.11[b]	7.79 ± 0.13[ab]	7.45 ± 0.12[b]	8.03 ± 0.11[a]
Total Volume	6.50 ± 0.92[b]	6.76 ± 0.11[ab]	6.62 ± 0.11[b]	7.30 ± 0.11[a]
Daily weight gain				
First Month	0.88 ± 0.019[c]	0.97 ± 0.02[a]	0.95 ± 0.02[ab]	0.90 ± 0.01[bc]
Second month	0.96 ± 0.018	0.94 ± 0.03	0.92 ± 0.03	0.95 ± 0.02
Third Month	1.01 ± 0.02[ab]	1.07 ± 0.03[a]	0.98 ± 0.02[ab]	0.93 ± 0.02[c]
Fourth Month	1.05 ± 0.03[ab]	1.10 ± 0.02[a]	1.30 ± 0.02[ab]	0.99 ± 0.02[bc]
Total Volume	0.97 ± 0.02[ab]	1.02 ± 0.02[a]	0.97 ± 0.02[ab]	0.94 ± 0.01[b]
g feed/g gain				
First Month	6.41 ± 0.10[a]	5.95 ± 0.11[b]	5.93 ± 0.14[b]	6.66 ± 0.10[a]
Second month	6.36 ± 0.06[b]	6.89 ± 0.21[a]	7.15 ± 0.20[a]	7.20 ± 0.11[a]
Third Month	6.75 ± 0.05[b]	6.67 ± 0.15[b]	7.02 ± 0.13[b]	7.80 ± 0.17[a]
Fourth Month	7.80 ± 0.10[b]	7.03 ± 0.10[b]	7.17 ± 0.09[b]	8.13 ± 0.20[a]
Total Volume	6.65 ± 0.06[b]	6.63 ± 0.12[b]	6.82 ± 0.12[b]	7.45 ± 0.10[a]

[ad,] Values in the same row and variable with no common superscript differ significantly (P<0.05).

On the other hand increased their feed intake increases the passage rate of gastrointestinal digestion materials by microorganisms thus less time to have a material impact on the result of reduced digestibility and consequently also reduced weight gain (rejection, 1386). Mole and Waterman (1987) on 38 animal research conducted, which was determined that high levels of tannin (20-10 percent) decreased the growth rate of sheep was due to reduced digestibility and thus weight gain reduced. Whatever digestibility of dry matter is less, the amount of material absorbed from digestive canal will less, and excretion of materials from gastrointestinal tract will further that this can affect daily weight gain and subsequently feed conversion ratio (Cunh, 2001). DM digestibility is dependent to content of lignin and crude fiber. There is evidence that the strong connections between lignin and many plant polysaccharides and cell wall proteins (lignocellulosic complex) prevents from digesting carbohydrates or reduces the rate of digestion (Cunh, 2001).

In general, older animals tend to have more fat and saves since carcass fat than protein with small amounts of water, pounds of fat stored on a supply of stored energy than one kilogram of dietary protein, more expensive and the need to consume more food and feed in ruminants on the other hand increased the absolute weight increases, so can say with weight gain in ruminant feed conversion ratio is worse (Fazaeli et al, 2006). Differences in food conversion ratio between different experiments indicate that several factors such as age and breed animals, initial weight, forage: concentrate ratio, type and quality of food rations and other environmental factors such as temperature can be over affect feed conversion ratio (Fazaeli et al, 2006).

Comparison of production costs

Project costs related to food and diets prices per kilogram dry matter is shown in Table 4 and Forage sorghum and corn planting costs for the silo is shown in Table 5. The results showed that levels of income per acre of corn compared with sorghum was more, but in contrast, the cost per ton of the produced silage for sorghum forage was 146,413 rials that in compared to 174,781 rials of corn was lower. Price per kg DMI (dry matter based) and cost per kg live weight of livestock not significantly changed between treatments (Table 6), so that with replacing SS in diet costs of one kg of feed decreased and cost of one kg live weight increased.

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Table 4 - Food and diets prices per kilogram, or per 100 percent dry matter (RLS)

Diet ingredient	Per kilogram	Per 100%DM	1	2	3	4
corn silage	400	1544	652.7	435.71	217	0
sorghum silage	470	1631.9	0	205.3	412.2	617.6
Dried lucerne	2000	2242	336.3	336.3	336.3	336.3
Barley	2200	2436	511.5	511.5	511.5	511.5
Wheat straw	1700	3899	290.5	290.5	290.5	290.5
Soybean meal	4500	5039	362.8	362.8	362.8	362.8
Urea	500	500	2	2	2	2
Calcium carbonate	500	500	2	2	2	2
Vitamin & Mineral supplement	700	7000	21	21	21	21
Salt	400	400	1.6	1.6	1.6	1.6

Table 5 - Forage sorghum and corn planting costs for the silo

Cost	Sorghum (per hectare)	Corn (per hectare)
Product per hectare (tons)	56.88	61.7
Price per ton product (RLS)	400000	470000
Income per hectare (RLS)	22752000	2899000
Seed	135000	900000
Herbicide	142000	142000
Fertilization	217000	277000
Expenses machinery	3358960	3860000
Water cost	250000	450000
Human resources	1425000	2355000
Ground rent	2000000	2000000
Miscellaneous	800000	800000
Total costs	8327960	10784000
Cost per ton silage (total cost / value of product)	146413	174781

Table 6 - Price per kg DMI (dry matter based) and cost per kg live weight of livestock

Parameters	1	2	3	4
Price of one kilogram of feed intake (RLS)	2180.4	2168.71	2159.9	2147.3
Cost of one kilogram of live animal weight (RLS)	14477.8	14378.5	14708.9	15975.9

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Sorghum and corn production costs

According to Table 5 it is indicated that the level of income per hectare of corn compared with sorghum was more that could be due to higher product and the high price of corn forage compared with sorghum. Dumler (2008) with study on sorghum was concluded that the amount of revenue and costs of production significantly depends on the product value and stated that with increasing production of products, production costs per unit was reduced and the resulting revenue increase. On the other hand the cost of producing one ton of forage of sorghum compared with corn is much lower, which is due to use smaller amounts of seed (5.4 vs. 30 kg, respectively), fertilizer, water, manpower etc. in cultivation of sorghum than maize. Less use of these inputs lowers costs and thus bring about reduce the production cost of one ton of sorghum forage in compared to maize.

In experimental diets with increasing levels of sorghum silage in replace with corn silage, price per kg of DMI is reduced due to lower prices of sorghum silage than corn silage (Table 6). Therefore, because of increase the replacement percentage of SS with CS, price per kg DMI also reduced. Cost per kilogram of live animal weight in parallel with percent substitution SS with CS has upward path due to the increase in feed conversion ratio. Highest price of a kilogram of animal body weight is related to T4 (100% SS) is due to higher feed conversion ratio compared to other treatments. Lowest cost of a kilogram live weight of cattle is belonging to the second group (33% SS) because of its low feed conversion.

CONCLUSION

From the results of present study, the higher feed intake and lower feed conversion ration were observed in fattening bulls fed dietary group 4 (100% SS replaced in diet). Groups fed 33% SS (T2) did showed the higher DWG in compared to other groups. Considering to entire cost per kg SS and CS, cost of one kg of food intake had a descended path from T1 to T4. However, price of one kilogram of FI not significantly decreased, cost of one kg of cattle live weight in SS group increased slightly, due to higher FCR of sorghum silage. As a consequence, the diet supplemented with 66 and or 100% sorghum silage in 60% of hay portion, seem to be capable of improve performance.

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