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Annals of Biological Research, 2011, 2 (3) : 223-235
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0976-1233
CODEN (USA): ABRNBW

Utilization of sorghum silage in steer: Using a dietary replacement with corn silage

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ABSTRACT

An experiment was conducted to assess effects of dietary corn silage (CS) replaced with sorghum silage (SS) on chemical composition, nutrient digestibility, product costs and performance of growing Steers. Thirty two steers (182.3 ± 5 kg BW) allocated in 4 treatments of 8 replicates based on a CRD. A diet including 60% hay (experimental part) plus 40% concentrate were fed to steers 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, 33, 66 and 100% (T1-T4, respectively). Dietary CS replacement with SS significantly improved performance traits (P > 0.05). Crud protein (CP) and DM digestibility of sorghum forage and silage were significantly (P > 0.05) lower than corn, while NDF, ADF and Ash values were significantly higher in corn in compared to sorghum. The rumen DMD was significantly decreased and instead DMD rate of small and large intestine increased. *It is concluded that, sorghum silage can be replaced in hay portion of diet up to 66 and or 100 % for better utilization of performance accompanying with an economic advantage in product expenses.*

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

INTRODUCTION

One of the most important forages is sorghum grain, often called Milo which in hot and dry areas and low water is cultivable. Sorghum grain is the principal grain used to finish cattle in some regions of the Iran and probably other Asian countries [1]. 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 [2]. 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 [3]. Because, seed hardness of sorghum grain is high digestibility can be decreased that is linked to variety [4]. 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. [5] documented that steers fed either corn or sorghum wet distillers grains, fed at 30% of the ration DM, had increased efficiency of gain. Hough et al. [4] 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 silage.

Miron et al. [6] was investigated dry matter production rate of a variety of corn and two varieties of sorghum (*Brown MidRib* and *FS-5*) and reported that dry matter production rate of corn was higher than two varieties of sorghum that the results were in accordance with results obtained by some other researchers [7]. Dann et al. [8] was investigated comparison of brown midrib sorghum-sudangrass with corn silage on lactational performance and nutrient digestibility in holstein dairy cows and reported that sorghum-Sudangrass silo had more moisture and crude protein than corn silage and expressed that because of poor land, the harvest has been delayed and thus the protein in sorghum and maize was decreased.

Olivera et al. [9] reported that tannin prevents digestion and generally causes delaying the digestion which this makes more undigested nutrients passed from the rumen into other parts of the digestive system.

Therefore, an experiment was carried out to assess effects of CS replacement in diet with SS on chemical composition, nutrient digestibility, product costs and performance of fattening Steers.

MATERIALS AND METHODS

Ecological features of the project place: In this research, agricultural operations was performed in the region Aghili (Kazem village) located 10 km West Gotvand city and the animal husbandry sector in the same area was conducted in a private animal husbandry farm. The average annual rainfall was about 320 mm in area and annual maximum temperature was 50 degrees Celsius and minimum annual temperature was 2 ° C and its height above sea level about 80 meters.

Farming and silo operations: After preparing the ground (any two pieces of land area 5.1 acre) 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. Each month, five bags have been opened and then samples were transferred to the laboratory of Research Center Safi-Abad stated in Dezful for chemical analysis.

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. After transferring animals to selected place of study, steers quarantined for 10 days and during this period numbers and 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 dietary deprivation and to obtain performance and also conducted for utilization from a new weight for the determination of DMI rate.

Diets and feeding: 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 including 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 part of diet 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).

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*.

Performance calculating: 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.

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.

Determination of apparent digestibility of dry matter of rations in various parts of the digestive system: To determine the apparent digestibility of dietary dry matter, methods on acid insoluble ash (AIA) procedure was used that is as follows: samples of food for 5 consecutive days, was performed. So that the early morning after weighing, daily food was thoroughly mixed, samples prepared and were left inside nylon bags. Then samples from each repetition, with mixed thoroughly and a sample required for testing, were taken.

To determine the apparent digestibility of dry matter in different parts of the digestive system, after the slaughter of livestock, samples were taken from the duodenum (the rate of 500 ml in 50 cm distance from the pylorus valve) from ileum part (about 300 ml in 20 cm of the cecum) and 200 g from rectal part and these obtained samples from each treatment within the plastic bags at a temperature –15 ° C were separately stored for subsequent analysis.

Determination of acid insoluble ash (AIA) in feed and feces samples: Feed and feces samples after being ground, were placed in 105 ° oven for about 24 hours and after cooled in device, the amount of four grams of them as double samples taken and was placed inside glass crucible kilns that previously had been weighed, and all were placed in the oven with a temperature about 450 ° C for a period of 12 hours and after obtaining the ash were placed in the automatic device measuring crude fiber.

After the device turned on, amount of 100 cc hydrochloric acid was added to per crucible and after heater turned on and 5 minutes in boiling was kept. Then with hot distilled water (85-100° C) washed them to be completely free of acid. Crucible were once again placed in the oven with a temperature about 450 ° C for a period of 12 hours and were burned. After cooling, crucible containing ash samples were weighed. However according to the initial sample weight (Ws) and weight of final ash with crucible (Wf) and weight of empty crucible (We) and percentage of acid insoluble ash using the following formula was calculated:

$$AIA\% = \frac{Wf - We}{Ws} \times 100$$

After determination of acid insoluble ash in feed and feces samples of each treatment, apparent digestibility of dry matter using the following formula was calculated: Percentage of apparent digestibility of dry matter = 100- (percentage of AIA in diets/ percentage of AIA in feces) ×100.

Chemical composition analysis: All feed samples were ground to pass a 1-mm screen. Dry matter (DM) was determined by oven drying at 60 °C for 24 h. Crude protein (% total nitrogen ×

6.25) was determined by the Kjeldahl method, using 1.0 g samples [10]. Cellulose, hemicellulose and lignin were determined as in Bailey [11]. The neutral detergent fibres (NDF) and acid detergent fibres (ADF) were measured according to the methods described by Van Soest et al. [12].

Production price: 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 of live weight in 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.

Statistical analysis: The data obtained from research using Excel software (Excel) compiled and recorded. All data by statistical software SAS [13] using the following statistical model analysis ($Yij = \mu + Ti + \varepsilon ij$) 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: $FWij = \mu + Ti + b\ (IWij) + \varepsilon ij$. 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

Crop parameters: Consumption level for sorghum seed per hectare was 5.4 kg that this amount in compared with the corn seed that was 30 kilograms per hectare, was significantly lower. As regards research on water use efficiency is a specialist job and should be in the form of a project be considered, need only be noted that from planting to harvest time, sorghum fields were irrigated for 11 times, while irrigation for maize was performed 16 times. The total amount of fresh forage yield and dry matter produced of sorghum, was 56,880 15,640 kg/hectare, respectively while this amounts for corn 61,700 and 18,630 kg/hectare was achieved.

Chemical analysis: Averages of compounds of the forage and silage of corn and sorghum as well as residues during silo time, is given in Table 4. Study of results of averages comparison the showed that corn forage compared with the sorghum had significantly greater dry matter and crude protein. But the amount of cell wall (NDF), cell wall without hemicelluloses (ADF) and ash in the sorghum forage significantly was higher from the corn forage. The corn silage compared with sorghum silage had a significant amount of dry matter and crud protein, while the values of NDF, ADF and ash of sorghum silage was significantly higher than corn silage. PH levels between both silages had no significant difference. Analytical results of the dry matter, crude protein, NDF, ADF and ash of corn silage and sorghum silage were similar to the analysis results of their fresh Forage. Recovery amount of DM, CP, NDF and ADF were not significantly changed between S and C silage.

Dry matter digestibility of experimental diets: Effect of replacing different levels of corn silage with sorghum silage on dry matter digestibility (DMD) is shown in Table 4. Rumen DMD rate significantly (P<0.05) decreased with replacing SS in hay part of diet, while in small intestine not showed significant different. But colon DMD of SS was significantly (P<0.05) increased when replacement amount was over 66% or in 100%. Overall, total DMD showed a decline (P<0.05) during replacement of SS with CS in hay part of steer diet.

Performance: The results related to performance of fattening steers have been presented in Table 5. Average initial weight of fattened calves at the start of the experiment showed not significant difference between treatments and only the highest and lowest body weight in terms of numerical treatment was related to the T3 and T4, respectively.

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. Results showed that the lowest weight gain was related to T4. 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. In throughout trial period 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).

Comparison of production cost: Price per kg DMI 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.

DISCUSSION

Amount of used seed and water: According to the research results indicated that sorghum compared with corn, a much smaller amount of seed needed. Fazaeli et al. [14] in an experiment similar to presented study reported that amount of used seed of cord and sorghum was 30 and 4 per hectare, respectively that was almost the same amount of seed used in this study. Results from study of Ward et al. [15] was 58 and 13 for corn and sorghum, respectively, that was almost the same amount of seed used in study carried out by Cumo et al. [16]. In other study that conducted on some varieties of forage sorghum, the most appropriate number of brushwood per unit area was obtained that 160000 plants per hectare reported [6]. Cumo et al. [16] stated that reason for differences in amount of used seeds in the different experiments is due to different varieties, planting styles and regional climate.

Regarding to results related to number of irrigation it was detected that compared with corn, sorghum requires less water that likely could be low due to adequate water storage within the stems and lack of water evaporation from the surface of leaves in dry conditions and heat stress. Also, Fazaeli et al. [14] concluded that the sorghum in compared to corn requires much less water.

Plants harvest yield per unit area: According to the results indicated that the amount of forage yield and total dry matter production of maize compared to sorghum was a bit more. Ishin et al.

[17] has been reported that forage yield of wet sorghum was about 36 tons per hectare, while even higher rate of 80 tons per hectare has also been reported [18]. In some studies, fresh forage yield of sorghum between 50 to 60 tons per ha expressed [19] that the same value obtained in current experiment.

Dry matter production rates of a variety of corn and two varieties of sorghum (Sorghum Fs-5 and Sorghum BMR) were considered by Miron et al. [20] and Lundeen [21]. They expressed that the amount of dry matter production of corn was more than two varieties of sorghum that tests were conducted by Nir et al. [7] also confirmed it. According to researchers, the amount available forage harvest when the grain sorghum is in the late dough stage, reaches its maximum [22].

The difference between the results obtained in this trial with other experiments could be due to using small experimental plots in the previous studies which their forage is harvested by hand. While in the current study due to area of planting forage, harvest was conducted with chopper machine that cause increasing waste. On the other side due to narrow stems and light clusters of sorghum compared with corn plants may make plants during the chopper, some of this grass by the wind wasted to out of the trucks and the product reduced. This reduction in the amount of harvested product with chopper machine complies with previous reports related to comparing the BMR sorghum product with the trading sorghum [23]. Also other reasons for the difference in the amount of forage production can be noted to the difference in the rate of seed consumption, climate, fertile land, water levels etc. [17].

Chemical analysis, the constituent ingredients of sorghum and corn forage: Regarding to results in the current study (Table 3) it is detected that dry matter of both sorghum and corn forage was higher than minimum dry matter (24.7 %) suggested by Castle and Watson [24] to ensure the production of desirable silage. On the other hand Ward et al. [15] in a research on sorghum and maize they expressed dry matter of both forage were less than 28 percent said and suggested that silos with dry matter less than 28 percent are susceptible to fermentation because cause reduce the silo quality.

In the current study sorghum forage in compared to corn contained more NDF and ADF due to high amount of seed in corn forage than sorghum. Also corn seed contain lower NDF and ADF [14]. Average amount of pH in the current study was lower 4 that were similar to results obtained to Fazaeli et al. [14]. Silos contain pH lower than 4.2, properly are stored and maintained but in pH>4.2 level especially if dry matter is lower than 28% are prone to putrefaction by the fermentation [15]. Hence, one of the reasons for the low pH of sorghum and corn silos in the present test considering the fact that they were low dry matter could be due to large amounts of water soluble carbohydrates that consumed by microorganisms producing lactic acid and its accumulation reduced pH. Ishin et al. [17] also reported that cause of low pH of sweet sorghum silo is potential ability of sorghum in storing sugar within the stem and leaves and stated that the sugar can cause better fermentation silo and improve its quality.

Dann et al. [9] reported that sorghum silage had higher moisture and crud protein than corn silage and expressed that a poor ground being delayed in the harvest and subsequently reducing protein in sorghum and maize; however, stated that the quick harvest reduces the performance and product content and value.

Regarding to results related to nutrient recycling rate of S and C silages it is detected that silo to make a standard waste in nutrients of forages. Most recycling rate was related to the ash that about 100% rates in both forages is recycled. Residue rate of dry matter of S and C silages was almost the same (93% - 94%). But the recovery in crude protein in corn silage was higher than sorghum silage (93% - 91%). ADF recycling rate in sorghum silage was slightly higher than corn silage (98% - 97%), while the recycling rate of NDF in corn silage was slightly higher than sorghum silage (98% -97%).

Miron et al. [20] expressed that the level of recycled NDF and ADF of sorghum and corn silage were in the highest level that was similar to results obtained in the current experiment. Manhanta and Pachauri [25] concluded that the silo sorghum to make waste at about 5.64% of the protein that these losses could be due to fermentation. On the other hand, an increase (4.13%) in the amount ADF of forage after silo was observed. Savoie and Jofriet [26] expressed the silo sorghum and corn with high humidity can causing waste DM due to fluid loss from the silo and therefore less recycling of the nutrient of silage that is probably one of the reasons for lower recovery of sorghum DM in compared to the corn silage in present project could be high humidity of silo sorghum.

DM digestibility of experimental diets and different parts of the digestive system: Total DMD showed a decline ($P<0.05$) during replacement of SS with CS in hay part of steer diet, probably because of high fiber and lignin in sorghum silage (Table 4). Chekani-Azar and Chekani-Azar [27] also reported that the lignocellulosic complex and the cellulosic fraction are important resistance grafts against microbial digestion in ruminants that in the current study are capable to decline DMD of diets contain higher sorghum silage. On the other hand, average amount of pH in the current study was < 4 due to large amounts of water soluble carbohydrates that consumed by microorganisms producing lactic acid and its accumulation reduced pH. Although, Ishin et al [17] reported that low pH of sweet sorghum silo is due to potential ability of sorghum in storing sugar within the stem and leaves which can cause better fermentation of silage and improve its quality, but lower pH of rumen prevents the proliferation and growth of cellulolytic bacteria, which play the main role in the digestion of forage materials, and subsequently decrease of fiber digestion [28]. Olivera et al. [9] stated that condensed tannins reduces digestibility of organic and dry matters of plants by ruminants. Because of the complex formation of tannin-protein of food that can prevents the effect of *Cellulase* enzyme in rumen. Martinesz and Moyano [29] in a study used Tannic acid to seeds of legumes such as soybeans that reduces the degradation of protein and dry matter in the food.

DM digestibility of rumen significantly ($P<0.05$) decreased with replacing SS in hay diet because of tannin in sorghum grain silage. Olivera et al. [9] reported that tannin prevents digestion and generally causes delaying the digestion which this makes more undigested nutrients passed from the rumen into other parts of the digestive system. DM digestibility in small intestine not showed significant different, because secrete digestive juices in the small intestine are limited and the digestive juices can be digested the limited amounts of nutrients [30]. Also in the small intestine, the microbial digestion which is the main factor in digestion of woody material is not conducted [31].

Colon DM digestibility of SS was significantly (P<0.05) increased when replaced in diet in 66% or 100%. As mentioned above, in diets containing high amounts of sorghum silage, more undigested food passes into the large intestine from the rumen and small intestine, where microbial digestion by microorganisms within the large intestine occurs.

Performance: Results from the presented study (Table 5) showed that, 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.

Hough et al. [4] reported that the rations containing corn silage reduced feed intake in fattened heifers compared with sorghum silage because of 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 [32]. 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 [16]. 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 [25].

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, which eventually would be reduced daily gain in treatments of sorghum silage (t3 and T4). 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. Mole and Waterman [33] 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 reduce weight gain is.

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 [34]. 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 [28]. 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 [13].

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	7.80	48.90	29.60	0.22	0.20
sorghum silage	25.9	7.38	54.60	38.70	0.21	0.15
Dried lucerne	89.2	17.20	43.00	32.30	1.40	0.27
Barley	90.3	10.80	22.00	9.00	0.05	0.30
Wheat straw	89.5	15.25	43.20	17.10	0.12	1.10
Soybean meal	89.3	42.00	23.10	12.00	0.35	0.63
Urea	100	280.00	_____	_____	_____	_____
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 (%)	Parameters			
	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

Economic comparison of experimental diets: In experimental diets with increasing levels of sorghum silage to replace with corn silage, price per kg of DMI is reduced due to lower prices of sorghum silage than corn silage. 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.

Table 3: New forage and silage of corn and sorghum components based on 100 percent dry matter (mean ± standard error).

Diet ingredient	Forage		Silage		Recovery amount	
	Corn	Sorghum	Corn	Sorghum	Corn silage	Sorghum silage
Dry matter	30.20±0.46a	27.50 ± 0.32 b	28.80±0.38 a	25.90±0.32 b	0.95±0.10	0.94 ± 0.004
Crud protein	7.94±0.73a	7.63 ± .072 b	7.80±0.62 a	7.38 ± .092 b	0.93±0.004	0.91 ±0.008
Cell wall (NDF)	47.40±0.09a	52.40 ± 0.21 b	48.90±0.27 a	54.60 ± 0.19 b	0.98±0.004	0.97 ± 0.005
Cell wall without hemicellulose (ADF)	28.90±0.10a	36.50 ± 1.61 b	29.60±0.24 a	38.70 ± 1.40 b	0.97±0.06	0.98 ± 0.006
Ash	6.92±0.4a	7.99 ± 0.34 b	7.27±0.6 a	8.49 ±0.25 b	1.00±0.17	1.00 ± 0.004
pH	--	--	3.84±0.19	3.76 ± 0.035	--	--

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

Table 4: Effect of replacing different levels of corn silage with sorghum silage on dry matter digestibility (DMD)

Parameters	1	2	3	4
DMD in Rumen	65.80 ± 0.24 a	64.15 ± 0.40 ab	62.95 ± 0.49 bc	61.41 ± 0.45 c
DMD in Small intestine	23.64 ± 0.21 a	24.7 ± 0.29 a	23.98 ± 0.41 a	24.87 ± 0.59 a
DMD in Colon	11.28 ± 0.45 b	11.78 ± 0.11 b	13.07 ± 0.08 a	13.72 ± 0.14 a
Total DMD	67.32 ± 0.44 a	67.84 ± 0.49 a	65.92 ± 0.71 ab	63.87 ± 0.42 b

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

Table 5: 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	6.50 ± 0.92b	6.76 ± 0.11ab	6.62 ± 0.11b	7.30 ± 0.11a
Daily weight gain	0.97 ± 0.02ab	1.02 ± 0.02 a	0.97 ± 0.021 ab	0.94 ± 0.013 b
g feed/g gain	6.65 ± 0.06b	6.63 ± 0.12b	6.82 ± 0.12b	7.45 ± 0.10a

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

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

CONCLUSION

Dietary replacement of sorghum silage with corn silage significantly increased feed intake but the best results related to DWG and FCR were observed in diet containing 33% SS (T2). Total

DM digestibility not significantly decreased in dietary SS replacement up to 66%, so that the rumen DMD was decreased and while DMD rate of small and large intestine increased. Due to higher feed conversion ratio of sorghum silage, cost of one kg of cattle live weight slightly increased by SS replacement of diet.

Iran is one of the Asian countries that is susceptible to sorghum cultivation and uses silage as a major source of food for livestock because cultivated green fodder is not sufficiently available. Also, more work in these areas is necessary to detect applicable results and study of different levels and varieties types of sorghum silage, test diets in different criteria of feeding (*ad libitum* vs. restricted), the sex and age of animal and many more factors could have contributed to this variability.

Acknowledgments
The presented study financially assisted in part by Islamic Azad University, Khorasgan Branch, Iran. It was summarized from Master thesis project number 23850101862002. The authors are grateful to Dr. Shahin Eghbal-Saeid the assistant professors of Animal Science Department of Islamic Azad University of Khorasgan Branch, for their technical and statistical assistance related to current study. Also, valuable support of Dr. Eshagh Kordnejad, head of Animal Science Research Institute of Safi-Abad Dezful, Iran, in all steps of experiment is gratefully acknowledged.

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