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The Effects of Sorghum Grain on Live Weight Gain, Feed Conversion Ratios and Digestibility of Nutrients in Beef Cattle

[1]M.S. Baran, [2]R. Demirel, [3]B. Yokus and [4]N. Kocabagli
[1]Department of Animal Nutrition, Faculty of Veterinary Medicine,
[2]Department of Animal Science, Faculty of Agriculture,
[3]Department of Biochemistry, Faculty of Veterinary Medicine,
Dicle University, Diyarbakır, Turkey
[4]Department of Animal Nutrition, Faculty of Veterinary Medicine,
Istanbul University, Istanbul, Turkey

Abstract: In this research, the effect of sorghum in beef cattle mixture feeds as energy source instead of wheat on live weight gain, feed conversion ratio and digestibility of nutrients were investigated. In the experiment, 20 Holstein male beef cattle of 1.5 years old and each weighing average 330 kg were used as animal material. The trial was done in two stages: the first stage was pre-experimental period for 2 weeks and the second stage was the main experimental period for 10 weeks, totally lasting 12 weeks. During the whole experimental period, isocaloric and isonitrogenic 2 diets were used. In control group, feed mixtures involved 27% wheat, but in experimental group, 27% sorghum was used instead of wheat. Dried alfalfa hay was used as roughage. Both rations consisted of 80% concentrated feed and 20% roughage. The differences between the control and treatment groups, in terms of live weight gains, feed intakes, daily live weight gains, feed conversion ratios and digestibility of nutrients, during 84 days of feeding period were not significant ($p>0.05$). Trial results indicated that sorghum grain could be used instead of wheat as an economical energy source in beef cattle rations.

Key words: Sorghum, beef cattle, digestibility, weight gain, feed conversion ratio

INTRODUCTION

Grain sorghum has been used as an animal feedstuff in developed countries, whereas it is a food source in human nutrition in developing countries. As an energy source, grain sorghum is approximately 10-15% cheaper than corn and wheat and contains 2-3.5 percentage unit more crude protein than corn (Arnold, 1989). Sorghum varieties and species can be preferred to meet basically roughage and concentrated feed requirements of animal (Baran and Kocabagli, 2000).

In Turkey, sorghum is sown in 3250 ha and annual production is 3950 tons (Gul, 1998). Baytekin *et al.* (1991) obtained 450-800 kg day^{-1} grain sorghum yield in Çukurova conditions as the second cropping, according to trial results of three years. Wheat production values are 220-500 kg day^{-1} (Gul, 1998). In Arizona University, research has been carried out by using castrated beef cattle and advantageous values were obtained by sorghum (live weight gain 2.3%, feed conversion ratio 5.8%) than corn (Arnold, 1989).

Galloway *et al.* (1993) investigated the effects of sorghum and wheat on digestibility, feed consumption and live weight gain, using approximately 400 kg average live weight beef cattle. According to their results, there were no statistically important differences between groups for NDF digestibility, feed consumption and daily live weight gain. Gaebe *et al.* (1998) studied the effects of grain sorghum and corn on digestibility, live weight gain and performance. They reported that there were not statistically important differences between groups for feed consumption, feed conversion ratios, live weight gains, dry matter, NDF, ADF digestibility. Köster *et al.* (2002) using different levels of grain sorghum and urea in beef cattle rations, they stated that digestibility of organic matter was increased by the increasing level of sorghum; however digestibility of NDF was not affected of trials. In most studies, it has been reported that

Corresponding Author: Murat Sedat Baran, Department of Animal Nutrition, Faculty of Veterinary Medicine, Dicle University, 21280 Diyarbakir, Turkey

sorghum and wheat affected similarly live weight gain, feed conversion ratios, digestibility and feeding performance (Axe *et al*., 1987; Hermesmeyer *et al*., 2002; Zinn *et al*., 2008; Sindt *et al*., 1993; Miller *et al*., 2007; Zinn, 1994).

The aim of this research, is to investigate grain sorghum that is produced in Turkey in beef cattle diets as an energy source instead of wheat, considering live weight gain, feed conversion ratio and the digestibility of nutrition.

MATERIALS AND METHODS

In this research, 20 Holstein male beef cattle of 1.5 years old were used. Animals were assigned to 2 groups, considering similar average live weights after they were kept hungry for 24 h. Every group had 10 animals. Initial weights of animals were approximately 330.9±18 and 329.8±16 kg in sorghum and wheat groups, respectively. Prior to trial, all of the animals were medicated for internal and external parasites.

Mixed feeds to be given were prepared according to NRC (2000) beef cattle nutrient requirements as isocaloric and isonitrogenic in a private feed mill. Dried alfalfa was used as roughage (15.85% CP). In control group, wheat constituted 27% of the mixed feed; in treatment group, the same level of sorghum was used instead of wheat. Control (wheat) and treatment (sorghum) groups' diets consisted of 80% concentrated feed + 20% dried alfalfa. Feedstuffs and nutrient contents of feeds and metabolisable energy levels are given in Table 1. Feeds were given twice a day (at 08:00 and 16:00 o'clock) by weighing daily consumption as ad libitum, after pretrial period for two weeks. Daily feed consumption was determined by weighing excess feed the following day. Water was supplied freshly and ad libitum.

The trial lasted totally 12 weeks (2 weeks as pretrial and 10 weeks for trial period). During trial periods, all of the animals were weighted while hungry in every 14 days and thus live weight values of animals were determined at the same time for feed consumption. Values were calculated and by using these parameters, feed conversion ratio values were determined. Feces samples were collected clearly for determination of digestion percent of nutrients (*in vivo*) at last 7 days of trial. Feces samples were dried at 60°C for 36-48 h. Indicator method was used because of difficulty in collecting all of beef cattle manure. Insoluble ash content in HCl was used as indicator (Sarı and Cerci, 1993). Digestibility rates of nutrients were calculated by following equation which is stated by Sarı and Cerci (1993).

Table 1: Feedstuff contents and nutrient of diets (DM basis)

Feed stuffs (%)	Wheat (%)	Sorghum (%)
Dried alfalfa	20.00	20.00
Sorghum	-	27.00
Wheat	27.00	-
Wheat bran	18.50	18.50
Cotton seed meal	20.00	20.00
Molasses	11.00	11.00
Marble flour	2.05	1.80
Salt	1.20	1.20
Urea	-	0.25
Vit. and min. mixture (Vimarmix BR1+M)*	0.25	0.25
Total	100.00	100.00
Calculated and analyzed values		
Dry matter (%)	89.99	90.38
Metabolisable energy, MJ kg^{-1} (calculated)	11.08	11.16
Crude protein (%)	17.55	17.56
Ether extract (%)	3.36	3.77
Crude fiber (%)	11.71	11.30
Crude ash (%)	5.50	5.23
Nitrogen free extract matter (%) (calculated)	51.87	52.53
NDF (%)	27.12	26.71
ADF (%)	17.15	16.82

*Vimarmix BR1+M: In each kg: 4.800.000 IU Vitamin A, 1.200.000 IU.D_3, 12.000 mg Vitamin E, 1.500 mg Vitamin K_3, 1.200 mg Vitamin B_1, 2.400 mg Vitamin B_2, 2000 mg B_6, 8 mg B_{12}, 16.000 mg Niacin, 4000 mg Cal-D-Pantotenat, 400 mg Folic acid, 20 mg D-Biotin, 200.000 mg Colin Chloride, 32.000 mg Mn, 24.000 mg Zn, 24.000 mg Fe, 2000 mg Cu, 400 mg I, 200 mg Co, 60 mg Se

$$\text{Digestibility rate}(\%) = 100 - 100 \times \frac{\text{indicator level in feed}(\%)}{\text{indicator level in feces}(\%)} \times \frac{\text{nutrients in feces}(\%)}{\text{nutrients in feeds}(\%)}$$

The nutrient contents of feed stuffs, dried alfalfa, feces and trial rations were analyzed according to AOAC (1995) method. ADF and NDF analyses were performed according to Van Soest (1987) and crude fiber contents were analyzed according to Crampton and Maynard (1938).

Statistical analysis: All of data in tables were presented as arithmetical mean (x) and standard deviation (SD). Statistical differences between the groups were examined according to "independent-samples t-test". All statistical analyses were performed with statistics package SPSS version 10.0 (SPSS Inc., Illinois, USA).

RESULTS AND DISCUSSION

Periodically, live weight values and daily live weight gains according to groups are given in Table 2. During total feeding period, live weight values were 149.5 and 151.7 kg, daily live weight gain values 1.77 and 1.81 kg for wheat and sorghum groups, respectively. The differences between wheat and sorghum groups for periodic live weight and daily live weight gain values were not significant ($p>0.05$).

Table 2: Periodic live weight values and daily live weight gain values according to wheat and sorghum groups (n = 10)

	Live weight values (kg)				Live weight gain values (kg/day/animal)			
	Wheat		Sorghum		Wheat		Sorghum	
	x	S.D.	x	S.D.	x	S.D.	x	S.D.
Initial live weights	329.80	13.4	330.90	12.9				
0-14	351.00	16.1	352.50	14.2	1.51	0.22	1.54	0.16
14-28	375.00	18.2	377.20	15.7	1.68	0.17	1.76	0.22
28-42	401.10	19.4	403.90	16.5	1.86	0.12	1.91	0.15
42-56	427.30	19.0	430.45	16.4	1.87	0.08	1.90	0.07
56-70	452.90	18.2	456.40	16.4	1.83	0.12	1.85	0.16
70-84	479.30	17.7	482.60	16.5	1.88	0.07	1.87	0.12
Total live weight gain	149.50	5.43	151.70	9.42	1.77	0.06	1.81	0.11

Table 3: Feed consumption and feed conversion ratio values in wheat and sorghum groups (n = 10)

	Feed consumption (kg/day/animal)				Feed conversion ratio (Feed consumption, kg/Live weight gain, kg)			
	Wheat		Sorghum		Wheat		Sorghum	
	x	S.D.	x	S.D.	x	S.D.	x	S.D.
0-14	9.03	0.47	8.98	0.24	5.98	0.83	5.83	0.59
14-28	9.17	0.46	9.13	0.27	5.45	0.45	5.19	0.56
28-42	9.20	0.50	9.29	0.25	4.95	0.23	4.86	0.30
42-56	9.24	0.47	9.30	0.22	4.94	0.28	4.89	0.16
56-70	9.27	0.38	9.26	0.26	5.06	0.35	5.00	0.38
70-84	9.29	0.35	9.25	0.26	4.94	0.24	4.94	0.35
0-84	9.20	0.42	9.20	0.23	5.20	0.14	5.08	0.27

Table 4: Digestibility of crude nutrients in wheat and sorghum groups (%), (n = 10)

	Wheat		Sorghum	
	x	S.D.	x	S.D.
Dry matter	69.48	0.48	70.50	1.50
Organic matter	68.90	0.47	69.30	0.91
Crude protein	69.80	0.71	70.20	0.88
Crude fat	70.90	1.14	71.40	1.19
Crude fiber	59.70	0.65	60.30	0.74
Nitrogen free extract matter	73.90	1.21	74.40	0.51
NDF	46.00	0.73	46.40	0.56
ADF	43.20	0.64	43.70	0.77
Crude ash	59.70	0.59	60.10	0.66

Feed consumption and average feed conversion ratio values of wheat and sorghum groups are given in Table 3. There were not important differences between the groups for feed consumption and feed conversion ratio values. Digestion rates of crude nutrients in sorghum and wheat groups are given in Table 4. Differences between the groups for digestibility of crude nutrients were not significant ($p>0.05$).

The differences between the groups for live weight values of beef cattle were not significant ($p>0.05$), which were fed sorghum and wheat-based diets (Table 2). Galloway *et al.* (1993) reported that, differences between wheat and sorghum groups were not significant ($p>0.05$) in average 400 kg live weight beef cattle for live weight values. Axe *et al.* (1987) stated that, by using beef cattles, average 334 kg live weight fed with wheat and high moisture content sorghum, they compared it for digestibility and performance and found that daily live weight gain values were similar for wheat and sorghum groups. Miller *et al.* (2007) used grain sorghum and barley in beef cattles and they have found that grains didn't affect the digestibility of organic matter, crude fiber and feed efficiency.

Zinn (1994) have found similar daily live weight gain values, giving wheat millings with steam. Using average initial live weights of 348 kg beef cattle. In Arizona University, 2.2% advantageous daily live weight gain results were obtained from sorghum in castrated beef cattle (Arnold, 1989). Zinn *et al.* (2008) used dry-rolled and steam-flaked sorghum grain in feedlot cattle and they found that grain processing didn't affect live weight gain. These results of this study are compatible with those reported in literature (Galloway *et al.*, 1993; Sindt *et al.*, 1993), as to the fact that there is not any statistical importance of sorghum feeding on feeding performance.

As seen in Table 3, differences between sorghum and wheat based diets for feed consumption and feed efficiency ratio values were not significant ($p>0.05$). During trial period, average feed consumption values were 9.2 kg in both groups, but feed efficiency ratio values were 5.08 in sorghum and 5.20 in wheat based diets. Galloway *et al.* (1993) reported that, by comparing grain sorghum and wheat on feed consumption, ruminal fermentation and live weight gains in beef cattle, there

was not statistical significance between the groups for feed consumption. Sindt *et al.* (1993) investigated different grains and protein sources in beef cattle and reported that there were not significant differences for feed efficiency ratio values of groups. Our findings seem to be consistent with some research results (Gaebe *et al.*, 1998; Miller *et al.*, 2007; Zinn, 1994) for feed consumption and feed efficiency ratios.

As seen in Table 4, there were not statistically significant differences between sorghum and wheat based diets for digestion degree of crude nutrients ($p>0.05$). Hermesmeyer *et al.* (2002) investigated limited and ad libitum wheat on digestion and they found that differences between the groups for the digestion of dry matter, organic matter and crude protein were not significant ($p>0.05$). Gaebe *et al.* (1998) compared grain sorghum and wheat groups on digestibility and live weight gain in finishing diets of cattle and have found that there were not significant differences on the digestibility of dry matter, NDF and ADF.

CONCLUSION

As a result of this research, use of sorghum instead of wheat in beef cattle diets did not affect digestibility of crude nutrients, but affected favorably daily live weight gains and feed efficiency ratio values. In addition, in Turkey, sorghum is cheaper than other energy source grains such as wheat and corn; at the same time, sorghum has higher protein content and more yields can be produced per unit area. Therefore, use of sorghum in beef cattle diets may be advantageous for meat production cost.

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