Influence of the dietary sorghum grains on fattening steers performance as an alternative to commonly used cereals

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SUMMARY

The productive effects of sorghum grains were tested on 24 Romanian Spotted steers with an average initial body weight of 287 kg, assigned uniformly to three groups. The three groups received different amounts of sorghum grain through the compound feed: group 1 (control) no sorghum, group 2 (experimental) 20% and group 3 (experimental) 30% sorghum grain, together with corn silage. The trials showed that the use of dietary sorghum grains for fattening steers didn't change feed intake or diet palatability. Average daily gains was not significantly influenced by the diet for the experimental groups (1734 g/day in E1 and 1527 g/day in E2), compared to control group (1747 g/day). The increase of the dietary sorghum grains inclusion to 30% decreased steer performance while increasing the cost of feeding compared to control and E1.

Keywords**:** steers, corn silage, sorghum grains, performances

INTRODUCTION

Sorghum crops have particular climate and soil requirements, being draught-resistant, with generally moderate requirements for growth. The climate and soil conditions which are unfavourable for other crops are optimal for sorghum, compared to corn, for instance, which would be totally unproductive under the same conditions. Hence, sorghum crops will never compete corn crops; on the contrary, it will increase the total production of energy concentrate feeds by using the climate areas and soils which are unfavourable to corn, barley or other cereal crops (Voicu, 2011; 2013).

In Romania, the sorghum grains were rather little used in steer fattening. Their chemical composition resembles that of the corn, which it can replace in different amounts, even completely, producing basically the same performance for the fattening steers. Jurubescu et al. (citing INRA, 1988) show a content of 1.18 feeds units (FU) and 75 g DP/kg DM for the sorghum grains,

compared to 1.29 FU/kg and 68 DP/kg DM for the corn grains. Stoica et al. (1997, 2001) also reported a similar nutritive value of the sorghum grains: 1.15 FU and 70 g DP/kg DM.

In the United States, Holland, Austria, the diets for fattening steers replaced 93-95% of the corn grains with sorghum grains, and produced similar average daily gains and feed intake for one kg of gain. Owensby et al., (1995) studied for about four years, on representative groups of fattening cattle, the influence of the dietary sorghum grains in diets combined with greenchop, of steer performance. They noticed that the weight gain was not significantly influenced during the early growth period, but during the finishing period, the performance increased proportionally with the amount of supplemental sorghum grains. Baran et al., (2008) studied the effect of the sorghum grains on the body weight, feed conversion and nutrient digestibility in steers, concluding that sorghum grains can replace wheat as low-cost source of energy for ruminants.

Based on these findings, we aimed to determine the bioproductive and economic effect of the sorghum grains given to fattening steers.

Material and Methods

The fattening steers were treated in accordance with Romanian law no. 305/2006 regarding handling and protection of animals used for experimental purposes. All experimental procedures were approved by the Ethical Committee of the National Research-Development Institute for Animal Biology and Nutrition, Balotesti, Romania.

The trial used fattening Romanian spotted steers with an average initial body weight of 287 kg ± 29.09, assigned uniformly to three groups of 8 animals each. The diets were formulated according to Burlacu et al., (2002) and consisted of corn silage as bulk feed (the basal diet) and a concentrate mixture of corn, barley, wheat, sunflower meal, limestone and salt, plus a vitamin-mineral premix adequate to the category of weight. The three groups differed by the level of dietary sorghum grains, as shown in Table 1.

The energy and protein value of the forages was evaluated according to the new system adopted in Romania after 1990, based on the French model of evaluation (INRA, 1988).

The protein content was expressed in IDP (intestinal digestible protein) with its two forms adapted after Vérité et al., (1987), as follows:

1. IDPN (intestinal digestible protein derived from nitrogen) where we calculated the value of Dg (nitrogen matter degradability in the rumen), with the formula of Alderman, (1993);

2. IDPE (intestinal digestible protein derived from energy) estimated with FOM (fermentescible organic matter - g/kg DM), used for the synthesis of 145 g microbial protein.

Table 1. Compound feeds formulation, chemical composition and nutritive value

Specification	C (%)	E1 (%)	E2 (%)
Corn	15.00	16.50	-
Barley	25.00	-	13.00
Wheat	21.00	26.00	23.50
Grain sorghum	-	20.00	30.00
Sunflower meal	34.50	33.00	29.00
Calcium carbonate	2.00	2.00	2.00
Salt	1.50	1.50	1.50
Vitamin mineral premix	1.00	1.00	1.00
Analyzed, g/kg DM			
DM	882	879	877
OM	926	932	934
CP	202	174	162
EE	20	28	26
Fiber	110	105	208
NFE	594	625	538
Ash	74	68	66
GE (MJ)	17.82	17.91	18.08
Nutritive value, g/kg DM			
MFU	1.23	1.27	1.26
IDPN	138	123	115
IDPE	121	124	121
Ca	12.22	11.41	11.31
P	7.66	7.16	6.63

DM – dry matter; OM – organic matter; CP – crude protein; EE – ether extractives; CF – crude fiber; NFE – nitrogen-free extractives; GE – gross energy; MFU - meat feed units; IDPN - intestinal digestible protein derived from nitrogen; IDPE -intestinal digestible protein derived from energy; Ca – calcium; P – phosphorus;

The net energy was calculated from the efficiency of metabolisable energy utilization for meat production starting from the energy concentration of the forage (q) and from the yield of metabolisable energy (k) utilization as net energy for maintenance (NEm) and as net energy for meat production (NEm). Finally, the content of net energy for meat (NEm) of the feeds was related to the oats standard, according to Burlacu et al., (2002) adapted after Vermorel et al., (1987).

The experiments run for 74 days and started with a sub-period of 14 days during which the animals were accustomed to the new diets, followed by the period of actual determinations when the following parameters were monitored: average daily feed intake, average daily body weight (weighing at

the beginning of the experiment, each month and at the end of the experiment), feed conversion ratio and the cost of feeding. The daily feed intake and the leftovers were recorded on a daily basis for each group (on a DM basis). Animal health was monitored continuously. The animals were kept in a house for fattening steers, in collective stalls with slatted floor and central alley. The feeding space was enough for all animals to eat at once and water for provided permanently by constant-level drinkers.

RESULTS AND DISCUSSION

Table 2 shows the chemical composition of the feed ingredients determined with the Weende scheme. These standardized methods are according to Commission Regulation (EC) no. 152/2009 (Official Journal of the European Union, 2009). The corn silage had 294 g DM, 82 g CP, 299 g crude fibre (CF) and 17.93 MJ GE/kg DM, estimated according to the chemical composition and using different caloric coefficients determined for each component of the organic matter (Burlacu et al., 1991; 2002).

The compound feed ingredients contributed with different proportions to the total dietary protein level: 88 g from corn, 101 g from barley, 129 g from wheat, 77 g from sorghum grains and 341 g/kg DM from sunflower meal; crude fibre was determined in amount of 32 g in corn, 68 g in barley, 37 g in wheat, 31 g and sorghum grains and 241 g/kg DM in sunflower meal. Previous studies (Abdul et al, 2008; Baran et al, 2008; Singh et al, 2009), Jambunthan et al, 1981) on the chemical composition of the sorghum grains revealed rather similar values with the ones determined by us for most nutrients. Comparable values for the sorghum grains were also reported by other teams (Village World Journal, 2009).

Table 2. Chemical composition and the nutritive value of the feed ingredients (g/kg DM)

Item	DM, g/kg	OM	CP	EE	C.fib	NFE	Ash	GE (MJ)	MFU	IDPN	IDPE
Corn silage	294	949	82	20	299	548	51	17.93	1.03	49	66
Corn	825	987	88	32	32	835	13	18.21	1.54	70	121
Barley	874	973	101	18	68	786	27	17.83	1.26	65	89
Wheat	862	980	129	14	37	800	20	17.96	1.52	85	105
Sorgh. grains	845	980	77	28	31	844	20	17.92	1.41	63	117
Sunfl. meal	897	926	341	29	241	315	74	19.26	0.79	219	114

DM – dry matter; OM – organic matter; CP – crude protein; EE – ether extractives;
CF – crude fiber; NFE – nitrogen-free extractives; GE – gross energy; DM – dry matter; MFU - meat feed units; IDPN - intestinal digestible protein derived from nitrogen;
IDPE -intestinal digestible protein derived from energy

The chemical composition results suggest the existence of a lower difference between the feeding value of the sorghum grains and of the corn, than in reality, as also reported by older investigations (Rick Stock et al, 1974).

Feed and nutrient intake

The amounts of ingested feeds were similar both for the bulk forage (corn silage) and for the concentrates (CF), expressed as dry matter (table 6). The average intake of corn silage was 13.65 kg steer/day in the control group, 13.03 kg in group E1 and 12.93 kg in group E2, which means 4.38, 4.18 and 4.15 kg DM/steer/day. As shown in the table below, the compound feed represented about 50% of the diet, ranging between 4.69 and 4.73 kg DM. Overall, the steers ingested 8.33 to 8.59 kg DM/day.

Table 6. Average feed intake (kg/steer/day and kg DM/steer/day) and bulk forage (BF) to compound feeds (CF) ratio

Item	C	E1	E2
Corn silage – gross	13.65	13.03	12.93
Compound feed – gross	4.73	4.69	4.69
Corn silage – DM	4.38	4.18	4.15
Compound feed – DM	4.21	4.18	4.18
Total ingested DM	8.59	8.36	8.33
BF/CF ratio (%)	51/49	50/50	50/50

No significant fluctuations of the daily feed intake were noticed throughout the experiment, which shows the homogeneity of the animals from the three groups; their health state was optimal and supported proper animal performance.

Nutrient supply of the feeds

The feed intake data were used to calculate the supply of nutrients (energy, protein, calcium and phosphorus) and how much of the norm was provided (Table 7).

There were very small differences between the groups in terms of the energy and protein supply. Thus, the control group consumed daily 9.37 FUmeat, 725.85 g IDPN and 699.01 g IDPE, the experimental group I, 9.23 FUmeat, 705.61 g IDPN and 711.29 g IDPE, and the experimental group II, 9.29 FUmeat, 690.85 g IDPN and 714.47 g IDPE. This shows that all groups received 90.35 to 91.67% of their energy requirement and 111.97 – 117.64% (of their IDPN requirement) and 113.29 – 115.80% of the IDPE requirement).

Table 7. Nutrient supply of the diets and how much of the requirement was covered (g)

	Item	FUm	IDPN	IDPE	Ca	P
Control group	Dietary supply	9.37	725.85	699.01	56.87	36.99
	Animal requirement	10.22	617	617	60.28	33.71
	Supply/ requirement (%)	91.67	117.64	113.29	94.35	109.73
Experimental group I	Dietary supply	9.23	705.61	711.29	55.12	35.53
	Animal requirement	10.22	617	617	60.28	33.71
	Supply/ requirement (%)	90.35	114.36	115.28	91.44	105.39
Experimental group II	Dietary supply	9.29	690.85	714.47	54.24	33.92
	Animal requirement	10.22	617	617	60.28	33.71
	Supply/ requirement (%)	90.97	111.97	115.80	89.98	100.62

FUm - meat feed units; IDPN - intestinal digestible protein derived from nitrogen;
IDPE -intestinal digestible protein derived from energy; Ca – calcium; P – phosphorus;

The situation is different, however, for Ca and P supply, which were lower in the experimental groups (91.44% and 105.73% in group E1; 89.98% and 100.62% in group E2) than in the control group (94.35% and 109.73%), for Ca and P, respectively. However, the values range within the normal limits allowed by the used feeding system.

Body weight and average daily gain

The average daily gain was similar for the control group (1747.7 g) and for group E1 (1734.8 g) and lower for group E2 (1527 g), values comparable with those reported by Burlacu et al., 1998 cited by Georgescu, 2001, showing that this breed has a special capacity to convert optimised diet formulations into quality meat through a high fattening capacity. Table 8 shows a comparable performance of the control group with group E1 where the 20% sorghum grains replaced entirely the barley. On the other hand, in group E2, the total replacement of the corn from the concentrate mix (15%) and of 50% of the barley, decreased not significantly (P>0.0844) the weight gain by about 220 g.

Table 8. Body weight and average daily weight gains *

Item	Control	Experimental I	Experimental II
Average initial weight (kg)	296.88±33.88	268.13±20.38	295.25±33.00
Average intermediary weight (kg)	365.33±29.33	323.13±30.17	338.75±31.69
Average final weight** (kg)	438.50±25.83	396.50±32.13	408.25±23.94
Total gain (kg/animal)	141.62	128.37	113.00
Average daily gain ** (g/animal)	1.747.7±144.14	1.734.8±183.27	1.527±162.16

*average values and standard deviation
**same superscript in a line shows not significant differences (P≥0.05)

Although there were some differences in the average daily weight gain, they were not statistically significant (P>0.05); however, between groups C and E2 and between groups E1 and E2, there is a trend to influence the reference values (P>0.05 up to 0.10).

Feed conversion

Feed conversion ratio was correlated with steer performance expressed in DM, FUmeat, UDPN and IDPE, and showed that group E2 used the largest amount of energy and protein for one kg of gain (6.00 FUmeat, 460.10 IDP); this means that the animals from groups C and E1 used better the dietary energy and protein than the animals from group E2 (Table 9).

Table 9. Feed conversion ratio

Item	C	E1	E2
Kg DM/kg gain	4.91	4.82	5.45
Meat FU/kg gain	5.30	5.30	6.00
g IDPN/kg gain	415.30	406.70	452.40
g IDPE/kg gain	399.90	410.00	467.80

DM – dry matter; Meat FU - meat feed units; IDPN - intestinal digestible protein derived from nitrogen; IDPE -intestinal digestible protein derived from energy

Economic efficiency

The cost of feeding (Table 10) shows that the diet with 20 sorghum grains in the compound feed improved the intake of silage and compound feed and feed conversion ratio. The cost of feeding was 9% higher in group E2 treated with 30% sorghum grains in the compound feed than in the control group because of the lower average daily weight gain, thus of a poorer feed conversion efficiency; the differences, however, were not significant (P≥0.05).

Table 10. Cost of feeding

Item	C	E1	E2
Lei/animal/day	5.117	5.106	4.947
Lei/kg gain	2.93	2.90	3.20
Cost /kg gain - % compared to group C	100	99	109

CONCLUSIONS

In the conclusion, inclusion of 20% (E1) ground sorghum grains in the compound feed for fattening steers replacing completely the barley produced comparable results with the control group with no sorghum treatment. This inclusion level can be recommended to the farmers who fatten steers with silages, also being cost-efficient. On the other hand, the complete replacement

of the corn and almost half of the barley from the compound feed (E2) compared to the control group resulted in weight gains lower by about 220 g. Also, the increase of the dietary sorghum grains inclusion to 30% decreased steer performance while increasing the cost of feeding compared to control and E1, which shows a poorer use of the dietary energy and protein/kg gain, implicitly higher feeding costs.

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