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Influence of Diets with Different Ratio of Ground: Whole Sorghum Grain on Growth Performance of Feedlot Lambs

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Abstract: It was evaluated the influence of diets with different ratio of whole:ground sorghum grain on growth performance of feedlot lambs. Seventeen castrated males Rambouillet x Suffolk lambs of 20±5 kg initial weight were randomly assigned to 3 treatments (T) containing different proportions of ground (G) and whole (W) sorghum grain, T_1 = 100 G: 0W; T_2 = 50G: 50 W and T_3 = 0 G: 100 W. Lambs were weighed at the beginning of and every 15 days to estimate daily weight gain. Offered and refused feed was weighed daily to determine feed consumption. Feed efficiency was determined as daily DM consumption divided by daily weight gain. The experimental period lasted 60 days. Daily feed consumption, weight gain or feed efficiency were not affected by treatments ($p>0.05$), except for feed consumption from 31-60 days period, in which whole sorghum grain treatments (T_2, T_3) were higher (12%; $p<0.05$) than the ground sorghum grain treatment (T_1). It is concluded that whole sorghum grain may replace part or all the ground sorghum grain in diets, without affecting the productive performance of feedlot lambs.

Key words: Sorghum grain, sheep, feedlot, grain processing

INTRODUCTION

Grains increase energy density of diet, which optimizes production in the efficient intensive systems (Huntington, 1997). The finishing of lambs in high-energy diets improves ME intake, feed efficiency, ADG, nutrient digestibility, slaughtering characteristics and carcass weight (Haddad and Husein, 2004). However, high-grain diets may produce ruminal acidosis, which is caused by carbohydrates of fast fermentation, decreasing ruminal pH, with a reduction in feed consumption (Blood *et al*., 1993). It has been pointed out that acidosis is a digestive disorder caused by feeding more grain and less roughage as an attempt to improve the efficiency in beef production. Control of acidosis may be through nutritional management and no single solution exists; nevertheless some aspects can be considered: an effective dietary formulation, a consistent feeding program, proper bunk management, use of nonstarch by-products and feed additives to minimize pen-to-pen and animal-to-animal variations in feed intake (Nagaraja and Lechtenberg, 2007). Similarly, an alternative to reduce ruminal acidosis is to stimulate the saliva flow during rumination to neutralize ruminal pH (McBurney *et al*., 1983). It has been shown by Pérez (2000) in sheep that whole sorghum grain had longer rumination time with higher ruminal pH than ground sorghum grain.

In feedlot cattle, the advantage in sorghum grain processing was showed by Zinn *et al.* (2008), they found that ruminal digestion of OM and starch was greater (14 and 16%) for steam flaked sorghum vs. dry rolled sorghum. Steam-flaking sorghum increased and total tract digestion of OM (8.3%), N (8.2%) and starch (8.9%). Horadagoda *et al.* (2008) reported higher rumen OM degradability for processed than whole grains. In agreement, Bowen *et al.* (2007) found less starch in feces for expanded than whole sorghum grain. The high ruminal fermentation of processed grains also may reduce ruminal pH in low forage diets and it may affect feedlot cattle performance (Zinn *et al*., 2000). However, in feedlot lambs, the processing of corn or barley did not affect hay dry matter intake, ADG, the gain: feed ratio and warm carcass weight (Petit, 2000).

There is limited information in the use of whole or ground sorghum grain in diets for feedlot lambs. We

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hypothesized that the increase in whole sorghum grain in diet will provide more buffer to rumen through the saliva and it will increase feed consumption improving the growth performance of feedlot lamb fed high-grain diets. The present research was conducted to evaluate the growth performance of feedlot lambs fed high-grain diets with different proportions of ground and whole sorghum grain.

MATERIALS AND METHODS

Seventeen castrated males (Rambouillet × Suffolk) of 20±5 kg initial live weight were used. The animals were assigned at random to 3 Treatments (T) groups. Lambs were housed in individual pens. A lamb was considered as an experimental unit. The treatments were 3 different ratios of Ground (G) and Whole (W) sorghum grain in diets: T_1 (G) = 100:0; T_2 (G+W), 50:50; T_3 (W), 0:100, for G: W ratio, respectively. All diets were formulated to contain 70% sorghum grain (Table 1). Diets had same level of crude protein (14%) and energy (1.88 NEm and 1.25 NEg; Mcal kg^{-1} DM basis). The NDF was 14.5%, the non Structural Carbohydrates (NSC) 59.4%, Ca (0.70%) and P (0.50%). Nutrient content was estimated based on NRC tables for sheep (NRC, 1985). Feed was offered twice daily (9:00 and 15:00 h). Daily feed consumption was calculated (offered less refused). The amount of daily offered feed was 10% more than consumed. Fresh drinking water was *ad libitum*.

Because the animals came from range, they were progressively adapted to diet and management in a 20 days period; the first 2 days the animals received only forage, from 3-20 days the percentage of offered forage was reduced 25% per week until 25%, while, concentrate was increased in a similar proportion. During the adaptation period, the animals were treated against internal and external parasites and vitamins (A, D, E) were applied. Animals received a wide spectrum bacterine against clostridial infections. The animals were housed in individual covered pens (2×1.5 m) with feeder and drinker. The experimental period lasted 60 days.

Daily samples of offered and refused feed were obtained and kept in refrigeration until analysis. Samples were analyzed for Dry Matter (DM) at 105°C. The Non-Structural Carbohydrates (NSC) were calculated with the equation: NSC (%) = DM – [CP + EE + ash + NDF] (Mertens, 1979).

Lambs were weighed at the beginning of the trial after a 12 h fast period, repeating the procedure every 15 days. Live weight was recorded at the same time (8:00 h) before of first meal of day. Daily weight gain was the difference between initial and final weight divided by the considered days of the experiment. The DM consumption was calculated as the difference between the DM offered and DM refused feed. Feed conversion was estimated dividing daily DM consumption by daily weight gain.

Table 1: Experimental diets with different ground:whole sorghum grain ratio in lamb feeding (% DM basis)

	Ground:Whole sorghum grain ratio		
Ingredients	100:0 (T_1)	50:50 (T_2)	0:100 (T_3)
Ground sorghum	70.0	35.0	----
Whole sorghum	----	35.0	70.0
Soybean meal	10.5	10.5	10.5
Sugar cane molasses	7.5	7.5	7.5
Alfalfa hay	10.0	10.0	10.0
Premix*	2.5	2.5	2.5

*MNA de México S.A. (calcium carbonate, dicalcium phosphate, sodium chloride, ammonium sulfate, zinc sulfate, ferrous sulfate, magnesium oxide, cupper sulfate, cobalt sulfate, Dihydroiodine Etilendiamine (DHIE), sodium selenite, vitamins A and E, sodium monensin and antioxidant)

The experiment data were analyzed as a one-way design, using different repetitions per treatment, T_1 and T_2 had 6 lambs each 1 and T_3 with 5 experimental units. The data were adjusted by covariant. Each animal used represented an experimental unit (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The growth performance of lambs fed diets with different ratio of ground and whole sorghum grain is shown on Table 2. Dry matter consumption from 31-60 days of the trial showed that whole sorghum grain treatments (T_2, T_3) were higher (12%; $p<0.05$) than the ground sorghum grain treatment T_1, while T_2 and T_3 were similar ($p>0.05$). There were no treatment effects ($p>0.05$) on daily weight gain, feed efficiency and for DM consumption for period from 1-30 days and total feeding trial (1-60 days).

In agreement with present results, others have observed higher feed consumption in animals fed whole cereal grains (Orskov and Greenhalh, 1977; Mancilla *et al*., 1995). Consistently, Hejazi *et al*. (1999) in diets with whole and ground corn grain reported higher dry matter consumption in lambs fed whole corn grain. Similarly, Preston and Willis (1974) pointed out that DM consumption in cattle decreases with the grinding of grains. In contrast, Oviedo (2002) using whole and ground sorghum grain in sheep diets found that as whole sorghum grain was increased in the diet, there was a decrease in feed consumption from 1099-951 g $days^{-1}$. Fimbres *et al*. (2002) also observed higher DM consumption in lambs without sorghum grain in ration, compared to those fed whole sorghum grain.

In relation to inclusion percentages of grains in diets, Gómez *et al*. (1982) observed that increasing the percentages of whole grains in diets increased dry matter consumption. This situation was observed in the present

Table 2: Growth performance of lambs fed diets with ground and whole sorghum grain in rations

	Ground: Whole sorghum grain ratios				
Item	100 G:0 W	50 G:50 W	0 G:100 W	SEM	p-value
Initial weight (kg)	25.792	25.492	26.900	0.580	0.612
Final weight (kg)	37.750	38.750	40.280	0.740	0.577
1-30 days					
DM consumption (kg days^{-1})	0.962	0.976	1.052	8.230	0.618
Weight gain (kg days^{-1})	0.212	0.249	0.258	9.740	0.196
Feed conversion	4.530	3.990	3.860	0.209	0.368
31-60 days					
DM consumption kg days^{-1}	1.006a	1.169b	1.085b	24.930	0.048
Weight gain (kg days^{-1})	0.186	0.194	0.222	0.018	0.740
Feed conversion	5.280	5.960	4.880	0.484	0.807
1-60 days					
DM consumption kg days^{-1}	0.981	1.063	1.078	18.140	0.141
Weight gain kg days^{-1}	0.199	0.221	0.242	7.210	0.138
Feed conversion	4.960	4.800	4.450	0.203	0.520

Different literals in the same row differ ($p<0.05$)

research, since increasing whole sorghum grain in diet, it was observed an increase in dry matter consumption. However, Arciga and Gómez (1991) reported a diminution in consumption of diets using 88% of whole sorghum grain.

According with, Baumgardt (1974) the regulation of feed consumption in sheep is dependent on digestible energy content in diet; therefore, low digestible diets will be more consumed than those high in digestibility. For present trial all diets were formulated with the same energy content; because of this, the difference in feed consumption may be attributed to grain processing. It is possible that diets with whole sorghum grain provided more buffer to rumen through more chewing and saliva supply. Also, diets with whole sorghum grain were fermented slowly in rumen, compared with the ground sorghum grain diet. The high fermentation in the diet with ground sorghum grain increased VFA production, which might reduce ruminal pH, affecting feed intake. In addition, whole sorghum grain in feedlot lamb diets could have better rumen environment that increased feed consumption. This sense, Pérez (2000) found that sheep fed 75% whole sorghum grain had longer rumination time; with ruminal pH of 6.9, but increasing ground sorghum grain in diet; ruminal pH was reduced to 6.3.

In grain type (corn, wheat, oat, or sorghum) used in sheep and cattle diets Sindt *et al.* (1993), reported diminution in consumption of diets with sorghum, compared to the corn grain diet. However, Orskov *et al.* (1974) did not find effect in dry matter consumption using whole grains of barley, corn, oat and wheat.

In present study for the entire experiment (1-60 days), the feed conversion and daily weight gain did not show statistical difference between treatments. However, diets with whole sorghum grain (T_2 and T_3) tended ($p = 0.13$) to better weight gain than the diet with ground sorghum grain (T_1). Lambs in diets with whole sorghum grain had 16% more weight gain than diet with ground sorghum grain. Similarly, lambs in diets with whole sorghum grain tended ($p = 0.14$) to better feed consumption than the diet with ground sorghum grain. Lambs in diets with whole sorghum grain had 9% more feed consumption than diet with ground sorghum grain.

For first period of trial (1-30 days), although weight gain did not show statistical difference between treatments, however diets with whole sorghum grain (T_2 and T_3) tended ($p = 0.19$) to better weight gain than the diet with ground sorghum grain (T_1). Lambs in diets with whole sorghum grain had 19.5% more weight gain than diet with ground sorghum grain.

In present experiment, feed efficiency (1-60 days) was of 4.96, 4.80 and 4.45 for T_1 to T_3, respectively, although no statistical, the diet with only whole sorghum grain (T_3) improved 10.3% feed conversion (feed/gain) compared with lambs in only ground sorghum grain in diet (T_1). It was found better daily weight gain and feed conversion in sheep fed 75% of sorghum grain (Stanton and Swanson, 1992; Arciga and Gómez, 1991). Also, Gómez *et al.* (1982) found this effect in ovine feeding, using 80 and 60% of whole sorghum grain in diet. In agreement, others (Gutiérrez and Lara, 1995; Mancilla *et al.*, 1995; Hanke and Jordan, 1963) showed that whole cereal grains increased productivity compared to processed cereals grains in small ruminants, maybe because sheep have ability to break whole grains during chewing, which may produce better ruminal environment, through saliva production and microbial fermentation, without detriment in digestibility. Same sense, Hejazi *et al.* (1999) reported higher weight gain with whole corn grain than ground or pelleted in diets; they concluded that the grinding of gains in high-energy rations did not improve growth performance and the inclusion of some fiber could improve feed consumption and daily weight gain, even if grain is ground or in pellets. The positive effect of fibre in feedlot cattle was demonstrated by Zinn *et al.* (2000), who found that when sudangrass hay is the main fibre source

in steam-flaked corn-based finishing diets, growth performance is optimized when forage level is 15%; below and above this level, ADG decreased. Another, way to improve ruminal environment in high-concentrate rations is the use of additives. Kawas-Garza *et al.* (2007) using sodium bicarbonate in lamb diets, found increased ($p<0.05$) DM intake. However, for present research is possible that whole sorghum grain provided better ruminal environment than ground grain, through slower carbohydrate fermentation and more saliva production by longer time for chewing and rumination and maybe sodium bicarbonate is not necessary.

For present experiment, the ground of sorghum grain did not improve feed efficiency. In agreement, Bowen *et al.* (2007) concluded that processing sorghum grain by cracking or expanding did not significantly improve lamb performance, however additional N with whole sorghum grain increased lamb performance. Also, Petit (2000) reported that cereal processing had no effect on hay dry matter intake, ADG, the gain:feed ratio. This effect is opposite to cattle, which strictly need processed cereal; this sense, Church (1977) pointed out that productive efficiency is improved when some grain is ground, broken, rolled and/or flaked. In agreement, Zinn *et al.* (2008) reported that body weight gain averaged 1.49 kg days^{-1} and was not affected ($p = 0.47$) by treatments, however steam flaked corn reduced ($p<0.01$) DMI (9%) and enhanced ($p<0.01$) G:F (13%) and the NE_m and NE_g value of the diet (9 and 11%, respectively). In contrast with present research, an improvement in weight gain and feed efficiency was reported using ground sorghum, compared with whole grain (Oviedo, 2002), however diet composition like forage level or additives may have influence on growth performance.

CONCLUSION

Although, our hypothesis is rejected because the substitution of ground by whole sorghum grain in high-concentrate rations is without effect on growth performance of feedlot lambs. However, this represents a benefit in energy saving, which is required for the sorghum grain grinding.

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