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Effect of Corn Grain Particle Size on Nutrient Digestibility of Awassi Rams Fed High and Low Level Alfalfa Containing Diets

[1]Can, A., [2]N. Denek, [1]E. Alicioglu, [1]K. Yazgan, [1]M. Seker and [2]H. Ipek
[1]Department of Animal Science, Faculty of Agriculture, University of Harran, Sanliurfa, Turkey
[2]Faculty of Veterinary Medicine, University of Harran, Sanliurfa, Turkey

Abstract: Two apparent digestion trials were conducted to determine the effect of corn grain particle size on nutrient digestibility using nine Awassi ram lambs (48.3 ± 3.2 kg). They were allocated to three treatments (3 per treatment) at random within live weight. Three treatments were used in completely randomized design with three millings degrees which included: 4mm (fine), 6 mm (coarse) and (70%) coarse + whole grain (30%) (coarse+whole) of ground corn in both apparent digestion trials. Corn:alfalfa ratios were 40:60 in trial 1 and 85:15 in trial 2. Diets were offered 2.5% of body weighs as fed basis. In trial 1, corn particle size did not DM, OM and ADF digestibility (P>0.05). Moreover, rumen fluid pH and protozoa number did not change due to dietary treatments (P>0.05). Crude protein digestibility was greater for coarse than the other two dietary treatments. In trial 2, Finely grinding decreased DM and OM digestibilities (P<0.05). Acid Detergent Fibre and CP digestibilities were not altered by the treatments (P>0.05). Rumen fluid pH was lower for finely grinding (P<0.05) compared to coarse or coarse+whole. Protozoa number also numerically decreased with finely grinding. As a result, there was no advantage of feeding finely ground corn compared with the coarsely ground or coarse+whole corn on nutrient digestibility and ruminal parameters.

Key words: Corn, Particle size, Awassi, Digestibility

Introduction

Starch utilization may be markedly enhanced by proper grain processing; however, extent of improvement may depend on the ruminant species, grain source and method of processing. Grain processing has less impact on starch digestion by sheep than cattle (Theurer, 1986). Whole cereal grains can appear in the feces of sheep, but the fibre of digested grain is usually digested more completely so that the net effect is often an increase rather than a decrease in digestibility (Tait and Byrant, 1973). Physical processing of whole grain, such as grinding, increased the digestibility of starch in the rumen and total tract and increased digestibility of starch postruminally (Orskow, 1986; Owens *et al*., 1986; Theurer, 1986), thereby improving the availability of energy from the grain (Joy *et al*., 1997). Processing grains by grinding disrupts the starch granule and increases starch digestibility in cattle, primarily through increasing amount of starch digested in rumen (Nocek and Tamminga, 1991). Reducing particle size of corn sorghum grains resulted in a increase in digestibility (Galyean *et al*., 1981). Anderson *et al*. (1988) suggested that reducing the particle size of ground feedstuffs would cause a greater surface area and improve digestion compared with whole feedstuffs. Starch of the corn is less ruminally degradable than that of barley (Herrera-Saldana *et al*., 1990) and its digestibility generally increases following processing while that of barley does not change (Theurer, 1986).

The aim of this study is to determine effect of different particle sizes of corn grain on nutrient digestibility and ruminal parameters of Awassi rams fed high and low level alfalfa containing diets.

Materials and Methods

Nine, 2 years old Awassi rams (48.3 ± 3.2 kg) were used as experimental animals in apparent digestion trials. They were allocated to three treatments (3 per treatment) at random within live weight. Three treatments were used in completely randomized design with three millings degrees which included: 4mm (fine), 6 mm(coarse) and 70% coarse + 30% whole grain (coarse+whole) of ground corn in both apparent digestion trials. Corn:alfalfa ratios were 40:60 in trial 1 and 85:15 in trial 2 respectively. Diets were offered 2.5% of body weigh as fed basis. Also mineral blocks was offered on an ad-libitum basis. Ingredients and chemical composition of diets fed to rams are presented in Table 1. Periods consisted of a 15-day diet adaptation and 7-day feces collection. During the collection periods, the experimental animals were fed at 15:00 with free access to water at all times. Collection of feces was accomplished by housing the animals in crates and animals were fitted with specialized harnesses and bags which facilitate total collection of feces. Feces were collected after excretion and bulked daily for total weight determination and a 10% representative sample was composited for individual animals. All the diet and fecal samples were preserved in sealed polyethylene bags stored in freezers until chemical analyses.

Rumen fluid pH values were measured immediately following 3 hrs. feedings by pH meter. Rumen fluid was filtered through four layer cheese cloth and 10 ml filtrates stored at +4 C in refrigerator after addition of 2-3 drops of

formaldehyde for counting of microorganism. Protozoa were counted according to method described by Boyne *et al*., (1957). Fecal samples were dried in an oven at 65 °C for 48 hrs. Fecal and diet samples were ground to pass 1mm screen for chemical analysis. Dry matter (DM), organic matter (OM) and crude protein (CP) of diet and fecal samples were determined (AOAC, 1990). Acid detergent fibre (ADF) was determined as described by Goering and Van Soest, (1970).

Statistical Analysis: Data for nutrient digestibility and rumen parameters in both trials were analyzed using a model for completely randomized design (CRD) using GLM procedure and means were compared using Fisher's least significant differences (SAS, 1989).

Results and Discussions

In trial 1, effect of corn grain particle size on nutrient digestibility and rumen parameters of rams fed 40:60 ratio of ground corn and alfalfa hay are presented in Table 2. Corn particle size did not affect digestibility of DM, OM and ADF (P>0.05). Moreover, ruminal fluid pH and protozoa number did not change by treatments (P>0.05). Crude protein digestibility was greater for rams fed coarse compared fine or coarse +whole corn. In trial 2, effect of corn grain particle size on nutrient digestibility and rumen parameters of rams fed 85:15 ratio of ground corn and alfalfa hay are presented in Table 2. Finely grinding corn decreased DM and OM digestibility (P<0.05). Acid Detergent Fibre and CP digestibilities were not altered by dietary treatments (P>0.05). Ruminal fluid pH was lowered by finely grinding (P<0.05) compared to coarse or coarse +whole corn. Protozoa number was also numerically decreased with finely grinding.

Corn particle size in high level of alfalfa containing diet (in trial 1) did not change DM and OM digestibility, but in low level alfalfa diet (trial 2), finely grinding of corn lowered (P<0.05) DM and OM digestibility compared with diets containing of coarse, or coarse + whole corn. Collison *et al*. (2001) found that fine grinding of corn may have only modest impacts on total tract OM digestibility.

Table 1: Ingredients and chemical composition of diets consumed by rams in the trials

Item	Trial 1			Trial 2		
	Fine	Coarse	Coarse+whole	Fine	Coarse	Coarse+whole
Ingredient Composition	% as fed basis					
Corn	40	40	40	85	85	85
Alfalfa	60	60	60	15	15	15
Chemical Composition (as fed basis, %)						
Dry matter	89.87	89.97	90.94	88.26	88.64	89.55
Organic matter	84.04	84.26	84,97	86.33	86.66	87.24
Crude protein	13.48	13.97	13.49	9.74	9.87	10.23
ADF	21.77	21.30	20.25	9.36	9.56	9.91

Finely ground, 4mm; coarsely ground 6mm; 70% coarse+ 30% whole grain

Table 2: Effect of corn grain particle size on nutrient digestibility and rumen parameters of rams fed high and low level alfalfa containing diets

	Treatments							
	Trial 1				Trial 2			
Item	Fine	Coarse	Coarse+whole	SE	Fine	Coarse	Coarse+whole	SE
DM Digestibility,%	74,78[a]	75,61[a]	75,42[a]	0,63	67,88[b]	82,77[a]	79,44[a]	2,70
OM Digestibility,%	76,85[a]	77,52[a]	77,71[a]	0,65	69,02[b]	83,84[a]	80,89[a]	2,55
ADF Digestibility,%	52,62[a]	51,03[a]	49,30[a]	1,80	45,05[a]	52,88[a]	44,30[a]	7,97
CP digestibility,%	70,88[b]	73,79[a]	70,75[b]	0,42	57,33[a]	64,68[a]	58,06[a]	4,63
Rumen pH	5,73[a]	6,1[a]	5,90[a]	0,24	4,98[b]	5,37[ab]	5,77[a]	0,16
Protozoa number per ml of rumen fluid	347774[a]	401477[a]	222779[a]	96039	79443[a]	173887[a]	134166[a]	47586

Finely ground, 4mm; coarsely ground 6mm; 70% coarsely + 30% whole grain

[ab]= Means within a row in each trial with different superscripts differ (P<0.05).

In contrast, Hejazi *et al.* (1999) reported that whole corn improved DM and OM digestibility compared with ground corn in sheep fed high concentrate diet. The current study indicates that corn particle size did not affect DM and OM digestibility in high forage diet, but coarsely grinding of corn improved DM and OM digestibility in rams fed a high concentrate diet. In both trials, adding whole corn to coarsely grinding ground corn did not enhance OM and DM digestibility. Conversely, Hejazi *et al.* (1999) observed that whole corn has a "fiber effect" on ruminal papillae, which can lead to greater surface area for absorption of volatile fatty acids compared with processed corn. In the previous studies, reducing corn particle size increased digestibility of DM and OM when diets were fed less than twice maintainance (Galyean *et al.*, 1976; Murphy *et al.*, 1994) which is not the case in this study when rams were fed 2.5% of body weigh as fed basis.

Digestibility of ADF was not affected by treatment in both trial ($P>0.05$). Tjardes *et al.*, (1998) reported that ADF digestibility was not different regardless of whether the corn in limit-fed diet was craked or whole. Controversy, Hejazi *et al.*, (1999) indicated that apparent digestibility of ADF was greater for whole corn compared with ground corn in high concentrate diet. Coarsely ground corn including diets had a higher CP digestibility than other treatments in the high alfalfa containing diets ($P<0.05$). There wasn't any significant difference in CP digestibility among the treatments in low alfalfa containing diets ($P>0.05$). In contrast, Hejazi *et al.* (1999) reported that lambs fed whole corn had a greater N digestion compared with lambs fed ground corn. In our case, adding whole corn to coarsely ground corn did not had any improvement in CP digestion. Paziani *et al.*, (2001) reported that milling degrees of corn grain did not have affect CP digestibility which is in line with results of trial 2.

Ruminal pH was not different among treatment in trial 1($P>0.05$), but in high concentrate diets, feeding coarse+whole corn resulted in a higher pH value than feeding finely ground corn ($P<0.05$). Murphy *et al.* (1994) reported that feeding rolled corn in concentrate diets result in decreased ruminal pH for 9 hour after feeding compared with whole corn. In contrast, Paziani *et al.* (2001) observed that milling degrees of ground ear corn did not affect ruminal pH. If ruminal pH remains low, destruction of papillae and damage to linings of the intestines may result in poor absorption of nutrient and poor digestibility. Change in ruminal fluid pH in high concentrate diet may suggest that buffering within the rumen was inadequate for diet containing finely ground corn. Whole corn in trial 2 might have "fiber effect" as mentioned previously by Hejazi *et al.* (1999). Treatments in both trial did not affect the ruminal fluid protozoa number ($P>0.05$). Yakoyama and Johnson (1993) mentioned that feeding smaller amount of concentrate actually stimulates higher concentrations of protozoa in the rumen. With the pH maintained at about 5.5, large numbers of protozoa may be present in the rumen, but below 5.5 their numbers are greatly depressed. In our current study, feeding finely ground corn treatment in diets with a high concentrate level resulted in lowest pH and numerically lowest protozoa numbers.

Conclusions

There was no advantage of feeding finely ground corn compared with feeding coarsely ground or a mixture of whole and coarsely ground corn for nutrient digestibility and ruminal parameters in sheep. Conversely, coarsely grinding should be preferred in high concentrate diets. Additionally, whole corn may maintain higher ruminal pH and improve nutrient utilization in high concentrate diets.

Referances

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