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Effects of Different Levels of Zeolite on Digestibility and Some Blood Parameters in Arabic Lambs

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Abstract: In this study effect of different levels of zeolite on digestibility and some blood parameters in Arabic lambs investigated. In this experiment a change-over design with eigth Arabic lambs with an average live weight of 35±2 selected. Foure rations and foure period was employed. The 4 treatments were: control groups, C+ 3%, C+ 6% and C+ 9% zeolite. The rations were fed to lambs as total mixed feed offered and orts and fecal samples were recorded daily. Blood samples were collected on the end of each period. Plasma glucose concentration was not significantly affected by treatment but tended to be lower with added zeolite. Conversely, the dietary inclusion of resulted in a lower plasma urea-N concentration ($p<0.05$). Intake of DM was higher for lambs receiving zeolites ($p>0.05$). Digestibility of DM was lowered with added zeolite ($p<0.05$). Digestibility of CP and NDF were increased by inclusion of 6% zeolite. This difference was significant ($p<0.05$) but digestibility of ADF was not significantly affected ($p>0.05$).

Key words: Arabic lambs, zeloite, digestibility, blood parameters, CP, NDF

INTRODUCTION

Natural zeolites are a family of minerals of volcanic origin that are made of crystalline aluminosilicates with excellent ion exchanging properties. Zeolite has been increasingly used in various application areas such as industry, agriculture, environmental protection and even medicine (Mumpton and Fishman, 1977). Due to unique ability of rumen microbes, ruminant animals may produce protein in their rumen without getting any protein resources in their diet. Microbial proteins together with dietary proteins which escape ruminal degradation are utilized in small intestine. Nitrogen source for microbes in the rumen are protein feed ingested, non-protein nitrogen and nitrogen recycled to rumen for re-utilization (Owens and Zinn, 1988).

However, when add urea to the diet precaution should be exercised. Urea toxicity happens when large amount of urea is added to diet and ingested and it is hydrolyzed to ammonia and CO_2 by enzymatic actions. Ammonia is toxic to animal cells at low levels (Visek, 1978). Thus using some treatments to regulate ammonia concentration in rumen could be useful in terms of ammonia toxicity and microbial growth. Zeolite, with cation exchange property, binds ammonia to its structure when concentration in the rumen is high and releases bound ammonia to the rumen when its concentration in the rumen is low (Pond, 1993). Therefore, a decreasing effect of a clinoptilolite containing diet on BUN concentration (Pond, 1984) and an increasing one mesenteric blood glucose concentration (Nestorov, 1984). The potential for zeolite to release ions gradually in the rumen could prove its advantage to microbial synthesis and to the animal itself (Johnson *et al*., 1988). Organic-matter digestibility (3.5-4.5%) was increased by the addition of clinoptilolite to the diet. This response may be related to physical and chemical interactions between clinoptilolite, rumen microbes and forage fiber particles (Sweeney *et al*., 1984). The zeolite had an effect on acid-detergent fiber (a major component of organic-matter) digestion, increasing fiber digestibility possibly due to the maintenance of suitable levels of NH_3 for enhanced microbial growth in the rumen (Sweeny *et al*., 1984). The main objective of the presented study was to investigate the effects of zeolite as feed supplement on the digestibility of nutrient and blood parameters of Arabic lambs.

MATERIALS AND METHODS

The sheep were eight Arabic lambs (average weight 35±2 kg; 5 months of age; n = 2/treat/period) that were housed indoors and confined in metabolism cages and were fed individually *ad libitum*. The sheep in each

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Table 1: The ingredients of experimental diets

Dites	Treatment (%) 1	2	3	4
Soybean meal	5	4	3	2
Wheat meal	16	15	14	13
Barely	45.36	44.36	43.36	42.36
Alfalfa	8.9	8.9	8.9	8.9
Corn silage	15.9	15.9	15.9	15.9
Hay	8.2	8.2	8.2	8.2
Mineral and vitamin	0.5	0.5	0.5	0.5
Urea	0.14	0.14	0.14	0.14
Zolite	0	3	6	9

treatment were assigned to four treatments during four periods. Each experimental period was 17 days, with a 10 days adaptation period and 7 days sample collection period; offered feed and orts were recorded daily and sampled during these 7 days. In the end of 7 days periods all feces and orts of each animal were mixed and one sub-samples stored at -20°C for further analysis. The experimental treatment include: control diet (non zeolite), control diet plus 3% zeolite, control diet plus 6% zeolite and control diet plus 9% zeolite. The diets were iso-caloric and iso-nitrogenous, which formulated according to NRC (1985). The ingredients of experimental diets and their nutrients are shown in Table 1 and 2, respectively.

At the end of each period blood samples were taken through jugular vein at 4 h after morning feed, then centrifuged (3000 rpm, 15 min for separating of plasma) and used for measurement of glucose and Blood Urea Nitrogen (BUN) concentration. The glucose and BUN were assayed by spectrophotometer with laboratory commercial kits. Diets and faeces samples were dried (60°C, 48 h) and ground in a weley mill (1 mm). Samples were analyzed for DM (60°C, 48 h) (Memmert-854 schwabach-w, Germany), Crude Protein (CP) (Tecator, Kjeltec Auto 1030, Sweden), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) (Van Soest and Wine, 1967).

This experiment was carried out in a change over design set as several Latin square; 8 Arabic lambs were allotted to 4 diets with following model:

$$Y_{ij(k)m} = \mu + T_i + S_j + G_{k(j)} + P_{m(j)} + \varepsilon_{ij(k)m}$$

Where:

$Y_{ij(k)m}$ = Observation ij(k)m
μ = The overall mean
T_i = Effect of treatment i (i = 1-4)
S_j = The effect of square j (j = 1-2)
$G_{k(j)}$ = The effect of animal k within square j
$P_{1(j)}$ = The effect period l within square j
$\varepsilon_{ij(k)m}$ = Random error with mean

Table 2: Nutrients of experimental diet

Items	Amount
DE (Mcal kg^{-1} DM)	3
NEg (Mcal kg^{-1} DM)	1.30
CP (DM%)	11
NDF (DM%)	32.1
ADF (DM%)	15.1
Ca (DM%)	0.34
P (DM%)	0.21

TDN = Total Digestible Nutrient

RESULTS AND DISCUSSION

Glucose and BUN concentration in plasma are shown in Table 3. Glucose concentration of lambs fed 3% zeolite were increased compared with lambs that fed diet contain 0 and 9% zeolite, however this difference was not significant ($p>0.05$). The used of zeolite in diets could cause an increase in rumen pH and acetate to propionate ratio, therefore concentration of glucose in plasma will be decreased. Zeolite with ion-exchange property significantly decreased plasma BUN in lambs fed diets with 9% zeolite ($p<0.05$). Zeolite adsorbs inordinate of the ammonia generated from NPN and act as a reservoir and slowly release it in rumen. This action happens when animals ruminate. When animals ruminate, the bolus is regurgitated from rumen and is re-chewed in the mouth and re-swallowed thus saliva introduced during mastication contains sodium which replaces the ammonium. Thus slow release of ammonium due to replacement with sodium allows rumen micro-organisms to synthesize cellular protein that is easily digested by animals's digestive system (Koknarroglu *et al*., 2006). Dry matter intake of control group was lower than those received zeolite, which this difference was not significant ($p>0.05$). These results confirmed previous research (Koknarroglu *et al*., 2006). Apparent digestibility of nutrients obtained by total collection is shown in Table 4. Digestibility of DM decreased ($p<0.05$) when zeolite was added to diets, although only treatment containing 9% zeolite had significant difference with control (64.41 vs. 69.96%, respectively). Part of this reduction can be attributed to the consumption of the indigestible zeolites itself (Johnson *et al*., 1988). Decreases in DM digestibility can be cause decreases of digesta passage and decreases of consumption of feed.

Digestibility of CP was increased by present of zeolite in diets. Inclusion 6% zeolite in Arabic lamb diets had the highest digestibility of CP (67.04 vs. 64.68%, respectively). This difference was significant ($p<0.05$). Higher digestibility of CP can be attributed to the zeolite application. Since zeolite have special properties such absorption of moisture and adsorption of gases (Mumpton and Fishman, 1977). Zeolite acts as a reservoir for the nitrogen and during mastication release of ammonium and replacement with sodium allows rumen micro-organism to synthesize cellular protein that is easily

Table 3: Concentration of glucose and urea in plasma

Items (mg dL^{-1})	Zeolite (%) 0	3	6	9	SEM
Glucose	65.37	66.63	58.50	61.63	4.32
BUN	14.56^{a}	13.24^{a}	13.40^{a}	10.26^{b}	0.79

Numbers in the same rows followed by the different letter are significantly different ($p<0.05$); SEM: Standard Error of Mean; BUN: Blood Urea Nitrogen

Table 4: Effect of dietary treatment on digestibility

Item (%)	Zeolite (%) 0	3	6	9	SEM
DMD	69.96^{a}	68.20^{a}	66.06^{ab}	64.41^{b}	1.24
CPD	64.68^{a}	64.80^{ab}	67.04^{ab}	61.79^{b}	1.17
NDFD	33.67^{c}	37.98^{b}	44.47^{a}	35.62^{bc}	1.05
ADFD	34.52^{a}	31.84^{ab}	30.39^{ab}	24.47^{c}	1.13

Numbers in the same rows followed by the different letter are significantly different ($p<0.05$); DMD: Dry Matter Digestibility; CPD: Crude Protein Digestibility; NDFD: NDF Digestibility; ADFD: ADF Digestibility; SEM: Standard Error of Mean

digested by animal's digestive system (Koknarroglu *et al*., 2006). Digestibility of NDF was significantly affected by treatment containing 6% zeolite ($p<0.05$) but digestibility of ADF in control diet had no significant difference by diets containing 3 and 6% zeolite. In this aspect the results conflicts with previous report (Johnson *et al*., 1988).

The potential impact of zeolite on rate of digesta passage involves a possible attraction of zeolite for fiber particles and rumen micro-organisms.

It was hypothesized that a physical association of these fractions may alter the rate of passage and digestibility of fiber particles. The high affinity of zeolite for water and osmotically active cations may facilitate an interaction between fiber and bacteria and the osmotic activity could cause alteration in the rate of liquid flow through the rumen (Johnson *et al*., 1988; Sweeny *et al*., 1984). Rumen pH was increased when zeolite was added (Johnson *et al*., 1988) to the diets. Improve in pH of rumen lead to more favorable environment for the microbial fermentation and follow that increase of fiber digestion will be happened (Johnson *et al*., 1988; Sweeny *et al*., 1984).

CONCLUSION

This study indicated that lambs receiving zeolite in feedlot had less glucose and BUN concentrations. The addition of zeolite improved digestibility of NDF and CP in Arabic lambs. The data demonstrated that zeolite alters protein metabolism as reducing BUN and may lead protein digestion to intestine. It was concluded that supplementation of diets with 6% zeolite had appreciable effect on rumen fermentation and digestibility of nutrients in sheep. Zeolite decreased the risk of toxicity and acidosis by preventing to increase of ammonium in the blood and rumen pH, respectively, may one can use diets with high urea when zeolite add to diets, which should be study.

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