Growth Performance, rumen fermentation and blood constituents of goats fed diets supplemented with bentonite

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Summary :

Fifteen six months' old male Angora goats, weighing on average 12.9 kg were randomly assigned in three groups of five kids each in an 84 days' feeding trial. Animals were fed rations that consisted of concentrate mixture (CM) and urea (3%) treated rice straw. Urea treated rice straw (UTRS) was offered ad-libitum. Bentonite was mixed for each group with the (CM) before feeding at the rate of 0, 2.5 and 5%.

Three digestibility trials using three animals from each treatment were carried out at the end of the feeding trial to evaluate the nutritive value of these experimental diets.

Results showed that inclusion of bentonite significantly (P< 0.05) increased the daily gain of kids without a significant difference between bentonite groups (2.5 and 5%) in this respect. Bentonite significantly (P< 0.05) increased dry matter (DM), organic matter (OM) and crude protein (CP) digestibilities.

Results also showed that the addition of bentonite to the ration of kids caused a significant (P< 0.05) improvement in feed conversion efficiency. The nutritive value (%) expressed as TDN showed an increase in the treatment with bentonite in comparison to the control group. The nitrogen balance of bentonite groups was significantly (P< 0.05) higher than the non-treated control addition of bentonite to the ration containing urea-treated rice straw which led to a decrease in ruminal ammonia nitrogen concentration.

Bentonite did not have an effect on either propionic acid or butyric acid concentration and also had no effect on cholesterol, glucose and haemoglobin in the blood serum.

Introduction

Bentonite is an inorganic material with great ability for increasing absorption and for base exchange (SALEH 1994). Bentonite absorbs toxic productions of digestion and decreases the accumulation of toxic substances in tissues, thus decreasing the occurrence of internal disorders (HUNTINGTON et al., 1977). Bentonite has the ability to adsorb ammonia from a solution when the concentration of ammonia is high, and to release it when the concentration falls (MARTIN et al., 1969 and SALEH, 1994). Therefore, the addition of bentonite to the diet can partly equalise the supply of nitrogen to the rumen micro-organisms, so bentonite could be considered a useful material in animal rations to improve its nutritive value (GHANEM 1995). This study aimed to investigate the effect of adding levels of bentonite to rations in goat feed containing rice straw treated with urea solution (3%) on their performance, blood constituents, digestibility of the nutrients and feeding value.

This experiment was carried out at the experimental farm of the Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt.

Materials and Methods

Fifteen male Angora goats with an average body weight 12.9 kg were randomly assigned to three groups of five kids each in an 84 days' growth experiment. Animals were fed separately in semi-opened pens' rations that consisted of concentrate mixture (CM) containing 25% undercortecated cotton seed cake, 20% yellow corn, 25% wheat bran, 16% rice bran, 5% rice hulls, 5% molasses, 3%

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lime stone, 1% common salt and urea-treated rice straw. Rice straw was spread on the concrete floor and sprayed with 3% urea solution. Urea solution was prepared by dissolving 3 kg of urea in 50 kg water to be sprayed on 100 kg rice straw. Treated rice straw was tightly covered with a polyethylene sheet for 3-4 weeks and aerated for 2 days before feeding. Urea-treated rice straw (UTRS) was offered ad-libitum. The concentrate part of the ration was offered to the animals twice daily in almost two equal meals at 8 a.m. and 4 p.m. Water was available at all times. Bentonite was mixed for each group with the concentrate mixture before feeding. The daily amounts of concentrate mixture were adjusted bi-weekly according to individual changes of the experimental animal body weight to cover their requirements according to NRC (1981). 3% molasses was added to UTRS before feeding, 0.10% sulphur, 0.50% mineral mixture and 0.10% vitamins mixture (AD3 and E) were supplemented to all rations from the CM. Bentonite was mixed at the rate of 0, 2.5 and 5% with the CM.

Three digestibility trials using three animals from each treatment were carried out at the end of the feeding trial which lasted for 84 days. Each digestibility trial lasted for 21 days, whereby the first 14 days were for animal adjustments with the metabolic crates and the following 7 days to collect the faeces and urine. Chemical composition of feeds (Table 1), faeces and urine were determined according to A.O.A.C, (1984). Rumen samples were collected from each animal (the same three animals) by stomach tube, three hours after the morning feeding at the end of each digestibility trial. Ruminal pH was determined directly by a Beckman pH meter. Ruminal total volatile fatty acids concentrations (VFAs) were determined by steam distillation as described by WARNER (1964). Individual VFAs were determined according to (ERWIN et al., 1961). Ammonia nitrogen (NH3-N) was determined using magnesium oxide (MgO) distillation (A.O.A.O., 1990). Bentonite elements were determined using atomic absorption (Saleh, 1994).

Table 1: Chemical composition of feedstuffs

Item	%	% dry matter basis					
	DM	OM	CP	CF	EE	NFE	Ash
Urea treated rice straw	91.16	84.07	5.40	32.71	1.32	45.71	14.86
Concentrate mixture	89.89	87.22	16.02	15.42	2.26	57.23	9.07

Bentonite contains: Ca 17.00 and Mg 0.109/Kg DM and Pb 18.30, Mn 90.50, Co 18.90, Fe 29189.3, Cu 15.9, Ni 23.50, Cd 36.70 and Hg 156.50 PPM.

Blood samples were taken from the jugular vein of each animal, three hours after the morning feeding. Blood serum was separated within one hour and stored frozen at -20^{o}C till analysis for glucose by the method described by (Siest et al, 1981), total protein (HENRY, 1964), Urea-N (PATON AND CROUCH, 1977), albumin (DOUMAS, 1971), cholesterol (WATSON, 1960) and haemoglobin (Hb) (DRABKIN, 1932). Globulin concentration was calculated by the difference between total protein and albumin concentration. All the biochemical constituents of blood serum were determined calormetrically using commercial kits.

Data of the present study were statistically analysed according to SNEDECOR and COCHRAN, 1980.

Results and discussion

Data in Table (2) show that daily dry matter (DM) intake was similar in all groups and was not affected by the addition of bentonite with the two levels 2.5 and 5%. Addition of bentonite at the previous levels to the ration of kids caused a significant (P<0.05) improve in feed conversion efficiency. ABDELMAWLA et al., (1998) and SALEH (1994) mentioned that daily dry matter intake was not affected by feeding bentonite to goats and sheep. On the other hand MULLER et al. (1983) found that 2% sodium bentonite increased feed intake of young cattle fed high grain diets. Meanwhile JACQUES et al., (1986) reported that bentonite decreased feed intake of dairy cows fed on pasture. The variation in dry matter intake may be due to the type of diet and bentonite levels. IVAN et al., (1992) and SALEH (1994) reported that inclusion of bentonite significantly (P<0.05) improved feed conversion efficiency compared with non-treated control lambs. Inclusion of bentonite (Table 2) significantly (P<0.05) increased daily gain of kids, without significant difference between bentonite groups in this respect. These results are in agreement with those reported by HA et al., (1985), MURRAY et al., (1990) and SALEH (1994), they found that the addition of bentonite at the levels of 2, 2.5 and 5% improved the growth rate of lambs.

Goats fed bentonite supplemented rations had higher (P<0.05) DM digestibility than those fed on the control diet (Table 3). SALEH (1994) mentioned that 2.5% bentonite significantly (P<0.05) increased DM digestibility, although JACQUES et al., (1986) found that the addition of 2 or 10% bentonite to rations of steers and dairy cows caused a decreased of DM digestibility. Inclusion of bentonite significantly (P<0.05) improved OM digestibility. HA et al., (1985) and SALEH (1994) reported that the addition of bentonite at the rate of 2 and 5% in rations for lambs significantly increased OM digestibility. Digestibility of CP increased (P<0.05) significantly in bentonite groups than in the non-treated control one.

Table 2: Effect of rations containing different levels of bentonite on goats performance

Item	Bentonite %		
	0	2.5	5.0
No of animals	5	5	5
Initial body weight, kg	12.84	13.12	12.19
Final body weight, kg	18.34	18.26	18.23
Total gain, kg	4.50	5.14	5.33
Daily gain g	53.6[b]	61.2[a]	63.4[a]
Daily dry matter intake, kg	610	0.595	0.592
Roughage	0.170	0.165	0.172
Concentrate mixture	0.440	0.430	0.420
Feed conversion (kg/kg gain)	11.38[a]	9.72[b]	9.34[b]
Experimental period, days	84	84	84

Means in the same row with different superscripts are significantly different (P<0.05).

Table 3: Effect of bentonite levels on digestion coefficients of nutrients and nutritive value, %

Item	Level of bentonite, %		
	0	2.5	5.0

Digestibility, %			
Dry matter (DM)	61.88[b]	71.02[a]	69.38[a]
Organic matter (OM)	67.14[b]	76.22[a]	77.18[a]
Crude protein (CP)	59.74[b]	62.82[a]	63.16[a]
Crude fibre (F)	56.59	56.96	55.04
Ether extract (EE)	77.28	81.48	78.59
Nitrogen free extract (NFE)	77.56	80.58	78.71
TDN	53.45[b]	61.85[a]	60.36[a]
DCP	8.44[b]	10.43[a]	10.30[a]
NR	5.33[a]	4.93[b]	4.86[b]

Means in the same row with different superscripts are significantly different (P<0.05).

SALEH (1994) reported that addition of 2.5 and 7.5% bentonite to the ration of lambs caused a significant (P<0.05) increase in the digestibility of CP. HUNTINGTON et al., (1977) reported that bentonite (4 to 12%) had no effect on the digestibility of OM. Bentonite did not have an effect on the digestibility of CF, EE and NFE (Table 3). HA et al., (1985) and SALEH (1994) mentioned that the inclusion of bentonite at the level of 2 and 4% to the ration of both lambs and steers did not significantly (P>0.05) effect CF, EE or NFE.

The nutritive value (%) expressed as TDN showed an increase (P<0.05) for treatment with bentonite than control (Table 3). Bentonite levels did not express statistical significant differences between bentonite groups at the same significant level. Similar results were given by SALEH (1994). The DCP content of bentonite groups was significantly (P<0.05) higher than control, without significant difference between bentonite groups in this respect. A similar trend was observed by BERITTON et al., (1978) and SALEH (1994).

Results of nitrogen balance as affected by bentonite levels (Table 4) revealed that nitrogen intake and faecal nitrogen showed no differences in the treatments. Urinary nitrogen, however, was positively correlated with the bentonite in the diet. Nitrogen balance of bentonite groups was significantly (P<0.05) higher than the non-treated control, without significant difference between bentonite groups in this respect. The improvement of retained nitrogen in bentonite treatments, in comparison with ration without bentonite, may be due to the role of bentonite in increasing nitrogen efficiency and retention by stabilisation of ammonia release in the rumen when diets contain urea. These results are in accordance with those obtained by BRITTEN et al., (1978), EI-GENDY (1985) and SALEH (1994).

Table 4: Effect of different levels of bentonite on nitrogen balance

Item	Bentonite %		
	0	2.5	5.0
N intake g/day	10.85	10.92	10.75
N in faeces g/day	3.37	3.06	2.96
N in urine g/day	4.02	4.11	4.07
Digested N g/day	7.48	7.86	7.79
N balance g/day	3.46[b]	3.75[a]	3.72[a]
N balance % of NI	31.89b	34.34[a]	34.60[a]

Means in the same row with different superscripts are significantly different ($P<0.05$).

Results of pH, VFAs and ammonia-nitrogen are presented in Table 5. There were no significant differences between the experimental groups for ruminal pH and total VFAs' concentration. These results are in agreement with Ivan et al., (1992) and Saleh (1994) who reported that bentonite had no significant effect on either ruminal pH or total VFAs' concentration. However addition of bentonite to the ration containing urea-treated rice straw led to a decrease in ruminal ammonia nitrogen concentration. These results are in accordance with those reported by Wallace and Newbold (1991) and Saleh (1994) who found that the addition of bentonite to the ration led to a decrease in ruminal ammonia-nitrogen concentration compared to a controlled diet.

Acetic acid concentrations were significantly ($P<0.05$) increased in groups fed bentonite. Bentonite did not have an effect on either propionic acid or butyric acid concentration.

Table 5: Ruminal pH, total volatile fatty acids (VFAs) and molar proportion and ammonia-N of male goats fed different levels of bentonite

Item	Bentonite, %		
	0	2.5	5.0
PH	6.23	6.10	6.17
VFAs(mM/100ml)	11.53	11.88	12.37
NH_3-N(mg/100ml)	43.83^a	22.32^b	21.85^b
Molar proportion:			
Acetic	61.63^b	64.52^a	66.47^a
Propionic	21.17	20.86	20.18
Butyric	11.98	12.53	11.75

Means in the same row with different superscripts are significantly different ($P<0.05$).

Murray et al., (1990) and Ghanem (1995) indicated that addition of bentonite at levels from 2 to 5% to the diets increased acetic acid concentration. Ha et al., (1985), Jacques et al., (1986) and Ghanem (1995) reported that either propionic or butyric acids concentrations were not affected when lambs and steers were fed bentonite. It could be seen from Table 6 that the total serum protein significantly increased ($P<0.05$) in bentonite groups compared to the non-treated control. Ghanem (1995) observed a significant ($P<0.05$) increase in serum protein of sheep fed ration containing ammoniated rice straw (3%) supplemented with 4% bentonite. El-Gendy (1985) found no considerable changes in serum protein concentration of calves fed urea-treated rations containing 0 or 4% bentonite. Saleh (1994) reported that bentonite had no effect on the total plasma protein of sheep.

Table 6: Effect of rations supplemented with different levels of bentonite on some blood constituents of goats

Item	Bentonite, %		
	0	2.5	5.0
Total protein g/100 ml	6.63^b	7. I8^a	7.21^a
Albumin, (A)g/100 ml	3.79	3.63	3.72

Globulin, (G)g/100 ml	2.84[b]	3.55a	3.49[a]
A/G ratio	1.33	1.02	1.07
Urea mg/100 ml	32.64[a]	26.97[b]	26.48[b]
Cholesterol (mg/100 ml)	176.14	169.83	182.60
Glucose mg/100 ml	55.06	54.20	54.18
Hb mg/100 ml	13.64	13.35	13.27
$WBCxIO^3ml$	5.84	5.84	5.73
$RBCxIO^6ml$	10.39	9.97	10.87

It was also noticed that the inclusion of bentonite at the levels of 2.5 and 5% in the rations containing urea-treated rice straw (Table 6) did not affect the albumin fraction compared to the non-treated control, while the difference in globulin fraction in the treated animals was significantly (P<0.05) higher than that of the non-treated control. Albumin-globulin ratio (A/G ratio) did not appear to change between all dietary treatments. Similar results were obtained by GHANEM (1995) who observed that bentonite did not have an effect on albumin or A/G ratio, while bentonite significantly (P<0.05) increased the globulin fraction.

Data also showed that the urea nitrogen concentration in the blood serum tended to be lower in goats fed urea-treated rice straw supplemented with bentonite than that of the non-treated control. This may be due to that bentonite stabilises the ammonia release from the rumen and lifts it gradually afterwards. Thus the bentonite decreases the blood urea (FENN and LENG, 1989). BARTOS et al., (1982) and SALEH (1994) showed that adding bentonite to the ration containing urea caused a significant (P<0.05) decrease in blood urea nitrogen concentration in sheep, although GHANEM (1995) found that bentonite (4 & 8%) did not affect urea nitrogen concentration in blood serum of sheep fed on ammoniated rice straw. Data in Table 6 also showed that bentonite had no effect on cholesterol, glucose, haemoglobin and white (WBC) and red (RBC) blood cell counts. These results are in agreement with the findings of SALEH (1994).

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