

GROWTH PERFORMANCE, RUMEN FERMENTATION AND BLOOD CONSTITUENTS OF GOATS FED DIETS SUPPLEMENTED WITH BENTONITE

By

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ABSTRACT

Fifteen male Angora goats with an average body weight of (12.9) kg were randomly assigned to three groups of five kids each in an 84 days growth experiment . Animals were kept in semi - opened pens and fed ration that consisted of concentrate mixture and 3% urea treated rice straw. Bentonite 0 %(control), 2.5 and 5% was mixed for each group with the concentrate mixture.

Results showed that inclusion of bentonite significantly ($p < 0.05$) increased daily gain of kids without significant differences between the bentonite groups 2.5 and 5% respectively .

Results also showed that addition of bentonite to the ration of kids caused a significant ($p < 0.05$) improvement in feed conversion efficiency Bentonite significantly ($p < 0.05$) increased dry matter (DM), organic matter (OM) and crude protein (CP) digestibilities . The nutritive value (%) expressed as TDN showed an increase ($p < 0.05$) for the treatments with bentonite . Nitrogen balance of bentonite groups was significantly ($p < 0.05$) higher than the non-treated control, without significant differences between groups in this respect .

INTRODUCTION

Bentonite is an inorganic material, which has great ability for swelling absorption and for base exchange (Saleh,1994). Bentonite can absorb toxic production of digestion and decrease the accumulation to toxic substances in tissues, thus decreasing the occurrence of internal disorders (Huntington *et al* .,1977). Bentonite has the ability to absorb ammonia from solution when the concentration of ammonia is high, and release it back 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 goat rations 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 belonging to 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 ration that consisted of concentrate mixture (CM) containing 25% undercorrected cotton seed cake, 20% yellow corn, 25% wheat bran, 16% rice bran, 5% rice hulls, 5% molasses, 3% 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). Three % 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 trial which lasted for 84 days . Each digestibility trial lasted for 21 days, where the first 14 days were for animals adjustments with the metabolic rates and the following 7 days to collect the feces and urine. Chemical composition of feeds (Table 1) feces 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 (VFA's) 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., 1984). Bentonite elements were determined using atomic absorption.

Table 1 : Chemical composition of feedstuffs .

Item	% DM	% Dry matter basis					
		OM	CP	CF	EE	NFE	Ash
Urea treated rice straw	91.16	85.14	5.40	32.71	1.32	45.71	14.86
Concentrate mixture	89.89	90.93	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 (25ml/animal) were withdrawn from the jugular vein of each animal by a needle in heparinized tubes, before the morning feeding. Blood plasma was separated by centrifugation at 3000 rpm for 20 min. and stored frozen at -20 C° till analysis for glucose by the method described by (Siest et al ., 1981), total protein (Henry, 1964), urea-N (Patton and Crouch, 1977), albumin (Dumas , 1971), Cholesterol (Watson, 1960) and haemoglobin (Hb) (Drabkin, 1932). Globulin concentration was calculated by the difference between total plasma protein and albumin concentration. All the biochemical constituents of blood plasma were determined calorimetrically using commercial kits .

Data of the present study were statistically analysed according to Snedecor and Cochran, 1982 .

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 Müller et al., (1983) found that 2% sodium bentonite increased feed intake of young cattle fed high grain diets. On the other hand 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), 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 that of fed 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 addition of bentonite at the rate of 2 and 5% in rations of lambs significantly increased OM digestibility. Digestibility of CP increased ($p < 0.05$) significantly in bentonite groups than in the non – treated control one .

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.

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	17.34	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	0.610	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 (CF)	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 ($p < 0.05$).

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 different levels. Similar results were give 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 Britton 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 among 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 treatment, 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 containing urea. These results are in accordance with those obtained by Britten et al. (1978), El-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	31.89 ^b	34.34 ^a	34.60 ^a

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

Results of pH, VFA^s and ammonia-nitrogen are presented in Table (5). There were no significant differences between the experimental groups for ruminal pH and total VFA^s 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 VFA^s 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 butyric acid concentration.

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 concentration were not affected when lambs and steers were fed bentonite.

Table 5: Ruminal pH, total volatile fatty acids (VFA^s) 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
VFA ^s (mM /100 ml)	11.53	11.88	12.37
NH ₃ -N (mg /100 ml)	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 ($p < 0.05$).

It could be seen from Table (6) that total plasma 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 ration 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	7.18 ^a	7.21 ^a
Albumin, (A) g /100 ml	3.79	3.63	3.72
Globuline, (G) g /100 ml	2.84 ^b	3.55 ^a	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
WBC (x10 ³ / ml)	5.84	5.84	5.73
RBC (x10 ⁶ /ml)	10.39	9.97	10.87

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

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 blood plasma tended to be significantly ($p < 0.05$) lower for 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 and haemoglobin . This is in agreement with the findings of Saleh (1994).

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الملخص العربي

أداء النمو ، تخمر الكرش ومكونات الدم في الماعز المغذاة

على علائق تحتوي على البنثونيت .

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أستخدم في هذه الدراسة خمسة عشر من ذكور حملان الماعز الأنفراوى متوسط وزنها ١٢,٩ كيلو جرام وقسمت الحيوانات عشوائياً إلى ثلاثة مجاميع كل مجموعة تحتوي على خمسة حملان - في تجربة نمو لمدة ٨٤ يوم . غذيت الحيوانات على علائق تتكون من مخلوط العلف المركز (١٦,٠٢ % بروتين كلى) وقش الأرز المعامل باليوريا المذابة فى الماء (٣%) . كانت مستويات البنثونيت المستخدم صفر ، ٢,٥ ، ٥ % من العليقة المركزة .

أوضحت النتائج :

- ١-المجاميع المغذاة على بنتونيت ، زاد معدل الزيادة اليومية جوهرياً عن مجموعة المقارنة (صفر/بنتونيت) في حين لم يكن هناك أي اختلافات جوهريه بين المجموعتين المغذاة على البنثونيت (٢,٥ ، ٥ %) .
- ٢-إضافة البنثونيت إلى عليقه حملان الماعز سببت تحسن ملحوظ في كفاءة التحويل الغذائي.
- ٣- زاد معامل هضم كل من المادة الجافة والمادة العضوية والبروتين الخام بإضافة البنثونيت إلى العليقة .
- ٤- إضافة البنثونيت سببت زيادة في القيمة الغذائية معبراً عنها بمجموع المواد الغذائية الكلية عن مجموعة المقارنة
- ٥- الاتزان الأزوتى للمجموعتين المغذاة على البنثونيت كان أعلا من مجموعة المقارنة ولم يكن هناك أي اختلاف بين المجموعتين المغذاة على البنثونيت (٢,٥ ، ٥ %) .
- ٦- إضافة البنثونيت إلى العليقة سببت نقصاً ملحوظاً في نيتروجين الامونيا في الكرش ولم يكن هناك أي تأثير ملحوظ في تركيز الأحماض الدهنية الطيارة الكلية بينما زاد تركيز حمض الخليك زيادة واضحة بإضافة البنثونيت .
- ٧- يمكن إستخدام البنثونيت بأى من النسبتين ٢,٥ & ٥ % من العليقة المركزة لحملان الماعز الأنفراوى الذكور لتحسين القيمة الغذائية وميزان الأزوت و معدل النمو .