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INFLUENCE OF BENTONITE SUPPLEMENTATION TO CONCENTRATE RATION CONTAINING UREA ON PERFORMANCE OF GROWING GOATS

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ABSTRACT

Sixteen growing Angora male kids weighed average 14.5 kg live body weight and aged about seven months were divided into four similar groups (4 kids each) to carry out of feeding trial. The kids were assigned randomly to fed one of the following four experimental rations:

Group 1 : Concentrate feed mixture (CFM) + rice straw (control ration, G1).
Group 2 : G1 + 1.3% urea of the CFM (without bentonite, G2).
Group 3 : G2 + 2.5% bentonite of the CFM (G3).
Group 4 : G3 + 5% bentonite of the CFM (G4).

Four digestibility trials were carried out by using three animals from each group at the end of the feeding trial to evaluate the experimental rations.

Results indicated that digestibility of the dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) and nutritive values as total digestible nutrients (TDN) and digestible crude protein (DCP) improved by adding bentonite clay to the concentrate mixtures. Values of pH were unaffected, while ruminal ammonia nitrogen (NH_3-N) concentration increased significantly ($P<0.05$) in all groups that fed diets containing urea comparing with the control group, but the groups fed the diets containing bentonite (G3 and G4) had a lower ($P<005$) NH_3-N concentration comparing with those fed ration containing urea without bentonite (G2). However, total ruminal volatile fatty acids (VFA's) concentrations indicated a contrarily trend with that of NH_3-N for G3 and G4 compared to G2.

Blood urea and globulin concentrations decreased ($P<0.05$) by addition of bentonite, while most of blood constituents slightly fluctuated by adding bentonite to concentrate ration.

Average daily gain, dry matter intake and nitrogen retention, were improved by adding bentonite compared to the ration containing urea-only.

Feed conversion efficiency (kg DM/kg gain) increased by 15.96 and 23.48%, also economical efficiency increased by 18.62 and 33.51%, however, feed cost decreased by 15.76 and 25.14% for groups 3 and 4 (fed rations containing bentonite), respectively compared to group 2 (fed ration containing urea without bentonite).

Keywords: Bentonite angora kids, digestible nutrients; N-balance, rumen and blood parameters, live weight gain; feed conversion and feed cost.

INTRODUCTION

Several studies were conducted to improve urea utilization in ruminant's rations by adding clay to the feeds containing non-protein nitrogen (NPN). Since clays which act as a regulator of ammonia concentration in the rumen, prevent urea toxicity, correct rumen acidity and basically and improve urea utilization (Pond and Yen, 1985; Hassona, 1997 and Abd El-Baki *et al*.,1998). Bentonite is an inorganic material, which has great ability for swelling, adsorption and base exchange. Addition of bentonite to high concentrate diets containing urea can maintain a more constant rumen ammonia level by holding it in a readily exchangeable form, thus nitrogen utilization efficiency could be increased even though there is a depression of nitrogen digestibility (Rindsig and Schultz, 1970).

Bentonite has the ability to adsorb ammonia from solution when the concentration is high and release it back when the concentration is low. Therefore, addition of bentonite to the diet can partially equalize the supply of nitrogen to the rumen microorganisms; so, bentonite could be considered as useful component in the rations containing high soluble nitrogen such as urea to improve its nutritive value (Bartos *et al*., 1982). It also can adsorb toxic products of digestion and decrease the accumulation of toxic substances in tissues, thus it decreased the occurrence of internal disorders (Huntington *et al*., 1977). They also found that, feeding lambs on high concentrate diets containing bentonite improved daily gain and feed efficiency. Bentonite is one of the common natural clay used in animal diets to improve the nutrient digestibility (Kirilov and Burikhonov, 1993). However, addition of bentonite to high grain diets of lambs did not affect on neither total VFA's nor individual VFA's concentrations (Ha *et al*., 1985). The objective of this work was to study the influence of bentonite addition at different levels to concentrate rations containing urea on the performance and some rumen liquor parameters and blood constituents of growing Angora kids.

MATERIALS AND METHODS

The present study was conducted at the Experimental Farm of the Animal Production Department, Faculty of Agriculture Kafr El-Sheikh, Tanta University. Sixteen growing Angora male Kids with an average body weight of 14.5 Kg and aged about seven months were used in a feeding trial. Animals were divided into four similar groups (four Kids each) and kept in semi-open pens. Animals were fed concentrate feed mixtures twice daily in almost two equal portions at 8.0 a.m and 4.0 p.m. Components of the experimental concentrate feed mixture fed in the different trials are presented in Table 1. Careful and uniform mixing of bentonite (produced by sinai manganese company), urea (agricultural urea, 46% N), sulfur, minerals and vitamins mixture with other ingredients of the concentrate mixture and yellow corn were carried out to ensure homogeneity. Rice straw was fed as a sole source of roughage (1% from animal body weight) during the feeding trial, which terminated at 75 days. Fresh water was available to the animals all the day round time. Daily feed allowances were given to the animals according to NRC (1988). The kids were weighed at biweekly intervals before the morning feeding. The daily rations were adjusted biweekly according to the changes of animals body weight.

Four digestibility trials using three animals from each treatment were carried out at the end of the feeding trial. Each trial lasted for 21 days, the first 14 days for animal adjustments with the metabolic crates and the following 7 days to collect the feces and urine. Chemical composition of feeds

(Table 2), feces and urine were determined according to AOAC (1990). Rumen samples were collected from each animal 3 hours after the morning feeding at the last day of collection period by stomach tube. Ruminal pH was determined directly by Beckman pH meter. Ruminal total VFA's concentrations were determined by steam distillation as described by Warner (1964). Ammonia nitrogen (NH_3-N) was determined using magnesium oxide (MgO) distillation (AOAC, 1990).

Table (1) : Components of the experimental concentrate feed mixture used in the kids feeding.

Ingredients	Concentrate mixture			
	G1	G2	G3	G4
Bentonite*	0.00.	0.00	2.50	5.00
Yellow corn	2.10	25.25	22.75	20.25
Concentrate mixture**	97.20	72.65	72.65	72.65
Urea (46% N)	0.00	1.30	1.30	1.30
Sulfur	0.00	0.10	0.10	0.10
Minerals mixture	0.50	0.50	0.50	0.50
Vitamin mixture A, D_3 and E	0.20	0.20	0.20	0.20
Total	100	100	100	100

*** Bentonite contained: Ca 17.00, Mg 0.10 g/kg DM and Pb 18.30, Mn 90.50, Co 8.90, Fe 29189.30, Cu 15.90, Ni 23.50, Cd 63.70 and Hg 156.5 ppm (Saleh, 1994).**

**** Concentrate mixture composed of 25% undecorticated cotton seed cake, 20% yellow corn, 33% wheat bran, 16% rice bran, 3% molasses, 2% limestone and 1% common salt.**

Table (2) : The chemical composition of the different concentrate feed mixtures (CFM) and rice straw used in the kids feeding.

CM	DM %	DM composition, %					
		OM	CP	CF	EE	NFE	Ash
CFM1	90.70	90.12	15.15	12.12	3.92	58.93	9.88
CFM2	89.24	92.14	17.31	9.53	3.99	61.31	7.86
CFM3	88.58	89.62	17.07	9.48	3.88	59.19	10.38
CFM4	89.10	87.24	16.49	9.36	3.61	57.78	12.76
Rice straw	92.40	84.54	2.69	35.20	1.89	44.76	15.46

Blood samples were taken from the jugular vein of each animal three hours after the morning feeding. Haemoglobin was determined according to the method of Drabkin, (1932) in the whole blood. Blood serum was separated within one hour and stored frozen at-20ºC till analysis for glucose (Siest *et al.,* 1981), total protein (Gornall *et. al.*, 1949), urea-N (Patton and Crouch, 1977), albumin (Doumas, *et al.,* 1971), and Cholesterol (Watson, 1960). Globulin concentration was calculated by difference between the total protein and the albumin concentration..

The data were analyzed using General Linear Models Procedure adapted by SPSS (1997) for one way ANOVA model and means were differentiated using Duncan's multiple range tests.

RESULTS AND DISCUSSION

Results presented in Table 3 show that there were no significant differences between all the experimental rations for DM digestibility. These results were in accordance with those reported by Erwin *et al*. (1957), who found that DM digestibility unaffected when steers fed rations containing 3% bentonite. Likewise, NFE digestibility was insignificantly affected, but the rations containing bentonite (G3 and R4) were higher than the other rations concerning NFE digestibility. These results were in agreement with the findings of Huntington *et al*. (1977) and Saleh *et al*. (1999) when they fed lambs on rations containing from 2 to 10% bentonite. However, CF digestibility was significantly ($P<0.05$) higher for G3 or G4 containing bentonite than the other rations. This may be due to the higher ammonia-N in rumen liquor of kids fed on these rations which increased the amount of substrate available for rumen microorganisms to build microbial protein, consequently it became more efficiency on fiber digestion. These results were in harmony with those observed by Huntington *et al*. (1977), Ha et al. (1985) and Saleh et al. (1999) when the lambs fed on the rations containing bentonite at different levels. Furthermore, CP digestibility was higher ($P<0.05$) for bentonite group 3 than for the other groups. These results reported herein confirm those obtained by Britton et al. (1978) and Kirilov & Burikhonov (1993). However, Huntington et al. (1977) found that using bentonite had no effect on CP digestibility.

Digestibility of EE fluctuated between the different treatments, while it was the lowest for G4 and the highest for G3 than for the other rations.

Table (3): Average of the digestion coefficients and nutritive value for different experimental rations consumed by kids.

Items	Feeding groups			
	G1	G2	G3	G4
Digestion coefficients %				
DM	56.33±4.10	54.16±3.52	54.80±2.19	56.91±3.35
CP	64.83±3.67^{b}	64.45±3.74^{b}	72.45±0.81^{a}	65.98±2.70^{b}
CF	32.55±6.28^{b}	32.64±7.50^{b}	50.59±2.34^{a}	49.37±6.28^{a}
EE	81.46±1.20^{a}	79.48±2.97^{ab}	82.91±0.76^{a}	72.11±3.43^{b}
NFE	66.88±3.56	65.85±4.04	69.56±1.04	72.07±2.01
Nutritive value (%)				
TDN	61.58±3.20^{b}	60.32±5.61^{b}	77.60±1.67^{a}	64.33±3.35^{ab}
DCP	9.22±0.74^{c}	9.21±0.73^{bc}	13.95±0.04^{a}	10.66±0.53^{bc}
NR ratio	1 : 5.68±0.05^{a}	1 : 5.54±0.01^{a}	1 : 4.56±0.01^{b}	1 : 5.04±0.02^{c}

[a,b,c] Means within the same row with different superscripts are significantly different at ($P<0.05$).

Data concerning nutritive values (Table 3) indicated that, TDN & DCP values for bentonite rations (G3 and G4) were higher than the other rations. Generally, nutritive values improved for rations containing bentonite especially 2.5% bentonite ration, this might be due to increasing digestibility of most nutrients by addition of bentonite clay and improving the rumen microorganism's activity. These results were in accordance with those reported by Huntington *et al.* (1977), Britton *et al*. (1978) and El-Hakim et al. (1994).

Data concerning rumen liquor parameters are shown in Table 4. No significant differences were observed between the different animals groups for pH values. These results were in agreement with findings of both Moate *et al*. (1985) and Saleh *et al*. (1999). Total VFA's concentration unchanged by different levels of bentonite supplementation compared to control group (G1), whereas it was higher significantly ($P<0.05$) for G2 than the other groups. These results were nearly similar with those reported by both Ivan *et al*. (1992) and Saleh *et al*. (1999), who demonstrated that addition of bentonite to sheep rations at different levels had no significantly effect on total VFA's.

Table (4): Average of pH, NH_3 - N and total VFA's concentrations in rumen fluid of Angora kids fed the different tested rations.

Items	Feeding groups			
	G1	G2	G3	G4
PH	6.18±0.07	6.13±0.04	6.18±0.05	6.24±0.04
NH_3 – N, (Mg / 100 ml)	12.34 ± 0.46^{c}	41.47 ± 0.89^{a}	18.51 ± 0.51^{b}	21.67 ± 1.41^{b}
VFA's , (Meq/100 ml)	13.94 ± 0.29^{b}	15.95 ± 0.33^{a}	13.83 ± 0.20^{b}	13.05 ± 0.83^{b}

[a,b,c] Means within the same row with different superscripts are significantly different at ($p<0.05$).

Ruminal ammonia-N (NH_3-N) concentrations decreased significantly ($P<0.05$) when bentonite was added at both levels (2.5 and 5%) comparing with G2 containing urea only. These results were nearly similar with findings of Wallac and Newbold (1991) and El-Hakim et al. (1994), who found that the addition of bentonite at different levels in ruminants rations led to decrease ruminal NH_3-N concentrations in comparison with the diets containing urea without bentonite. Lower ruminal NH_3-N concentrations in groups fed rations containing bentonite may be due to the ability of bentonite to adsorb ruminal ammonia when the concentration is high and release it back when the concentration is low (Bartos *et al*., 1982).

Both nitrogen balance (NB) as g/head/day and N retention as % of total N intake (Table 5) were significantly higher ($P<0.05$) for bentonite groups than G2 fed ration containing urea without bentonite. The improvement of N retention in bentonite groups in comparison with the ration containing urea without bentonite (G2), may be due to a role of bentonite for increasing N-efficiency and retention by stabilization the ammonia release in the rumen when diets containing urea. The present results were in accordance with those reported by Britton *et al*. (1978), El-Gendy (1985) and El-Hakim *et al*. (1994).

Results of blood constituents (Table 6) demonstrated that, no significant differences were observed between the different groups concerning red blood cells (RBCs), white blood cells (WBCs), Haemoglobin (Hb), glucose and cholesterol concentrations. However, blood urea concentration decreased by adding bentonite compared to the groups fed ration-containing urea without bentonite (G2). These results were in agreement with the findings of Pond (1984), who found that the bentonite was affective in reduction of plasma ammonia. On the other hand, serum protein, globulin and albumin concentrations were fluctuated between the different groups. Generally, blood constituents were within the normal range reported by Reece (1991) and Wiliam *et al*.(1991), being 8.1 to $12x10^{6}$/ml for RBCs, 6.50 to $11.50x10^{3}$/ml for WBCs and 8-12 g/100 ml for hemoglobin. Moreover, Mohsen *et al*. (1993) reported that plasma protein value ranged from 6 to 9% in blood of sheep.

Table (5) : Effect of dietary treatments on nitrogen utilization by Angora kids.

Items	Feeding groups			
	G1	G2	G3	G4
N intake, (g/h/d)	26.46±0.78	26.08±0.68	26.07±0.33	29.71±0.29
N in feces (g/h/d)	9.25±0.80	9.23±0.82	9.94±0.36	10.09±0.71
N in urine (g/h/d)	6.23±0.51[b]	9.77±0.79[a]	10.64±0.32[a]	10.34±0.61[a]
N balance (g/h/d)	10.98±1.04[a]	7.08±0.66[b]	9.49±0.55[a]	9.27±0.63[a]
N retention (% of total N intake)	41.39±3.12[a]	27.18±2.05[b]	36.40±0.50[c]	31.18±1.87[c]

[a,b,c] **Means within the same row with different superscripts are significantly different at (P<0.05).**

Data concerning growth performance of kids fed the different tested rations are present in Table (7). Average daily gain increased significantly (P<0.05) by adding bentonite at levels 2.5% (104 g/d) and 5% (119.5 g/d) compared to the kids fed ration containing urea without bentonite (85.3 g/d). But the control group (G1) did not significantly affected compared to all the other groups (96 g/d). These results indicated that, the growth rate increased with increasing level of bentonite in the experimental rations. These results were in agreement with those reported by both Ha et al. (1985) and Murray et al. (1992), who found that the addition of bentonite at levels of 2, 2.5 and 4% improved growth rate of the ruminants. Moreover, DM intake (g/h/d) was higher for kids fed rations containing bentonite than those fed ration containing urea without bentonite.

Table (6) : Blood constituents of Angora kids fed on the different tested rations

Items	Feeding groups			
	G1	G2	G3	G4
RBC_s, x 10^6/mm	11.97± 0.13	11.66±0.28	11.46± 0.42	12.45±0.29
RBC_s, x 10^3/mm	6.07±0.09	6.08±0.16	6.45±0.28	6.26±0.26
Hb, g%	11.04±0.09	11.55±0.27	11.67±0.42	11.58±0.23
Glucose, mg %	55.96±1.61	53.84±0.90	52.31±1.27	52.77±1.99
Urea, mg%	19.65±0.87[c]	34.78±0.76[a]	27.95±0.10[b]	27.30±0.41[b]
Cholesterol, mg%	177.41±2.25	180.43±1.43	184.27±3.67	180.61±1.31
Total protein, g%	7.81±0.09[a]	7.57±0.22[ab]	7.51±0.16[ab]	7.23±0.17[b]
Globulin (G), g%	3.07±0.17[b]	3.44±0.07[a]	3.03±0.05[b]	3.19±0.07[ab]
Albumin (A), g%	4.74±0.08[a]	4.13±0.29[ab]	4.48±0.14[ab]	4.04±0.19[b]
A / G ratio	1.54	1.20	1.48	1.27

[a,b,c] **Means within the same row with different superscripts are significantly different at (P<0.05).**

Table (7) : Growth performance of kids fed the different tested rations.

Items	Feeding groups			
	G1	**G2**	**G3**	**G4**
No. of kids	4	4	4	4
Exp. Period (days)	75	75	75	75
Av. initial weight, kg	14.25	14.27	14.50	15.00
Av. final weight, kg	21.45	20.67	22.30	23.96
Av. Total gain, kg	7.20	6.40	7.80	8.96
Av. Daily gain, g	96.00[ab]	85.33[b]	104.00[a]	119.47[a]
Av. Daily DM intake, kg				
Concentrate mix.	0.68	0.70	0.73	0.76
Rice straw	0.13	0.14	0.13	0.14
Total dry matter intake (DMI)	0.81	0.84	0.86	0.90
Feed conversion efficiency				
Kg DM/kg gain	8.44	9.84	8.27	7.53
Feed cost/kg gain, LE*	4.47	5.33	4.49	3.99
Economic efficiency **	2.24	1.88	2.23	2.51

[a,b] Means within the same column with different superscripts are significantly different at ($P<0.05$).

*** based on the assumption that prices of one ton from concentrate mixture, rice straw, yellow corn, bentonite and agricultural urea were 550, 50, 500, 80 and 500 Egyptian pounds (LE), respectively. Also, price one kg from sulfur, minerals mixture and vitamin mixture were 7, 3, and 2.5 LE, respectively and price of one kg from live body weight on selling was 10 LE in year 2000.**

**** Economic efficiency = money output (price of weight gain) / money input (price of feed consumed).**

These results agreed with those of Muller *et al*. (1983) who found that addition of 2% Na-bentonite increased feed intake of steers. Conversely, Abdelmawlla *et al*. (1998) and Saleh *et al.* (1999) found that DMI unchanged by addition of bentonite at different levels to rations of both goats and sheep. However, feed conversion efficiency, as kg DM/kg gain increased with increasing bentonite levels, but kids fed ration containing urea without bentonite was lowest value comparing with the other groups. Feed conversion efficiency (kg DM/kg gain) increased by 15.96 and 23.48%, also economical efficiency increased by 18.62 and 33.51%, however, feed cost/kg gain decreased by 15.76and 25.14% for groups 3 and 4, respectively compared to group 2. It noticed that the feed cost decreased, while both feed and economical efficiency increased with increasing bentonite levels in the kid's ration. Improving feed intake and economical efficiency and reducing feed cost for kids by using bentonite were supported with other data obtained by Marrero *et al*. (1987), Ivan *et al.* (1992) and Abdel-Raouf *et al*. (1994).

It could be concluded that addition of bentonite at levels of 2.5 or 5% in concentrate ration of kids was beneficial and improved growth rate, feed efficiency and economical efficiency.

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تأثير إضافة البنتونيت إلى مخلوط العلف المركز المحتوى على اليوريا على مستوى أداء الماعز النامية.

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استخدم في هذه الدراسة ١٦ من جديان ماعز الأنجورا النامية ، متوسط وزنها ١٤,٥ كجم ، وقسمت الحيوانات عشوائياً إلى أربعة مجاميع بكل مجموعة أربعة جديان وذلك لإجراء تجربة نمو ، وغذيت كل مجموعة على إحدى العلائق الآتية:

مجموعة أولى : مخلوط العلف المركز + قش أرز (مجموعة المقارنة).
مجموعة ثانية : عليقة مجموعة المقارنة + ١,٣% يوريا من العليقة المركزة.
مجموعة ثالثة : عليقة المجموعة الثانية + ٢,٥ % بنتونيت من العليقة المركزة.
مجموعة رابعة : عليقة المجموعة الثانية + ٥% بنتونيت من العليقة المركزة.

وفى نهاية تجربة النمو تم إجراء أربعة تجارب هضم باستخدام ثلاثة جديان من كل مجموعة وذلك لتقييم العلائق السابقة.

وقد أظهرت الدراسة النتائج الآتية:

1- تحسنت معاملات هضم كل من المادة الجافة، البروتين الخام ، الألياف الخام ، والمستخلص الأثيري ، والكربوهيدرات الذائبة ، كما تحسنت القيمة الغذائية بإضافة البنتونيت إلى العليقة المركزة.
2- أظهرت نتائج تقديرات سائل الكرش أن حموضة الكرش (pH) وكذلك تركيز الأحماض الدهنية الطيارة لم تتأثر ، ولكن انخفض تركيز نيتروجين الأمونيا في المجاميع المغذاة على علائق محتوية على البنتونيت مقارنة بالعليقة المحتوية على اليوريا فقط.
3- انخفض تركيز كل من اليوريا والجلوبيولين معنوياً في سيرم الدم ، ولكن كان هناك تذبذب بسيط في بقية تقديرات الدم وذلك بإضافة البنتونيت مقارنة لمجموعة اليوريا فقط وعموماً كانت كل التقديرات تقع داخل المدى الطبيعي.
4- ازدادت معنويا كل من المادة الجافة المأكولة ، الآزوت المحتجز ، وكذلك معدل النمو في مجموعتي البنتونيت مقارنة بمجموعة اليوريا فقط.

من النتائج السابقة ينصح باستخدام البنتونيت بنسبة ٢,٥ أو ٥% فى علائق جديان الماعز لما له من تأثير إيجابى على مستوى أداء الماعز خصوصاً عند مستوى ٥% بنتونيت حيث أنه خفض من تكاليف الغذاء وأدى إلى زيادة الكفاءة التحويلية للغذاء وكذلك الكفاءة الاقتصادية.