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SUPPLEMENTATION OF BENTONITE AND DOLOMITE TO LACTATING GOATS' RATIONS

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SUMMARY

Fifteen early lactating goats were selected at 12-18 month and randomly divided into three experimental groups of five animals each. The animals received a control diet consisting of 30% roughage and 70% concentrate, without (group I) and with supplementing of 3% bentonite (group II) and 3%dolomite instead of concentrate (group III). The experimental trial extended from parturition until the sixth week of lactation. The results indicated that bentonite supplementation significantly (P<0.05) increased milk yield and both of fat and protein either percentages or yields in milk. However, dolomite insignificantly (P>.0.05) decreased milk yield and increased to somewhat both of fat and protein either percentages or yields in milk. Addition of bentonite and dolomite showed significant (P<0.05) increases in total protein (TP) concentration and glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) activity of blood serum. However, dolomite supplementation decreased (P<0.5) serum cholesterol. Calcium to inorganic phosphorus ratio was not affected by either bentonite or dolomite supplementation. It could be concluded that supplementation of sodium bentonite was more effective in improving milk production and increasing milk fat than dolomite.

Keywords : *Goats, Bentonite, Dolomite, Milk yield, Milk composition*

INTRODUCTION

Several researches have been directed toward improving milk production and its composition using different methods. One of these methods, is bentonite or dolomite supplementation to diets containing high levels of concentrates.

Bentonite increased digestibility of nutrients (Kirilov and Burikhono, 1993), and improved milk production (Yermolenko, *et al.*, 1996 and Saleh, *et al.*, 1999). Moreover, bentonite has positive effects on milk constituents, since, Zalewska, *et al.*, (1985) concluded that the addition of 3% bentonite to feed, increased milk fat content in cows, and Abdelmawla, *et al.*, (1998) observed that milk lactose significantly increased as bentonite level increased (up to 12g/ head/ day) in lactating goats rations. However, neither milk yield nor milk constituents were affected by adding bentonite to sorghum or maize grain – based supplements for cows (Ehrlich and Davison, 1997 and Hamilton, *et al.*, 1988).

With regard to dolomite, Kholif, *et al.*, (1999) reported that supplementing buffaloes' diets with dolomite up to 2% of dry matter intake DMI, increased (P<0.05) milk yield and milk Ca content, while decreased (P<0.05) C4 in milk fat. However, Kertz, *et al.*, (1977) suggested

that adding dolomite to dairy cows' rations decreased milk yield.

The objective of this study was to compare the effects of bentonite and dolomite added to lactating goats' rations on milk yield, milk composition and some parameters of blood serum.

MATERIALS AND METHODS

The present study was conducted at the Experimental Farm of the Department of Animal Production, Faculty of Agriculture of Ain Shams University.

Fifteen homoparity early lactating crossbred goats selected at 12-18 month, with average live body weight of 24.8 ± 0.20 kg were randomly distributed into three feeding experimental groups of five animals each.

The first group (I) was fed a control diet containing 70% concentrate feed mixture, 15% berseem hay and 15% rice straw while the other two groups (II) and (III) were fed the control diet supplemented with either 3% bentonite (group II) or 3% dolomite (group III).

Bentonite clay and dolomite replaced a part of the concentrate. The compostiton of sodium bentonite and dolomite used is shown in Table (1), while the chemical composition of the feed ingredients (which was done according to AOAC, 1990) is presented in Table (2).

The nutrient requirements were calculated according to Ghoneim, (1967), since, each metabolic body weight requires 0.113 Mcal as metabolizable energy (ME) and 2.5 gm digestible protein (D.P.) (maintenance requirements) and each 1.0 kg milk (4% fat) requires 0.940 Mcal as (ME) and 70 gm D.P. (productive requirements). The animals were housed and fed individually once daily and water was available ad lid.

Goats were milked twice daily (7.0 a.m. and 3.0 p.m.) and milk yield (g/d) of each animal was recorded during the second, fourth and sixth week of lactation. A milk sample of each animal represented a mixed sample of a constant percentage of the morning and the evening yield was taken.

Milk pH was immediately measured, then, milk samples were analyzed for total solids (TS), fat, protein and ash according to Ling., 1963), while, lactose content was estimated by the method of Barnett and Abd El Tawab (1957). Solids not fat (SNF) was calculated by difference.

Blood samples were taken after 4 hrs. of morning feeding from the jugular vein biweekly until the 6^{th} week of lactation. Blood serum was separated through one hour and stored frozen at 20 C^0 until analysis for total protein (Armstrong and Carr, 1964), liver enzymes GOT and GPT (Reitman and Frankel, 1957) and total bilirubin (Tendrassikl – Grof, 1938). Serum cholesterol was estimated by the method of Kostmer, *et al.*, (1979), serum calcium was determined according to Jackson (1958) and the serum phosphorus determination was according to Troug and Meyer (1939). All the biochemial constituents of blood serum were done colorimetrically using commercial kits purchashed from Bio-Merieux, Laboratory Reagent and Products, France.

The statistical analysis was carried out according to Snedecor and Cochran (1982). Differences among means of experimental groups or weeks were tested using Duncan's New Multiple Range test (Duncan, 1955).

Table 1. The chemical composition of sodium bentonite and dolomite.

Item		Bentonite*	Item		Dolomite**
Sio_2	%	53.05	P%	%	0.02
$Al_2 o_3$	%	20.26	Na %	%	0.20
$Fe_2 o_3$	%	6.74	Ca %	%	17.50
Ca o	%	2.02	Mg %	%	11.85
Mg o	%	1.95	K	%	0.16
Na_2o	%	2.19	Cu	%	0.48
K_2o	%	1.05	ZN	%	2.15
Loss of	%		Fe	%	0.04
Iginition	%	12.74	Mn	%	5.1

* Sinai manganese company, Kasr El-Nile Cairo.

** Phosphate and manganese company, El-Tahrir, Cairo.

Table 2. The chemical composition of the feed ingredients (dry matter DM basis %)

Item	DM	CP	CF	EE	NFE	Ash	Ca	P	Na	Mg
CFM*	94.60	13.83	10.2	3.1	66.58	6.2	0.57	0.6	0.21	0.56
Berseem hay**	89.50	13.5	27.5	1.95	44.95	12.1	1.61	0.14	0.65	0.41
Rice straw**	92.40	3.95	36.7	1.50	44.05	13.8	1.5	0.32	0.18	0.48

* Commercial concenrtate feed mixture (undecorticated cotton seed cake 10%, Linseed meal 10%, yellow corn 25%, barley 20%, rice bran 11%, wheat bran 17%, molasses 4%, limestore 2% and salt 1%) obtained from Zagazig Factory.

** ***Obtained from Dakahlia Province.***

RESULTS AND DISCUSSION

Dry matter intake (DMI)

Total DMI insignificantly increased (P>0.05) by adding bentonite and dolomite, and the highest total DMI (1088 g/h/d) was observed for goats receiving the diet with bentonite (Table 3). [These findings may be related to that sodium bentonite had certain physical and chemical properties by which it had a good effect on palatability and might enhance the ruminal digestion]. These results are in agreement with those obtained by Abdelmawla *et al.*, (1998) who suggested that total DMI of lactating goats was not significantly affected by bentonite supplementation. However, Muller *et al.*, (1983), Dehean *et al.*, (1984) and May and Barker (1988) observed that adding bentonite by 2% to rations of steers fed high grain diets, ncreased feed intake. On the other hand, Moate, *et al.*, (1985) reported that a significant decrease in DM intake was observed for dairy cows fed pasture diet supplemented with sodium bentonite as 60 g /h/d.

Milk yield

Data of Table (4) clearly indicated that remarkable (P<0.05) increase in milk yield was recorded for animals supplemented with sodium bentonite. Obviously, milk yield increased by 33.5% for bentonite than the control. However, supplementation of dolomite insignificantly decreased the milk yield comparing with control diet. These results may be explained on the basis of findings reported by Richter *et al.*, (1990), Kirilov and Burikhonvo (1993), El-Hakim *et al.*, (1994), Yermolenko, *et al.* (1996) and Saleh, *et al.*, (1999) who used fatting bulls, stear heifers, rams,

Table 3. Effect of bentonite and dolomite supplementation on daily feed intake during six weeks of lactation.

Item	Experimental groups		
	I Control	II 3% bentonite	III 3% dolomite
No of goats	5	5	5
Initial body weight (kg)	24.7	24.92	24.77
Feed intake (g/d):			
Concentrate mixture	745[a]	782[a]	775[a]
Berseem hay	145[a]	156[a]	150[a]
Rice straw	142[a]	150[a]	147[a]
Total DM intake (g/d)	1032[a]	1088[a]	1072[a]

Means superscripted with the same letter not significantly (P≥ 0.05) differed.

Table 4. Effect of bentonite and dolomite supplementation on milk yield, composition (percent and yield) and pH value of goats

Item		Experimental groups			SE +
		I Control	II 3% bentonite	III 3% dolomite	
Milk yield (g/head/d)		800.56[b]	1068.89[a]	760[bc]	24.59
Week 2		993.3	1110	940	
Week 4		941.7	1160	973.3	
Week 6		466.7	916.7	366.7	
Fat	%	4.02[cb]	4.33[a]	4.12[b]	0.072
	g/d	32.6[cb]	46.58[a]	31.78[b]	1.37
Protein	%	2.79[bc]	3.06[a]	2.97[b]	0.047
	g/d	22.17[cb]	32.76[a]	22.52[b]	1.00
Lactose	%	4.57[cb]	4.75[a]	4.69[ab]	0.038
	g/d	36.40[b]	50.90[a]	35.85[bc]	0.87
TS	%	12.17[c]	13.00[b]	12.55[ba]	0.05
	g/d	98.83[bc]	139.30[a]	99.42[b]	3.94
SNF	%	8.15[c]	8.67[b]	8.43[a]	0.06
g/d		65.34[c]	92.78[a]	66.30[bc]	2.77
Ash	%	0.79[cb]	0.86[a]	0.77[c]	0.012
	g/d	6.4[bc]	9.23[a]	5.93[c]	0.26
pH	a.m	6.46[bc]	6.60[a]	6.47[b]	0.005
pH	p.m.	6.51[bc]	6.63[a]	6.50[c]	0.012

a,b,c Groups overall means with different superscripts were different (p<0.05)

cattle and lactating buffaloes, respectively and concluded that digestibilites of most nutrients increased when bentonite was added to rations which consequently affected milk yield positively. [However, when], Kholif (1989) fed lactating buffaloes on diets unsupplemented and supplemented either with 3% calcium bentonite or 2% dolomite of DMI (R : C was 30 : 70), he found that both bentonite and dolomite increased milk yield. The variability of results may show that animal type, roughage: concentrate ratio and supplementation level could affect the response to the additive material.

Table (5) clearly showed that daily milk yield increased (P>0.05) to reach its maximum at the 4th week, then,

decreased ($P<0.05$) at the 6th week, regardless to dietary supplementation.

Milk constituents

It is known that fat content is affected by the roughage / concentrate (R/C) ratio which directly affects the volatile fatty acids (VFA's) proportions, in particular, acetic to propionic ratio (Shaw, *et al.*, 1959, Storry and Rook 1965 and Davis 1967). However, data of Table (4) indicated significant differences ($P<0.05$) in fat either percent or yield among the three groups in which all animals received the same R / C ratio (30 : 70). The highest valaes of fat (either percent or yield) recorded for animals supplemented with bentonite may be explained on the basis of the mode of action of bentonite which alters the ruminal end products of fermentation towards a lower molar percent propionate via increasing the dilution rate (Rogers, *et al.*, 1982). Moreover, Baldi, *et al.*, (1996) concluded that bentonite significantly increased molar proportion of butyrate.

Butyrate can be used as a precursor of fat synthesis. The present result of bentonite effect on milk fat is in agreement with that obtained by Saleh, *et al.*, (1999). However, Kholif (1989) found that neither bentonite nor dolomite significantly affected milk fat of buffaloes.

Although, all experimental animals received approximately the same level of dietary CP, data of Table (4) showed that the animals which received bentonite (group II), significantly increased milk protein either as percent or yield. This finding may be illustrated on the basis of the findings reported by Ferr and Leng (1990) who suggested that bentonite supplementation increas-ed flow of protozoal protein from the rumen to the intestine. Also, Ivan, *et al.*, (1996) revealed that bentonite supplementation resulted in higher total amino acids and non NH_3 – N supplies to the intestine. Moreover, Saleh *et al.*, (1999) reported that bentonite addition increased the available digestible crude protein used for lactation as a result of its role in increasing N-efficiency and retention by stabilization the NH_3 release in the rumen with high concentrate rations. The results of the present study are in accordance with those obtained by Kholif (1989).

It is of interest to notice that animals which received diet supplemented with dolomite (group III), had higher percentages of lactose and SNF than the control (Table 4). This observation might be due to improving the utilization of starch (precursor of glucose) in the small intestine with a decline in the loss of energy as starch in feces by dolomite supplementation (Wheeler and Noller 1976).

Also, data of Table (4) showed that TS either as percent or yield recorded higher values ($P<0.05$) for both groups II and III comparing with group I. The highest values of ash either as percent or yield was observed for bentonite group. Moreover, Table (4) indicated that the pH values were slightly different ($P<0.05$) among the three experimental groups, but, all of these values were within the normal range.

The present results of lactose, SNF, TS, ash and pH are in line with those obtained by Kholif (1989).

Data of Table (5), obviously indicated that milk fat and total protein contents were significantly ($P<0.05$) higher at the 4th week than those at the 2nd or 6th week of lactation, and showed that milk ash yield decreased ($P<0.05$) as lactation time increased. In general the lowest values of milk contituents were observed at the 6th week of lactation, regardless to the dietary supplementation.

Table 5. Effect of lactation time on milk yield, composition and pH values of goats

Item		Lactation time (week)			SE
		2	4	6	+
Milk yield g/head /d		1014.44^{ab}	1031.67^{a}	583.33^{c}	36.79
Fat	%	4.09^{b}	4.48^{a}	3.91^{c}	0.05
	g/d	41.53^{ba}	46.37^{a}	23.06^{c}	1.54
Protein	%	2.86^{c}	2.99^{a}	2.98^{ab}	0.03
	g/d	28.97^{ab}	31.05^{a}	17.43^{c}	1.12
Lactose	%	4.96^{a}	4.45^{c}	4.60^{bc}	0.49
	g/d	50.54^{a}	45.97^{ab}	26.73^{c}	1.95
TS	%	12.72^{ba}	12.84^{b}	12.34^{c}	0.059
	g/d	128.98^{ba}	133.57^{a}	72.31^{c}	5.51
SNF	%	8.63^{a}	8.36^{b}	8.43^{bc}	0.07
	g/d	85.12^{a}	86.31^{ab}	50.45^{c}	4.02
Ash	%	0.81^{c}	0.92^{a}	0.85^{b}	0.01
	g/d	8.74^{a}	8.34^{ba}	4.95^{c}	0.31
pH	a.m	6.48^{bc}	6.54^{a}	6.51^{ab}	0.011
pH	p.m	6.5^{c}	6.58^{a}	6.56^{ab}	0.012

^{a,b,c} Weeks overall means with different superscripts were different ($p<0.05$)

Table 6. Effect of bentonite and dolomite supplementation on some serum parameters of goats.

Item	Experimenlal groups			SE
	I	II	III	+
	Control	3% bentonite	3% dolonite	
TP g/100 ml	6.57^{b}	6.70^{a}	6.66^{b}	0.09
GOT (U/L)	35.65^{c}	40.01^{ab}	39.72^{b}	1.03
GPT (U/L)	18.96^{c}	24.92^{a}	22.70^{b}	0.60
Bilirubin (mg/100ml)	0.40^{b}	0.47^{a}	0.47^{a}	0.006
Cholesterol (mg/100ml)	63.82^{ab}	64.35^{a}	59.91^{c}	0.47
Ca (mg/100ml)	4.79^{a}	4.59^{bc}	4.69^{ab}	0.03
P (mg/100ml)	2.70^{a}	2.38^{bc}	2.57^{ab}	0.056

^{a,b,c} Group overall means with different superscripts were different ($p<0.05$)

Table 7. Effect of lactation time on some serum parameters of goats.

Item	Lactation time (week)			SE
	2	4	6	+
TP g/100 ml	6.49^{b}	6.46^{b}	6.98^{a}	0.099
GOT (U/L)	33.13^{c}	38.06^{b}	44.18^{a}	1.04
GPT (U/L)	22.23^{a}	23.05^{a}	21.03^{a}	0.69
Bilirubin (mg/100ml)	0.45^{b}	0.40^{c}	0.49^{a}	0.008
Cholesterol (mg/100ml)	56.51^{c}	61.52^{b}	70.05^{a}	0.35
Ca (mg/100ml)	4.76^{a}	4.67^{a}	4.65^{a}	0.03
P (mg/100ml)	2.72^{a}	2.50^{b}	2.42^{bc}	0.045

^{a,b,c} Weeks overall means with different superscripts were different ($p<.05$).

Blood serum

Data presented in Table (6) showed that both of bentonite and dolomite supplementations resulted in significant increases in some of blood serum parameters such as TP, GOT and GPT, and the highest values of these parameters were recorded for bentonite group. These results may possitively correlated with bentonite ability to improve nitrogen nutilization.

Minute increases of serum total bilirubin were recorded for benonite and dolomite groups (Table 6) refered to normal liver function.

It is of interest to report that the slightly highest ($P<0.05$) value of serum cholesterol was observed for bentonite group (64. 35 mg/100ml) not for Jolomite group which had the lowest level of cholesterol in this trial (59.91mg/100ml). This result may be explained on the basis that gluconeogenesis precursors in the liver which could promote cholesterol synthesis, may be affected by increasing dilution rate (bentonite effect) in the rumen rather than by increasing starch digestibility in the intestine (dolomite effect). The same effect of bentonite was observed by Saleh *et al.*, (1999). Also, the present results are in line with those obtained by Kholif, (1989) and Simex *et al.*, (1994).

Concerning results of Ca and P (Table 6), it could be reported that slight differences were noticed among the overall means of the three experimental groups. Obviously, all means of Ca and P showed approximately the healthy normal ratio of Ca to P (2 : 1). The presrent results are in line with those obtained by Kholif (1989) and Rajcevic (1989).

With regard to the effect of lactation time on some blood parameters, Table (7) showed that serum total protein significantly increased at the 6th week, also, serum GOT gradually increased by advancing lactation time, however, serum GPT increased ($P>0.05$) at the 4th week, then, decreased ($P>0.05$) at the 6th week. Flactuated values were observed for bilirubin during the experimental weeks, regardless to the dietary supplements.

Furthermore , Table (7) indicated that serum cholesterol gradually increased ($P< 0.05$) to reach the highest value at the 6th week. The highest values of both Ca and P were recorded at the 2nd week of lactation.

From all the above mentioned results, it could be concluded that supplementation of sodium bentonite at 3% of the concentrate to rations of lactating goats containing 30% roughage and 70% concentrate was more effective in improving milk production and increasing milk fat than that of dolomite at 3% of concentrate.

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إضافة البنتونيت والدلوميت إلى علائــق الماعز الحلاب

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أختيرت ١٥ أنثى من الماعز الحلاب وقسمت عشوائيا إلى ثلاثة مجاميع تجريبية بكل مجموعة خمس حيوانات. غذيت حيوانات المجموعة الأولى (١) على عليقة كنترول مكونة من ٣٠% مادة خشنة و٧٠% مادة مركزة وغذيت حيوانات المجموعة الثانية والثالثة على نفس عليقة الكنترول مع استبدال ٣% من المادة المركزة بمادة البنتونيت (المجموعة (٢)) وبمادة الدولوميت (المجموعة (٣)) واستمرت فترة التجربة من الولادة حتى الأسبوع السادس. ويمكن تلخيص النتائج بما يلى:

١- أدت إضافة البنتونيت إلى زيادة معنوية (مستوى المعنوية ٠,٠٥) فى إنتاج اللبن وفى نسبة وكمية دهن وبروتين اللبن.

٢- أدت إضافة الدولوميت إلى نقص غير معنوى فى كمية اللبن وأزادت إلى حد ما من نسبة وكمية دهن وبروتين اللبن.

٣- أظهرت إضافة كل من البنتونيت والدولوميت زيادة معنوية فى كل من نسبة البروتين الكلى ونشاط الإنزيمين الناقلين للأمين (GOT و GPT) بسيرم الدم.

٤- أنقصت إضافة الدولوميت من مستوى كوليسترول سيرم الدم معنويا.

٥- لم تسبب إضافة البنتونيت أو الدلوميت أى خلل بنسبة الكالسيوم إلى الفوسفور غير العضوى بسيرم الدم.

وبذا نستنتج أن البنتونيت يفوق الدولوميت من حيث زيادة إنتاج اللبن وزيادة نسبة الدهن فى لبن الماعز الحلاب.