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Productivity, Blood Metabolites and Carcass Characteristics of Fattening Zandi Lambs Fed Sodium Bentonite Supplemented Total Mixed Rations

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Abstract: Thirty male Zandy lambs (25±0.50 kg BW, 10 lambs in each group) were randomly allocated in three (control, 2% bentonite and 4% bentonite) treatment groups. Lambs were fed Total Mixed Rations (TMRs) containing 75% Concentrate Mixture (CM) and 25% forage. Sodium bentonite was mixed with the CM part of TMRs before being mixed with the forage. The fattening period lasted 84 days and data were collected on the performance, blood metabolites and carcass characteristics of lambs. Results showed that sheep fed bentonite added diets had relatively higher feed intake than the control group which ended to slightly higher weight change with a fairly appropriate feed conversion ratio in bentonite fed animals. Compared to the control group, a reasonably lower glucose and urea concentration and a higher total protein content was observed in the blood of sheep fed bentonite supplemented diets. The use of bentonite in diets did not affect the blood cholesterol contents of sheep. Slaughter weights, carcass dressing out percentages and carcass cuts were a bit higher in sheep of bentonite fed groups compared to those in control group. Sheep fed bentonite added diets produced carcasses with lower subcutaneous fat thicknesses and lower fat-tail percentages. Furthermore, feed cost was estimated to be lower for sheep in 2% bentonite group than that in other two groups. In conclusion, the use of two-percent sodium bentonite is suggested for diets of fattening lambs in Iranian feed markets.

Key words: Sodium bentonite, Zandi lambs, total mixed ration, live weight change, blood metabolites, carcass characteristics

INTRODUCTION

The special properties of bentonite such as hydration, swelling water adsorption and viscosity made it a valuable material for wide range of applications in industrial and farming systems (Ralph, 1968; Fenn and Leng, 1989; Agnote, 2004; Miazzo *et al*., 2005). Bentonite is actually a mixture of minerals from montmorilonite group with high ion exchange capacity which binds with different cations. This compound has been utilized as a useful material in both high-roughage and high-concentrate based diets of ruminants due to its ability in absorption of toxic products from digestion and lowering the accumulation of toxic substances in tissues ending to the reduction of internal disorder occurrences in ruminant animals (Huntington *et al*., 1977; Fenn and Leng, 1989; Walz *et al*., 1998).

Fenn and Leng (1990) suggested that the action of bentonite raised the flow rate of protozoa from the rumen of sheep and increased dry matter intakes. Moreover, it was demonstrated that bentonite improved wool growth (Fenn and Leng, 1989, 1990; Cobon *et al*., 1992), decreased ruminal ammonia concentration (Saleh, 1994; Saleh *et al*., 1999), improved feed and bacterial protein flow to the small intestine (Ivan *et al*., 1992) and enhanced growth performance in steers (Muller *et al*., 1983; Jacque *et al*., 1986), sheep (Walz *et al*., 1998) and goats (Mohsen and Tawfik, 2000). The effects of bentonite utilization in diets on the rumen fermentation and blood metabolites of sheep (Murray *et al*., 1990; Walz *et al*., 1998) and goats (Mohsen and Tawfik, 2000) and that on the carcass characteristics of lambs (Walz *et al*., 1998) were also investigated. In addition, more recently, sodium bentonite was utilized as a detoxifier in broiler diets contaminated with aflatoxin and fumonisin (Miazzo *et al*., 2005).

Bentonite resources are estimated to be about twelve million tons in Iran (Soofizadeh, 2006). Although the use of bentonite in ruminant diets is becoming more common during the recent years (Aghashahi *et al*., 2004); but, little information has been published showing the effects of bentonite on sheep performances. Therefore, the main objective of this research was to find whether sodium bentonite supplemented total mixed rations will affect the productivity, blood metabolites and carcass characteristics of fattening Zandi lambs. The economical values of control and sodium bentonite added diets were also estimated as a derivative objective.

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MATERIALS AND METHODS

Animals and management: Thirty male Zandy lambs with an average live weight of 25±0.50 kg were randomly assigned into three groups (10 lambs in each group) so that their average live weight in each treatment group was nearly equal to the overall average live weight of lambs. Sheep were at their 120±10 days of age at the commencement of experiment and the trial lasted 84 days. At the beginning of experiment, lambs were treated with Mebendazol and Amprolin as anthelmintic and coccidiostat drugs, respectively. Lambs in each treatment group were fed together in separated semi-opened pens during the adoption and experimental periods.

Animals were gradually shifted from a high-forage: Low-concentrate diet to a high-concentrate: low-forage diet during a 14 day adoption period. The Total Mixed Rations (TMRs) used for the main 84 day experimental period in this trial all contained 75% Concentrate Mixture (CM) and 25% forage. The CM parts of TMRs were comprised of barley grain, cottonseed meal, sugar beet pulp, bentonite, urea and a commercial vitamin-premix. Alfalfa hay, corn silage and barley straw were also used in the forage part of TMRs (Table 1). The lambs' relative TMRs in treatment groups were offered twice daily in almost two equal meals at 8 am and 4 pm to meet their feed requirements at an *ad libitum* level according to the AFRC (1993) recommendations. Fresh water was also available for sheep at all times during the trial. Bentonite was mixed with the CM part of rations at a level of zero (control group) and two or four percentages of TMRs and the treatments were defined as control, 2% Bentonite and 4% Bentonite groups, respectively (Table 1). The sodium bentonite used in this experiment was of the Iranian origin with the chemical analyses as described in Table 2. Bentonite was mixed with the CM part of TMRs before being mixed with the forage section.

Following 14 h feed deprivation, lambs were weighed individually at day one (D1, the beginning of trial) and at D28, D56 and D84 (the end of trial). Sheep live weight changes were then calculated based on these records. Group feed consumption of lambs was also recorded per day. Every day, for each group, the 5 to 10% of ort from the previous day was added to the amount of feed for the current day to offer lambs' daily feed allowances. Based on these data, the feed intake of lambs in each treatment group was then calculated for the overall 84 day experimental period.

Blood sampling: Jugular blood samples were obtained from lambs 3 h after morning feedings on D28, D56 and D84 of experiment. Blood samples were collected via vein puncture in vacuum blood-collecting tubes containing Ethylene Deamin Tetra Acetic acid (EDTA). Samples were placed on ice, transported to the laboratory and centrifuged at 1500 x g and 4°C for 15 min. Plasma was harvested from samples and stored at -20°C until further analyses. The glucose content of samples was then measured using the method described by Barham and Trinder (1972). The cholesterol content of samples was determined through the method of Deeg and Ziegenhorn (1983). The Thomas (1998) method was also used to measure the total protein, urea, albumin and the globulin contents of blood samples.

Slaughter and carcass measurements: At the end of the experiment, all 30 lambs from three treatment groups were weighed after 14 h feed deprivation and slaughtered at Aburayhan Animal Research Unit abattoir using the Iranian slaughter method (Kashan *et al*., 2005). The lambs' liver and kidney were removed immediately after slaughter and weighed separately. The kidney surrounding fat was also collected and considered as the kidney fat. The Lambs' Carcass subcutaneous fat (rib fat) thickness was measured on carcasses between the 13-14th rib areas. The longissimus muscle (eye muscle) areas were also measured on the muscle taken from the 13-14th ribs of lambs' carcasses. In addition, the weight of offal parts of carcasses, namely; the feet, pelt, heart, lung and the spleen weights were also recorded. The hot carcasses weights were recorded at slaughter and the carcasses were chilled at 4°C overnight to record the weight of cold carcasses. After chilling, the carcasses were all longitudinally divided into two equal parts according to the procedure shown in Fig. 1. The right side of all

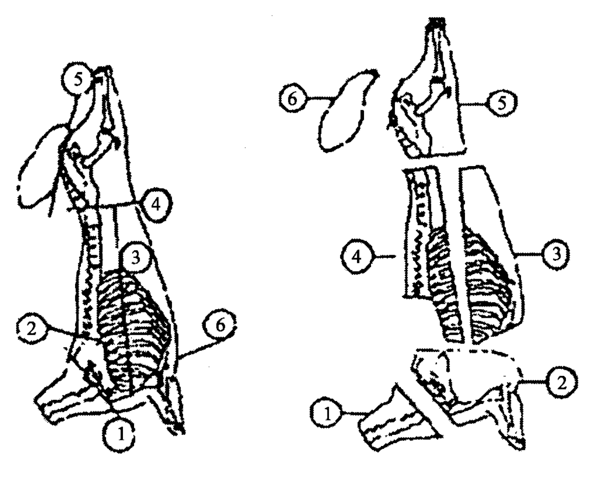

Fig. 1: Wholesale cuts of lambs' carcass. (1) Neck, (2) Shoulder, (3) Brisket, (4) Loin, (5) Leg and (6) Fat-tail

Table 1: The ingredients, energy and protein contents of control and sodium bentonite supplemented total mixed rations used in experiment (dry matter bases)

	Total mixed rations		
Items	Control	2% bentonite	4% bentonite
Ingredients (g kg^{-1})			
Alfalfa hay	150.0	150.0	150.0
Corn silage	75.0	90.0	100.0
Barley straw	25.0	10.0	-
Barley grain	550.0	600.0	620.0
Cottonseed meal	45.5	45.5	45.5
Sugar beet pulp	150.0	80.0	40.0
Sodium bentonite	-	20.0	40.0
Urea	3.0	30.0	3.0
Vitamin-premix[1]	1.5	1.5	1.5
Energy and protein contents[2]			
Metabolisable energy (ME, MJ kg^{-1})	10.8	10.7	10.6
Fermentable ME (MJ kg^{-1})	10.1	10.0	10.0
Effective rumen degradable protein (g kg^{-1})	100.0	100.0	102.0
Digestible rumen undegradable protein (g kg^{-1})	22.2	21.3	22.3
Metabolisable protein (g kg^{-1})	85.6	85.3	86.0

[1]: Contained of, vitamin A 50000 IU kg^{-1}, vitamin D_3 1000 IU kg^{-1} and vitamin E 100 IU kg^{-1} of premix; [2]: Calculated based on AFRC (1993)

Table 2: The chemical composition of sodium bentonite used in experiment

Items	g kg^{-1}
SiO_2	707.4
Al_2O_3	155.0
Fe_2O_3	22.3
Na_2O	21.2
MgO	8.5
CaO	4.6
K_2O	2.4
SO_3	1.7
Loss of ignition[1]	76.9

[1]: Sodium bentonite weight loss at 1000°C

carcasses were then cut into six separate pieces comprising neck, shoulder, brisket, loin, leg and fat-tail and their weights were recorded separately.

Economical evaluation: The commercial price for one kg of each feed ingredient used in this experiment was as; 1500, 300, 250, 1500, 1350, 1200, 8000, 650 and 500 Rials (Iranian currency) for alfalfa hay, corn silage, barley straw, barley grain, cottonseed meal, sugar beet pulp, vitamin-premix, urea and bentonite, respectively (each 9400 Rials = US 1$). By employing of these prices and via the amounts of ingredients used in different diets (Table 1), the feed costs for each kg of TMRs were estimated. Based on these data, the expenditure needed for each kg of live weight gain in lambs of each treatment group (Table 3) was then calculated. Since the labor costs and the all other rearing costs were the same for sheep in each of three treatment groups, the economical evaluation for the control and bentonite supplemented TMRs was reported based only on the aforementioned feed costs needed for obtaining 1 kg live weight in lambs of different treatment groups.

Statistical analysis: The trial was conducted using a completely randomized design by considering the three diets (i.e., TMRs contained zero (control) and two or four percentages of bentonite) as the main effects. Data were analyzed using SAS statistical software (SAS, 1999). The repeated measures analysis of variance (Littell *et al*., 1998) was used to analyze the performance and blood metabolites related data which were collected in repeated times during the experiment. But, the slaughter and carcass characteristics related data were analyzed using the ordinary GLM procedure of SAS (1999). Lambs' initial live weights were considered as co-variate in statistical models. Mean separation was achieved using an F-protected least significant differences test at $p<0.05$ level.

RESULTS AND DISCUSSION

Lambs' performances: Data in Table 3 show that Daily Feed Intake (DFI), Live Weight Gain (LWG) and Feed Conversion Ratio (FCR) of sheep were not significantly affected by treatment groups. But, sheep fed bentonite supplemented TMRs had relatively ($p>0.05$) higher DFI than that in sheep of control group which ended to a slightly higher LWG and a fairly more appropriate FCR in sheep fed bentonite added TMRs (Table 3). The slightly higher LWG and the improved FCR might be explained by increased feed and microbial protein supply to the small intestine of sheep fed bentonite supplemented TMRs compared to that in sheep of control group (Ivan *et al*., 1992). However, Fenn and Leng (1990) suggested that the action of bentonite in diets may increase the flow rate of protozoa from rumen to intestine rather than the flow rate of feed.

The variation in dry matter intake may be due to the type of diet and bentonite levels. In the study of Jacquce *et al*. (1986), when sodium bicarbonate and sodium bentonite were used at 1 and 2%

Table 3: The effects of control and bentonite supplemented total mixed rations on the performance and blood metabolites of lambs (mean±SE)

Items	Total mixed rations			p-values		
	Control	2% bentonite	4% bentonite	Control vs. 2% bentonite	Control vs. 4% bentonite	2% bentonite vs. 4% bentonite
No. of lambs	10.00	10.00	10.00	-	-	-
Performance						
Feed intake (g d^{-1})	1060.00	1070.00	1100.00	-	-	-
Live weight gain (g d^{-1})	177.00±120	180.00±120	176.00±110	0.6754	0.9664	0.6451
Feed conversion ratio	6.44±027	6.26±0.46	6.33±0.31	0.8608	0.7174	0.5917
Blood metabolites						
Glucose (mg dL^{-1})	72.07±1.33	66.63±1.53	69.93±1.69	0.6544	0.0206	0.0070
Cholesterol (mg dL^{-1})	38.10±1.26	34.65±1.36	34.96±1.20	0.1512	0.1578	0.9762
Albumin (g dL^{-1})	3.28±0.06	3.33±0.14	3.49±0.08	0.0010	0.0010	0.0600
Globulin (g dL^{-1})						
Alfa globulin	0.33±0.02	0.27±0.02	0.29±0.01	0.0220	0.1780	0.3028
Beta globulin	0.50±0.02	0.56±0.02	0.51±0.02	0.1862	0.8513	0.2510
Gamma globulin	1.53±0.07	1.91±0.08	2.00±0.08	0.0097	0.0070	0.8801
Urea (mg dL^{-1})	34.50±1.66	28.12±1.68	29.61±1.66	0.0050	0.0024	0.5378
Total protein (g dL^{-1})	5.52±0.86	5.83±0.10	5.94±0.09	0.0909	0.0236	0.5160

levels in diets containing 50 or 84% of silage, sodium bicarbonate increased dry matter intake of steers in 50% group, but neither compounds were affected the intake of steers in 84% group. Martin *et al.* (1969) reported that adding bentonite in high-roughage diet of growing Lambs' improved their feed utilization; but, when it was used in high-concentrate diets, lambs' feed intake was not significantly affected. Saleh (1994) reported that dry matter intake was not affected by adding bentonite in diets of goats and sheep. But, Muller *et al.* (1983) found that supplementation sodium bentonite at a level of two-percent in diet increased feed intake of young steers fed high energy containing rations. In addition, dry matter intake and average daily gain were fairly increased in lambs fed bentonite supplemented high-concentrate diets in the study of Walz *et al.* (1998).

Mohsen and Tawfik (2000) noted that the addition of bentonite to the ration of goats caused significant improvement in feed conversion ratio. Bentonite also significantly increased the daily live weight gain of goats without a significant difference between the levels (two-and a-half and five-percent of diets) which were used in that study. In contrast, supplementation of diet with bentonite decreased daily gain of sheep in the study of Ivan *et al.* (1992). However, both Ivan *et al.* (1992) and Saleh (1994) reported that the inclusion of bentonite significantly improved feed conversion ratios in treated lambs compared to that with no treated, control, lambs. In addition, in agreement with the results of the present study (Table 3), Ha *et al.* (1985), Murray *et al.* (1990) and Saleh (1994) also reported that the addition of bentonite in diets at the levels of two, two and a half and five-percent improved the growth rate of lambs.

Blood metabolites: The inclusion of bentonite at two and four-percent levels in diets had no significant effect on blood cholesterol concentrations of lambs, but both the glucose and albumin concentrations were significantly ($p<0.05$) affected by bentonite supplementation in diets (Table 3). In addition, blood urea content also tended to be lower ($p<0.05$) in lambs fed bentonite added TMRs than that in the control group. Sheep blood Beta globulin concentration was not affected by treatment groups, but lambs fed bentonite supplemented diets tended to have lower ($p<0.05$) Alfa globulin and higher ($p<0.05$) Gama globulin in blood than those in lambs of control group (Table 3). In the present study, the reasonably lower consecration of glucose in blood of lambs fed bentonite added diets, compared to that in control group, could be attributed to the decreased blood urea in these groups of animals indicating that bentonite fed animals had the opportunity to release ammonia very steadily in rumen environment allowing the rumen pool to have a chance to balance microbial protein production through better utilization of glucose and ammonia and hence improving the blood total protein consecrations. In agreement with these results, Saleh (1994) showed that adding bentonite to the sheep diets containing urea significantly decreased their blood urea concentration. Furthermore, Ivan *et al.* (1992) reported that the use of bentonite in grain-based diets increased the pH of ruminal fluid and improved the feed and bacterial protein flow to the small intestine of sheep. In contrast to present findings, Ghanem (1995) reported that bentonite had no significant effect on blood albumin concentration, but globulin fraction was, however, significantly affected by bentonite inclusion in diets of farm animals in that study. Total protein concentration was significantly ($p<0.05$) increased in blood of lambs fed 2% bentonite supplemented TMR compared to that in lambs of control and 4% bentonite groups (Table 3). In agreement with this result, Ghanem (1995) observed significant increase in serum protein of

Table 4: The effects of control and sodium bentonite supplemented total mixed rations on the slaughter weights, carcass characteristics, carcass cuts and the offal parts of lambs (mean±SE)

	Total mixed rations		
Items	Control	2% bentonite	4% bentonite
No. of lambs	10.00	10.00	10.00
Slaughter weight (kg)	38.70±2.06	40.00±1.36	38.50±1.99
Carcass characteristics			
Hot carcass weight (kg)	18.33±0.98	18.45±0.81	18.08±1.15
Hot carcass dressing out (%)	47.39±0.62	48.01±0.67	47.75±0.73
Cold carcass weight (kg)	17.65±0.96	18.27±0.78	17.82±1.14
Cold carcass dressing out (%)	45.65±0.78	46.60±0.63	46.82±0.72
Longissimus muscle area (mm^2)	1908.00 ± 167^b	2286.00 ± 761^a	2119.00 ± 125^{ab}
Subcutaneous fat thickness (mm)	6.28 ± 0.47^a	4.70 ± 0.26^b	3.88 ± 0.42^b
Kidney fat (kg)	0.51±0.07	0.41±0.03	0.45±0.06
Kidney fat (%)	1.29±0.18	1.02±0.07	1.17±0.15
Carcass cuts			
Neck (kg)	1.29±0.08	1.40±0.08	1.31±0.09
Neck (%)	7.38±0.41	7.79±0.57	7.38±0.26
Shoulder (kg)	1.17±0.09	1.21±0.09	1.05±0.07
Shoulder (%)	6.66±0.38	6.78±0.26	6.34±0.19
Brisket (kg)	5.07±0.24	5.32±0.24	5.07±0.35
Brisket (%)	28.95±0.76	29.09±0.54	28.91±0.40
Loin (kg)	2.64±0.14	2.65±0.12	2.60±0.19
Loin (%)	14.78±0.25	14.99±0.38	14.98±0.49
Leg (kg)	5.25±0.28	5.27±0.21	5.26±0.23
Leg (%)	28.89±0.74	28.90±0.52	29.95±0.98
Fat-tail (kg)	2.51 ± 0.25^a	1.78 ± 0.15^b	1.98 ± 0.17^{ab}
Fat-tail (%)	13.08 ± 1.05^a	10.12 ± 0.71^b	11.23 ± 0.90^b
Offal parts			
Feet (kg)	0.76±0.04	0.78±0.02	0.80±0.03
Feet (%)	1.97±0.06	1.97±0.04	2.10±0.06
Pelt (kg)	4.80±0.28	4.78±0.25	4.45±0.23
Pelt (%)	12.47±0.47	11.95±0.48	11.57±0.26
Heart (kg)	0.14±0.01	0.16±0.01	0.15±0.01
Heart (%)	0.38±0.01	0.41±0.02	0.39±0.01
Liver (kg)	0.66±0.02	0.65±0.03	0.63±0.02
Liver (%)	1.74±0.08	1.61±0.11	1.65±0.03
Kidney (kg)	0.11±0.005	0.10±0.003	0.10±0.003
Kidney (%)	0.27±0.007	0.26±0.008	0.27±0.008
Lung (kg)	0.46±0.02	0.47±0.01	0.45±0.01
Lung (%)	1.23±0.09	1.19±0.06	1.18±0.05
Spleen (kg)	0.09±0.004	0.09±0.005	0.10±0.007
Spleen (%)	0.24±0.01	0.23±0.01	0.26±0.01

$^{a, b \text{ and } c}$: Means within a row not followed by the same subscripts statistically different at p<0.05

sheep fed ration containing ammoniated rice straw supplemented with four-percent of sodium bentonite. However, Saleh (1994) reported that bentonite had no significant effect on the total plasma protein of sheep.

Carcass characteristics: Lambs' weight at slaughter was not significantly affected by treatment groups, but a slightly difference in this regard ended to a fairly higher ($p>0.05$) hot and cold carcass dressing out percentages in lambs fed bentonite added TMRs compared to those in sheep of control group (Table 4). Furthermore, lambs in control group performed carcasses with significantly lower ($p<0.05$) longissimus muscle areas than their counterpart groups. It is while sheep fed bentonite added diets performed carcasses with substantially lower ($p<0.05$) subcutaneous fat thicknesses compared to those in control group. In addition, lambs having diets with bentonite had carcasses with two to-three percent lower ($p<0.05$) fat-tail than that in lambs of control group. These results show that bentonite has the capability in degradation of dietary protein in the rumen towards an augmentation in ruminal bacterial protein production by balancing and normalization mixed ruminal population of protozoa (Ivan *et al*., 1992). Fenn and Leng (1990) suggested that a possible action of bentonite is an increased flow rate of protozoa from the rumen, as opposed to an increased post-ruminal supply of dietary protein. Bentonite supplementation with diets also decreased the breakdown of feed protein contents, thereby increasing the flow of dietary N from the stomach to the small intestine (Ivan *et al*., 1992).

Although the exact mechanism of the effects of bentonite on the apparent ruminal degradability of dietary protein might not clearly be known; but, it could be speculated, however, that because bentonite is a very good absorbent of ruminal substrates such as ammonia (Britton *et al*., 1978; Jacques *et al*., 1986), it might be able to absorb some proportion of proteolytic enzymes and decrease their actions which otherwise would act on the dietary protein. The other alternatives could be the absorption of free dietary amino acids by bentonite in rumen and hence increasing the bacterial microbial protein in the stomach of bentonite fed animals. In this latter case, since the amino acids would not be all accessible to bacterial fermentation in the rumen, their transport into the small intestine would be enhanced (Ivan *et al*., 1992). Furthermore, bentonite was supposed to have beneficial effects on either the rumen pool size or the turnover rates of ruminal fluids in sheep (Fenn and Leng, 1989). If a larger proportion of the total protozoa pool was free in ruminal fluids, the outflow from the rumen and the overall turnover rate of protozoa in the rumen would be increased. The result of this would be a reduced nutrient demand for maintenance requirements of gust animals due to a reduced average retention time and hence increased nutrient availability for growth and multiplication in animals fed sodium bentonite added diets. If growth rates were increased, then the same total pool of protozoa would be able to support a greater outflow down the tract and remain in equilibrium.

In addition, the apparent effect of bentonite on the rumen protozoa (Fenn and Leng, 1989) was suggested to be as a possible reason for the higher growth rates and lower fat accumulation in carcasses of farm animals when bentonite was offered to sheep diets. In this regard, Walz *et al.* (1998) reported that when sodium bentonite was used in replacement of fish-meal in high-concentrate diets of lambs, no considerable differences were observed on the carcass characteristics of animals in two groups indicating that, compared to sheep fed fish meal contained diets, sheep received bentonite in diet could partially compensate their true protein requirements via an enhancement in bacterial microbial protein production in the rumen. However, in contrast to the higher ($p<0.05$) longissimus muscle areas and lower ($p<0.05$) subcutaneous fat thicknesses obtained for sheep fed bentonite added diets, compared to those in control group, in this study (Table 4), Walz *et al.* (1998) reported that in sheep fed 0.75% bentonite added diet, in comparison to those not receiving bentonite in diet, these carcass characteristics were not significantly affected. This might signify that at least two-percent of bentonite is needed to be used in high-concentrate diets of lambs to enable them to demonstrate their potential in changing rumen bacterial microbial populations in favor of producing carcasses with reasonably lower fat and higher protein contents.

Economical estimations: Based on the prices already mentioned for the individual feed ingredients and by the use of information from Table 1 and 3, the feed costs for performing each one kg of live weight gain were estimated to be as; 9455, 8952 and 8967 Rilas for lambs fed control, 2% bentonite and 4% bentonite TMRs, respectively. These data designate that, under the Iranian commercial feed markets, if sodium bentonite was added to the high-concentrate finishing diets of lambs at levels of two or four percentages, their nutritional expenditures would decrease about six percentages. Since sheep in 2% bentonite group, compared to the control and 4% bentonite groups, had relatively higher live weight gain and produced moderately more appropriate market accepted carcasses (Table 3 and 4) with reasonably lower expenditures, the use of sodium bentonite at a level of two-percentage is suggested for lamb fattening systems in Iran. In agreement with this finding, two-percent of sodium bentonite was suggested to be mixed with grain rations to help to reduce the risk of poisoning during grain introduction to the ration of lambs in drought feeding and managing systems of Australia (Agnote, 2004).

CONCLUSIONS

It can be expressed that sodium bentonite has potential to relatively increase the dry matter intakes and to proportionally improve feed conversion ratios in Zandy fattening lambs. Based on the reasonably high live weights at slaughter accompanied with the production of carcasses with substantially lower subcutaneous fat thicknesses and that of lower fat-tail contents in sheep fed sodium bentonite supplemented diets and also due to the relatively lower expenditures spent for the feed of these sheep, compared to those in sheep of control group, two-percent of sodium bentonite is suggested to be used in total mixed rations of lambs under Iranian feed markets.

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