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Effect of Adding a Different Level of Bentonite on Arabi Lamb Performance and Nutrients Digestibility

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Abstract:. This study was conducted in one of the private fields in Maysan province to study the effect of adding a different level of bentonite to the lamb diets on the performance of lambs. The study included (18) male Arabi lambs weighted 24.5±1.22 kg and lasted 120 days. Lambs were taken after weaning at the age of 3 to 4 months. They were randomly divided into six groups. The diet was provided on the basis of 3% of live body weight. The diets of the trial included (A) a basic diet of 50% concentrated fodder + 50 alfalfa without any addition. (B) A plus 2% bentonite/ dry matter. (C) A plus 4% bentonite/ dry matter. Treatment (D) a diet of 100% concentrated feed + hay *ad libitum* (basic diet 2) and without any addition. (E) D plus 2% bentonite. (F) D plus 4% bentonite. The diet significantly affected the average final weight and total weight gain in favor of lambs fed treatment D (100% concentrated feed) with average final weight and total weight gain 46.57 and 22.11 kg, respectively. The addition of bentonite improved the rates of the rate of total weight gain is 17.71, 20.85 and 19.50 kg without adding and adding bentonite (2%) and bentonite (4%), respectively. The diet significantly affected the digestion rate of DM, OM, CP, EE, and NDF. Their digestion coefficients of 100% concentrate group were (75.98, 80.70, 80.09, 65.31 and 31.67%, respectively). 50% concentrated fodder (70.26, 71.53, 76.22, 45.47 and 27.36%, respectively).

Keywords: Bentonite, Concentrate: roughages, Lambs, Performance.

Introduction

Feeding ruminants depend on the consumption of generally coarse feeds that are poor in nitrogen and high in fiber (Kleefisch *et al.*, 2017). A group of fermentation in the rumen is caused by microorganisms, some of which subsequently transfer with the mass of undigested feed in the intestines to turn into microbial protein. Feeding roughages causes a decrease in the intake and digestion in the rumen. As well as the emission of gases is seen as a loss of animal energy and an economic loss for breeders (Morgavi *et al.*, 2010).

It is believed that bentonite affects the production of volatile fatty acids, especially acetate and pyruvate by reducing the number of bacteria that cause the conversion of pyruvate to acetate and thus reduce the availability of hydrogen ion inside the rumen (reduce the production of methane, Gouda *et al*., 2019). Bentonite can also be used in the manufacture of animal feed as an adhesive that binds food ingredients, a growth promoter, and to reduce the toxicity of some substances found in food such as aflatoxins and the toxicity of some insecticides (Maki *et al*., 2016). Bentonite also has the ability to store ammonium ions from rapidly degraded nitrogen sources (Helal & Abdel-Rahman, 2010). Different studies indicated that bentonite has the ability to maintain the pH value of the rumen fluid within normal limits and thus increase the utilization of the feed intake as well as improve the productive and physiological performance of animals (Bhatti & Sahota, 1998; Khattab *et al*. 2007; Hassan, 2009).

The present study aims to investigate the effect of adding different levels of bentonite to lamb diets on a productive performance that include body weights, total growth rate, feed consumption, and feed conversion ratio. Determination of nutrient digestion coefficient and some rumen parameters, which include pH, volatile fatty acids, total bacteria count, methane and ammonia concentrations.

Materials & Methods

Animal and nutrition groups

This study was conducted in one of the private fields in Maysan Governate for the period from 8/11/2018 to 22/2/2019. The study included 18 male Arabi lambs were randomly chosen after weaning at the age of 3 to 4 months with an average weight of (24.5 ± 1.22 kg). They were randomly divided into six groups by three animals/ group. The diet was provided on the basis of 3% (dry matter) of live body weight, and the amount of feed provided was adjusted every two weeks based on the new weight of each group. Diets were A (50% alfalfa, 50% concentrate and zero bentonites), B (50% alfalfa, 50% concentrate and 2% bentonites), C (50% alfalfa, 50% concentrate and 4% bentonites), D (100% concentrate and zero bentonites), E (100% concentrate and 2% bentonites), and F (100% concentrate and 4% bentonites). Concentrate diet included 38% corn, 22% barley, 30% wheat bran, 8% soya bean meal, and 2% mineral & vitamin. Table (1) shows the chemical composition of the concentrated feed and alfalfa used in this study.

The lambs were placed in semi-enclosed and equal sheds where each area was allocated an area of (2x2 m) and equipped with fodder and water strips throughout the study period. The feed was given on two meals in the morning (7 am) and evening at (3 pm).

Veterinary medical care continued throughout the study, where the animals were dosed against the intestinal and hepatic worms with Albendazole by 10 cm^3/ each animal. The animals were also given subcutaneous ivermectin for the prevention of external and internal parasites.

The lambs' initial body weights were taken after they were left for two weeks to adapt to the study conditions and their weights were recorded every two weeks until the end of the study period.

Table (1). Chemical composition of the concentrate diet and alfalfa used in the present study.

Items	Concentration	Alfalfa
Dry matter	91.43	24.00
Crude protein	13.33	17.00
Ether extract	4.12	3.50
Crude fiber	7.52	27.20
Nitrogen free extract	67.79	39.40
Ash	3.32	11.20
Metabolizable energy**	12.74	8.50

The amount of feed consumed per day was calculated and the efficiency of the feed conversion was calculated as the kg of feed consumed/ kg of growth rate. Weight growth rates were calculated as the difference in body weights between two different times. Samples of rumen liquid were taken monthly from the start of the study until the end of the trail after 3 hours of morning feeding. Estimate the digestion coefficient at the end of the study.

At the end of the study, the lambs were distributed and fed individually for ten days and in the last three days, feces samples were taken in the morning before feeding. Feces of each lamb was mixed and a sample of 10% was taken, placed in nylon bags until the chemical analyses were carried out. The chemical analysis included the percentage of moisture, protein, fiber, fat, and ash (A.O.A.C, 2001), NDF and ADF according to the methods described by Van Soest *et al*. (1991). ME estimated according to MAFF (1987): ME (MJ)= 0.012 CP+ 0.031EE+0.005CF+0.014NFE, The analysis was done in the Nutrition Laboratory, General Company for Livestock Services, Ministry of Agriculture, Baghdad, Abu Ghraib.

Statistical analysis

Data were analyzed as a completely randomized design using the General Linear Models procedure of SPSS (version, 24 IBM SPSS Statistics). The design included two factors, the first was level of concentrate (50% and 100%) and the second factor was the level of bentonite (0, 2, and 4%). The mathematical model was included: $Y_{ijk}=\mu+ A_{i.} + B_{.j}+ AB_{ij}+ e_{ijk}$; where Y_{ijk} is a k^{th} observation which belongs to i^{th} feeding type, j^{th} bentonite level, µ is the common mean, A_i is the effect of i^{th} feeding type (50% and 100% concentrate), B_j is the j^{th} bentonite level (0, 2 and 4 %), AB_{ij} is the interaction effect of both factors and e_{ijk} is the randomly normal distributed experimental error associated with each observation.

Results & Discussion

Bodyweight and growth rate

Table (2) indicates that there were no significant differences (P> 0.05) between treatments (0, 2 and 4% of bentonite) on body weight during the first, second and third month. The overall weight gain was significantly (P<0.05) improved in favor of the additional factors (2% and 4% of bentonite), which reached 20.85 and 19.50 kg, respectively, compared to the control treatment (17.71 kg). The reason behind this improvement may be due to the adsorption property of bentonite, which creates a state of balance in the concentration of ammonia.

inside the rumen and improve the digestibility of the feed consumption.

Hasna & Al-Qaisi (2001) also found significant differences in the rate of daily and total growth rate when adding bentonite by (0, 2% and 4%) to the diets of Awassi lambs, there was a significant superiority (P <0.05) in favor of the addition treatments (2% and 4%) compared to control. However, Azadbakht *et al*. (2017) found insignificant differences in growth gain when added bentonite (0, 1.5 and 3%) to lambs' diet. The relationship between the weight gain and the percentage of bentonite added to the diet was positive and non-linear, especially in the third month of the study (Fig. 1). The peak of the increase occurred when the addition of 2% of bentonite, weight gain decreased after the addition of 4% of bentonite with very high accuracy almost up to (R^2= 100%). Table (2) also indicates that there were significant differences (P <0.05) in the average final weight and total weight gain in favor of the treatments consisted of (100% concentrated feed) compared to the treatments consisted of (50% concentrated feed and 50% alfalfa). Mean final weight and total weight gain rate of 100% concentrated feed were 46.57 and 22.11 kg, respectively. Those of 50% concentrated feed and 50% alfalfa were 41.53 and 16.60 kg respectively.

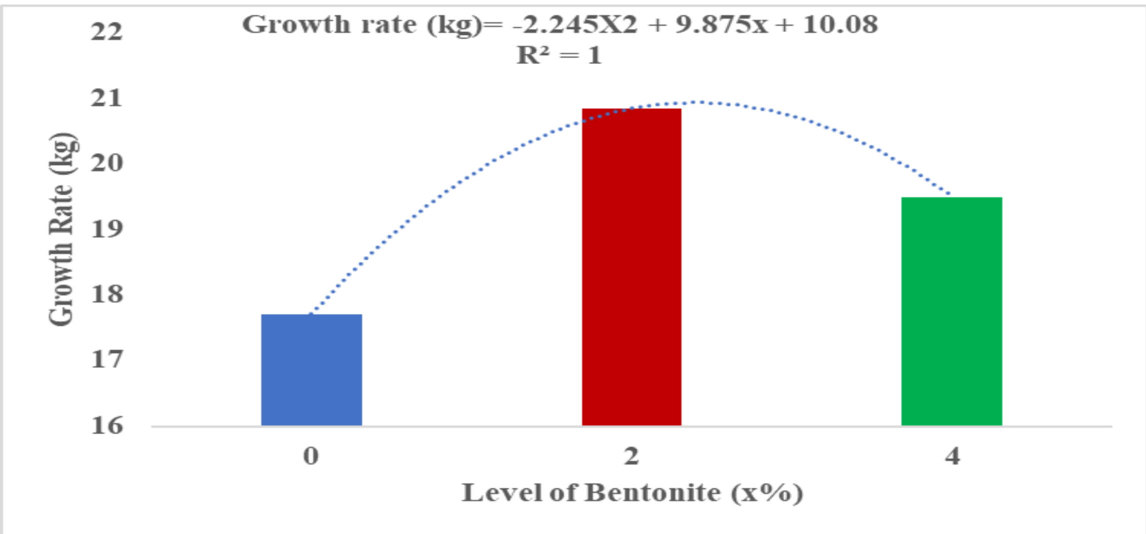

Fig. (1): Association of the level of bentonite (0, 2 and 4%) and lamb growth rate.

Table (2): Effect of adding different bentonite levels on mean live weights and total weight gain rate (kg/ head) for different experimental factors ± Standard deviation.

Treatments	Body live weight (kg)				Total growth rate (kg)
	Initial	1st month	2nd month	3rd month	
Effect of adding bentonite (%)					
0	24.75±3.38	3. 65±29.66	4.15±35.35	5. 03±42.46	4. 46±17.71b
2	24.78±2.39	08.3±08.30	15 .4±08.37	70.4±63.45	25 .3±85.20a
4	24.56±1.74	2.44±29.03	3.25±36.41	4.68± 44.06	19.50± 3.62 ab
p- value	NS	NS	NS	NS	0.05
Effect of different diet					
50% concentrate: 50% alfalfa	2. 78±24.93	3.37± 28.71	3. 92±34.70	53.41±4. 53 b	2.99±16.60 b
100% concentrate	2.18±24. 46	2.56±30.47	2.87± 37.86	46.57±3.49 a	22.11±2.23 a
p-value	NS	NS	NS	0.05	0.05
Effect of interaction					
A	61.3±03.25	3.45±43.28	3.00±96.32	38.93±2.61b	13.90±1.81b
B	3.38±25.25	4.54±76.29	5.07±20.36	44.13±5.22ab	19.03±2.17 a
C	2.51±24.66	3.20±27.93	4.34±34.93	41.53±5.30ab	16.80 ±2.80ab
D	2.91±46.24	4.10±30.90	4.13±37.73	46.00±4.35a	21.53±1.70 a
E	1.61±46.24	2.81±30.40	3.88±37.96	47.13±4.62a	22.66±3.44 a
F	1.10±47.24	1.02±13.30	3.96±90.37	46.60±2.72a	22.13±2.05a
p-value	NS	NS	NS	0.05	0.05

**** A(50% alfalfa, 50% concentrate and zero bentonites), B (50% alfalfa, 50% concentrate and 2% bentonites), C (50% alfalfa, 50% concentrate and 4% bentonites), D (100% concentrate and zero bentonites), E (100% concentrate and 2% bentonites), and F (100% concentrate and 4% bentonites)**

Table (2) showed that there were significant differences (P< 0.05) for the effect of the interaction between the diet and the addition of bentonite in the weight of the third month and the total weight gain. The fifth group, with a diet of 100% concentrate plus 2%, or 4% bentonite gave the highest rate in the final weight and the total weight gain rate, respectively, which was 47.13 and 22.66 kg in comparison with the first group (50% concentrate+ 50. % alfalfa without adding bentonite) which recorded the lowest value 38.93 and 13.90 kg, respectively.

The reason for this improvement is due to the adsorption property of bentonite, which creates a state of balance in the concentration of ammonia within the rumen and improves the digestion coefficient of consumed feed in addition to the role of bentonite in improving the environment of the rumen and stimulate the growth of microorganisms in the rumen. It is the main provider of nitrogen needed to build its bodies and get a good number of them and may have played a key role in increasing the intake of dry matter and this reflected positively on the overall performance of lambs, especially in growth characteristics (Tayyeb, 2017).

Nutrients Digestion

Table (3) shows a significant superiority ($P <0.05$) of the average dry matter digestion coefficient in lambs to which bentonite diets were added by 2 or 4%, respectively (77.50 and 74.63%, respectively) compared to lambs with no addition of bentonite. There was a significant difference ($P <0.05$) in the protein digestibility coefficient of lambs with 2% bentonite diets (80.11%) compared to lambs with no bentonite in their diets (76.84%), the differences were not significant between 2 and 4% bentonite groups. There were no significant differences between the lambs fed diet contain 4% bentonite (77.52% DM digestibility coefficient) compared to the lambs with no bentonite diets. As well as crude fiber, NDF and ADF and nitrogen-free extract (NFE) digestibility of different diet groups were similar. These finding may be attributed to the fact that bentonite has a significant effect on the digestion of dry matter, crude protein and ether extract through the absorption of water by bentonite in the digestive tract, which increases the volume of feed intake and thus reduces the speed of feed passage in the digestive tract, increases the rate of digestion and reduces undigested feed by 10-20% (Alhaisheh, 2015); or perhaps these changes are because bentonite has the property of adsorption of some enzymes that degraded protein in the rumen and increased the amount of protein in the intestine, bentonite also has the ability to store ammonium ions from rapidly degraded nitrogen sources (Helal & Abdel-Rahman, 2010). In addition, bentonite has the ability to increase its volume to 20 times when exposed to moisture and thus will increase the surface area that absorb ammonia resulting from the decomposition of nitrogen compounds, especially urea and then regulates its release according to the concentration of ammonia within the rumen and thus will reflect positively on digestion protein and dry matter in the diet (Gouda *et al*., 2019).

In the case of ether extract, bentonite clay absorbs unsaturated fatty acids and protects them from breakage in the rumen and moves to the intestines, which increases the digestion coefficient of fat (Oliveira *et al*., 2016), especially when added at a level of 2%. These results are consistent with the results of Helal & Abdel-Rahman (2010) when they added yeast and bentonite by 0.5 and 4%

Table (3): Effect of adding different bentonite levels on mean live weights and total weight gain rate (kg/ head) for different experimental factors ± Standard deviation.

Treatments	DM%	OM%	CP%	EE%	CF%	NDF%	ADF%	NEF%
Effect of adding bentonite (%)								
0	67.24±6.35b	75.24±6.09	76.84±2.25 b	55.84±7.41	66.82±5.67	30.99±5.50	34.69±6.78	85.54±5.21
2	77.50±4.28a	77.16±5.28	80.11±2.82a	54.19±6.22	69.79±4.95	29.03±4.26	34.94±4.50	85.53±3.50
4	74.63±5.10a	75.65±5.04	77.52±5.25 b	56.14±6.54	68.69±3.99	28.53±3.67	33.18±3.82	82.91±3.53
p- value	0.05	NS	0.05	NS	NS	NS	NS	NS
Effect of different diet								
50% concentrate: 50% alfalfa	70.25±6.82 b	71.53±4.02b	76.22±2.69 B	4.47±3.69 B	67.08±6.16	27.36±3.60b	32.95±5.42	88.91±2.34a
100% concentrate	75.98±5.48 a	80.70±1.15 a	80.09±3.77 A	65.31±3.43 A	69.79±2.57	31.67±3.07 a	35.58±4.31	82.41±1.82 b
p-value	0.05	0.05	0.05	0.05	NS	0.05	NS	0.05
Effect of interaction								
A	64.16± 5.57	70.19±1.70	73.69 ±1.90 b	49.10±6.10C	63.61 ±6.89B	29.38 ±6.35	34.14 ±7.03	90.01±1.50
B	75.46±5.60	73.24±4.67	57.78 ±97.1c	44.35±4.13Cd	70.16 ±7.20A	26.28 ±4.40	33.93 ±6.66	88.49±1.88
C	71.16±5.12	71.15±4.68	76.41±1.90B	42.95±2.40D	67.46± 4.48	26.43± 4.00	30.79±3.61	88.22±3.64
D	70.32±6.44	80.28±1.66	81.35±4.65A	62.58±2.06B	70.08±1.44 A	32.61±5.24	35.24±8.03	81.06±2.35
E	79.55±1.37	81.08±1.39	81.64±3.01A	64.03±3.77Ab	69.41±2.98A	31.78±1.85	35.95±1.82	82.57±0.95
F	78.10±1.67	80.74±1.37	77.28±2.92 B	69.33±1.61 a	69.92±3.90 a	30.63±2.11	35.57±2.52	83.60±1.41
p-value	NS	NS	0.05	0.05	0.05	NS	NS	NS

**** A(50% alfalfa, 50% concentrate and zero bentonites), B (50% alfalfa, 50% concentrate and 2% bentonites), C (50% alfalfa, 50% concentrate and 4% bentonites), D (100% concentrate and zero bentonites), E (100% concentrate and 2% bentonites), and F (100% concentrate and 4% bentonites)**

respectively to the ewe diets, where there was a significant superiority (P <0.05) in the digestibility of both dry matter and crude protein in favor of the Yeast and bentonite treatments compared to the control. However, the present results disagree with that obtained by Aazami *et al.* (2017) who found no significant differences in digestion coefficient of organic matter, ADF and NDF fibers when feeding Balouchi sheep diets containing bentonite by 4% compared to control treatment.

Table (3) also indicated significant differences (P <0.05) in the digestion coefficient of dry matter, organic matter, crude protein, ether extract and NDF in favor of lambs whose diets consisted of (100% concentrated feed) which reached 75.98, 80.70, 80.09 and 65.31 and 31.67% respectively compared with lambs whose rations consisted of (50% concentrated feed and 50% even) which were 70.26, 71.53, 76.22, 45.47 and 27.36% respectively. Also, the results indicated a significant superiority (P <0.05) in the digestion coefficient of nitrogen-free extract in favor of lambs whose diets consisted of (50% concentrated feed and 50% even) which was 88.91% compared to lambs whose diets consisted of (100% concentrated feed). There were no significant differences (P <0.05) in the digestibility of crude fiber and ADF between the two-dietary composition.

There were significant differences (P <0.05) due to the effect of interaction between bentonite levels and type of feed in the crude protein and the ether extract digestion coefficients (table, 3). The first group (50% concentrate + 50% alfalfa without adding bentonite) recorded the lowest rate in the crude protein digestion coefficient (73.69%). Group consumed a diet of 100% concentrate + 4% bentonite, gave the highest ether extract digestion (69.33%), while the group (50% concentrate + 50% alfalfa + 4% bentonite) exhibited the lowest ether extract digestibility (42.95%). However, the interaction between diet and supplementation had no significant effect (P <0.05) in the digestion coefficient of dry matter and organic matter, crude fiber, NDF, ADF and nitrogen-free extract.

These results confirm that the bentonite has the ability to store ammonium ions resulting from rapidly decomposing nitrogen sources in concentrated diets (Helal & Abdel-Rahman, 2010). Bentonite absorbs unsaturated fatty acids and protects them from breakage in the rumen and moves to the intestines, which increases the digestion of fat (Oliveira *et al*., 2016), especially in concentrated diets, as well as reduce saturated fatty acids in ruminants and prevent the hydrogenation of unsaturated fatty acids in the rumen.

Conclusions

Adding 2% bentonite improve growth rate of Arabi lambs. This improvement is a reflection of the improvement of rumen parameters and environment. As well as feeding a 100% of concentrate and 2% bentonite reduce methane emission.

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