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INFLUENCE OF SODIUM BICARBONATE SUPPLEMENTATION ON NUTRIENTS DIGESTIBILITY, MILK PRODUCTION, RUMEN FERMENTATION AND SOME BLOOD PARAMETERS IN SHEEP

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SUMMARY

This study was conducted to evaluate the effect of supplementing the diet of ewes or rams with sodium bicarbonate ($NaHCO_3$) as buffers at two levels on feed intake, milk yield, milk composition, nutrient digestibility, rumen fermentation and some blood metabolites. Twenty seven healthy mature local ewes were randomly assigned into three similar groups (9 ewes each). Three digestibility trials were also carried out using twelve local rams randomly assigned into three groups (4 rams/ trial). Each trial lasted for three weeks, the first two weeks were considered as a preliminary period followed by one week collection period. Groups of 9 ewes and 4 rams were the control group fed the basal diet without $NaHCO_3$supplement and treated groups were fed either 1.5 (T1) or 3% (T2) sodium bicarbonate mixed with the concentrate mixture. All animals were fed 70% of their requirements as concentrate mixture while, wheat straw was given ad libitum as roughage. Dietary supplementation of$NaHCO_3$ (1.5 or 3%) increased (P<0.05) dry matter intake (DMI) of roughage and total dry matter intake. Sodium bicarbonate supplement increased (P<0.05) milk yield. The milk fat (%) was improved (P<0.05) in ewes supplemented 3% of $NaHCO_3$ compared to other groups. Dietary supplement of sodium bicarbonate either 1.5 or 3% increased (P<0.05) serum pH and cholesterol. The organic matter, crude protein and crude fiber digestibility coefficients were improved (P<0.05) for rams supplemented with 1.5 and 3% sodium bicarbonate compared with the control group. Supplementation of sodium bicarbonate to rams rations increased (P<0.05) ruminal pH, concentrations of total VFAs and total protozoa count as compared with the control diet. However, rumen ammonia nitrogen was not affected. In conclusion, dietary sodium bicarbonate in particular 3% of concentrate mixture improves dry matter intake, milk yield, milk fat (%), nutrients digestibility and fermentation patterns in sheep.

Keywords: sodium bicarbonate, ewes, sheep, milk yield, milk composition, nutrient digestibility, rumen fermentation, blood parameters

INTRODUCTION

The ewes postnatal in early lactation require high energy levels for milk production, thus large amounts of concentrate ingredients in ewes rations are needed. High-energy, low-fiber rations are rapidly fermented to volatile fatty acids in the rumen resulting in a decrease of pH throughout the gastrointestinal tract (Linda *et al*., (1985). High concentrate diets decrease rumen pH and fiber digestibility (Santra *et al*., 2003), thereby reducing the buffering capacity of the rumen contents and increasing the risk of ruminal acidosis (Kawas *et al*., 2007). High-energy, low-fiber rations increased acid levels in the rumen, which could be detrimental to the rumen papillae. Ruminal papillae damage results in poor absorption of feed nutrients in the rumen which may reduce feed intake, and result in a decrease of milk yield and its fat content (Donald *et al*., 1984). To avoid such incidence, several nutritional therapies have been tried, including the use of dietary buffers. Sodium bicarbonate ($NaHCO_3$) is a natural buffer (Erdman, 1988), and one of the dietary buffers commonly used to prevent ruminal pH reduction and enhance ruminal fermentation of low roughage diets (Le Ruyet and Tucker, 1992; Russell and Chow, 1993). The NRC (1989) suggested that $NaHCO_3$ should be added at a level of 1.2 – 1.6 % in the concentrate mixture of dairy cattle rations to control ruminal pH. Dietary buffer supplementation has variable effects on animals, which may be attributed to concentrate to forage ratio, level of intake, types and levels of added mineral buffers (Santra *et al*., 2003).

The addition of sodium bicarbonate has variable effects on lamb's performance (Sen *et al*., 2006), including no effects (Gonzalez *et al*., 2008) or negative effects (Bodas*et al*., 2009).Also, $NaHCO_3$ has a buffer activity, increases dry matter intake and stabilizes rumen pH (Hutjens, 1991). Moreover, there are only few studies on the effects of $NaHCO_3$ supplementation in small ruminants, particularly in lactating ewes fed a high concentrate diet.

Therefore, the aim of the present study was to investigate the effect of different levels of dietary sodium bicarbonate supplementation in high concentrate-fed ewes and rams on feed intake, rumen fermentation, milk production along with some blood metabolites.

MATERIALS AND METHODS

This experiment was carried out at the Animal Production Research Farm, Faculty of Agriculture, Al-Azhar University, Assiut branch and Animal

Production Department, Faculty of Agriculture, Assiut University.

Animals, diets and management:

Twenty seven healthy mature local ewes (1.5- 2 years old with an average body weight 40 ± 2 kg) were divided into three groups (nine ewes each), according to their average live body weight. The average initial weights were similar in all groups. The control group was fed a basal diet consisting of roughage and concentrates mixture, but the two treated groups were fed the basal diet supplemented with either 1.5 % (T1) or 3% (T2) of sodium bicarbonate to the concentrate mixture. Seventy % of the requirement was covered by a concentrate mixture, while wheat straw was given *ad libitum* as a roughage.The quantity of concentrate mixture was adjusted every two weeks according to the change in body weight (NRC, 1985).Daily feed intake was recorded and representative samples from feed were taken for chemical analysis according to the procedures of Association of Official Analytical Chemists(AOAC, 2005).Fresh water was available *ad libitum*. The ewes were individually housed in pens. The ingredients and chemical composition of the concentrate mixture and the wheat straw are shown in Table (1).

Milk yield measurement:

Daily milk yield (g/day) for each ewe was recorded from the 15th day post lambing till weaning at about three months lactating period using lamb's suckling technique as described by Ashmawy (1980).This technique was used two times with each ewe per week .Milk samples were analyzed for protein, fat, solid not fat, total solids and lactose using the methods devised by (AOAC, 2005).

Table 1. Formulation of concentrate feed mixture and chemical composition of concentrate mixture and wheat straw

Items	Concentrate mixture	Wheat straw
Ingredients composition (%)		
Corn	44	-
Wheat bran	30	-
Corticated cotton seed meal	22	-
Limestone	2	-
Salt	1	-
Vitamin and mineral (Premix*)	1	-
Chemical composition, % on Dry matter basis		
Dry matter (DM)	96.06	90.63
Organic matter (OM)	91.77	88.20
Crude protein (CP)	14.20	3.00
Crude fiber (CF)	11.70	39.33
Ether extract (EE)	2.75	01.73
Nitrogen free extract (NFE)	63.12	44.13
Ash	8.23	11.80

*Minerals and vitamins premix composition, containing 18 % calcium (Calcium carbonate), 6 % phosphorus (Mono calcium phosphate), 6.5% sodium (sodium chloride), 3 % magnesium (Magnesium oxide), 450,000 IU Vitamin A/kg, 80.000 IU vitamin D3 /kg, 2.125 mg vitamin E/kg.

Blood sampling:

Blood samples were collected by jugular vein-puncture at the end of the experiment 6 hrs. after the morning feeding. Blood samples were then centrifuged at 3000 rpm for 20 min for harvesting serum then stored at −20°C till analyzed for blood parameters. Blood constants (cholesterol, pH, glucose, total protein, AST and ALT were analyzed by spectrophotometer (Unico, USA) using commercial test kits (Spinreact, Spain).

Digestibility trial:

The digestibility trials were carried out using twelve local rams (two years old and about 52 ± 1.25 kg body weight). Each trial lasted for 3 weeks, the first 2 weeks were considered as a preliminary period followed by one week collection period. Animals were randomly distributed into three experimental groups, each with four rams. The animals in group one were considered as a control, which was fed a basal diet consisting of concentrate mixture and wheat straw. The second group (T1) and the third one (T2) received the same basal diet with supplying the concentrate mixture with 1.5% and 3% of sodium bicarbonate, respectively.

Chemical analysis and digestion coefficients measurements:

The diet samples were taken daily during the collection period. At the end of the collection period, samples were mixed and grounded through 1 mm. screen for chemical analysis. Feces were collected daily and 10% of its weight were taken and dried at 60-70 ºC for 24 hrs. The fecal samples from each animal were composited and grounded through a 1mm mill screen for subsequent chemical analysis. The chemical analysis of feeds, residuals and feces were carried out using the procedures of Association of the Official Analytical Chemists (AOAC, 2005).The apparent digestion coefficients of nutrients were calculated by expressing the difference between the content of nutrients in both consumed feed and feces as a percentage of its intake.

Rumen liquor parameters:

Rumen content samples were collected once from each ram, using a stomach tube, at the end of the digestibility trial. Samples were taken 4 hrs. after the morning feeding. Rumen liquor samples were divided into two parts, the first part was filtered through one layer of cheese-cloth, which was used to measure the protozoa count. The total protozoa count was conducted according to Abou El-Naga (1967). However, the second part was filtered through four layers of cheese-cloth. The filtrated portion was used immediately for the measurement of pH using a digital pH meter, and ammonia N concentration according to Conway (1962) method. Few drops of saturated solution of mercuric chloride were added to the filtrate to stop the microbial activity before its storage for analysis, and then the samples were kept frozen at -20ºC for determination of total volatile fatty acids (VFAs). The total VFAs acids were measured using the procedures of Warner (1964).

Statistical analysis:

Statistical analysis was done according to general linear model (G.L.M) of S.A.S program version 8.2 (2001). Differences among groups for feed intake, milk production, blood parameters, nutrient digestibility and rumen liquor parameters were evaluated by one-way ANOVA. Duncan Multiple Range Test (Steel and Torrie, 1980) was used to test the effect of treatments. The data were presented as mean ± S.E. Level of significance was set at P<0.05. The statistical model was as follows.

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij}= the observation ij, μ =the overall mean, T_i = the effect due to treatment i., e_{ij} = the experimental error.

RESULTS AND DISCUSSION

Feed intake:

The results in Table (2) indicate that the daily DM intake from wheat straw and total DM intake by ewes fed rations supplemented with 1.5 and 3 % sodium bicarbonate were significantly (P<0.05) higher than the intake by control group. The roughage intake was higher (P<0.05) in group with 3% sodium bicarbonate compared with the group with only 1.5% (257.1 vs. 286 g). It has been reported that the addition of $NaHCO_3$ to high concentrate diets controls acidity and increases the palatability of lamb diets through neutralization of acidity which is responsible for improving feed intake (Jacques *et al*, 1986). Similarly, Tucker *et al*. (1991) and Shahzad *et al*. (2007a) found higher DM intake by buffaloes fed high $NaHCO_3$ due to higher rumen pH or acid base balance. Sarwar *et al*. (2007a) reported that the addition of $NaHCO_3$ at a rate of 1.15% increased the dry matter intake for 27% by growing lambs and for 29% by adding 1.5% $NaHCO_3$ in Nili Ravi buffaloes (Sarwar *et al*., 2007b). The results of the present study were similar to that reported by Wittayakun*et al*. (2015) who reported that roughage intake was significantly increased due to $NaHCO_3$ supplementation to dairy cow's rations. Furthermore, the addition of sodium bicarbonate to grass silage before feeding lambs increased the dry matter intake from 8 to 20% (Sormunen *et al*., 2006). Also, Aguilera-Soto *et al*. (2008) reported that the supplementation of $NaHCO_3$ to lamb diets increased dry matter intake and feed efficiency. On the other hand, on others studies the voluntary feed intake of the animals was not affected by supplementation of sodium bicarbonate (Mess *et al*., 1985; and Fellner *et al*., 2000). Similarly, Santra *et al*. (2003) found that the daily dry matter intake was not affected by increasing the level of sodium bicarbonate in rations from 0.75 to 2.25%.

Table 2. Effect of sodium bicarbonate supplement to ewe's ration on dry matter intake

DM Intake (g/day)	Treatment			P- value
	Control	T1	T2	
Concentrate	790.02 ± 16.02	823.5 ± 20.22	837.20 ± 17.84	0.186
Wheat straw	235.80[c] ± 4.47	257.10[b] ± 4.64	286.0[a] ± 5.41	0.001
Total intake	1026.00[b] ± 15.96	1080.60[a]± 19.57	1123.2[a] ± 20.47	0.004

[a, b,c] Means of the same row in each item with different superscripts are significantly different (P<0.05).

T1: ewes received 1.5% sodium bicarbonate, T2: ewes received 3% sodium bicarbonate

Milk yield and milk constituents of ewes:

The average daily milk yield (DMY) of lactating ewes in Table (3) was significantly (P<0.05) higher in the supplemented sodium bicarbonate groups than in the control group. Also, DMY in T2 which received 3% of $NaHCO_3$ was significantly (P<0.05) higher than in T1 that received 1.5%. Milk fat (%) was significantly (P<0.05) increased in the ewes of group fed 3% of $NaHCO_3$ than in the other groups. However, no significant differences were found among groups for milk constituents, total solid, lactose and protein. The increase of milk yield in ewes fed the diet containing the high rate of $NaHCO_3$ was due to the increased DM intake. Similar results were reported by Tucker *et al*. (1988) who found that the supplementation of a high level of $NaHCO_3$ improved the milk yield by lactating cows as compared with those fed a low level of $NaHCO_3$. Also, Block (1994) found that high Na or K contents from sodium or potassium bicarbonate increased milk production by lactating cows. The improvement of milk fat in the group fed the high sodium bicarbonate diet may be due to the increase of ruminal pH, which changes the fermentation pattern in a good turn of acetate and butyrate production (Kolver and Veth, 2002) and consequently leads to an increase of the *de novo* fatty acid synthesis which represented for 60% of milk fat (Bauman and Davis, 1974) and hence increased milk fat content. Hu and Murphy (2005) found positive relationships between milk fat and molar proportion of acetate. These findings are supported by Roche *et al*. (2005) who reported an increased milk fat when sodium bicarbonate was added to the diet. Sarwar *et al*. (2007b) found a linear increase in milk yield and milk fat % with increasing sodium bicarbonate levels. Similarly, Wittayakun *et al*. (2015) found that the daily milk yield was improved by cows supplemented with $NaHCO_3$ and $CaCO_3$. However, the constituents of milk including fat, protein, lactose, solids not fat and total solids were not affected.

Table 3. Effect of sodium bicarbonate supplement to ewe's ration on milk yield (g/day) and its composition (%)

Item	Treatment			P- value
	Control	T1	T2	
Milk yield	280^c± 8.97	379^b ± 18.71	489.44^a ± 13.00	0.001
Total solids	11.52 ± 0.22	11.75 ± 0.21	11.58 ± 0.19	0.716
Lactose	6.2 ± 0.09	6.16 ± 0.08	6.14 ± 0.08	0.863
Fat	6.08^b ± 0.11	6.28^b ± 0.08	6.99^a ± 0.16	0.001
Protein	4.0 ± 0.15	4.17 ± 0.09	4.22 ± 0.12	0.430

[a, b,c] Means of the same row in each item with different superscripts are significantly different ($P<0.05$).
T1: ewes received 1.5% sodium bicarbonate, T2: ewes received 3% sodium bicarbonate

Blood metabolites:

The data of serum parameters are summarized in Table (4). The addition of sodium bicarbonate to ewes rations significantly ($P<0.05$) increased serum pH and cholesterol as compared with control group. However, no significant differences were observed among all groups for total proteins, glucose, ALT and AST which indicate no deleterious effect due to $NaHCO_3$ supplement on liver metabolism. Erdman *et al*. (1982) attributed the changes in blood acid-base status to several factors like secretion of bicarbonate in saliva, abomasal acid secretion, and varied rates of acid utilization and absorption from the rumen. The present results agree with those of Sarwar*et al*. (2007a) who found a significant increase in blood pH and serum bicarbonate with increasing $NaHCO_3$ levels of the diet and attributed this to the gradual increase of sodium intake. Leanna (2002) found that the blood protein was not affected by diet or free-choice options of sodium bicarbonate.

Table 4. Effect of sodium bicarbonate supplement to ewe's ration on some blood parameters

Item	Treatment			P- value
	Control	T1	T2	
Total protein, g/dl	6.85 ± 0.15	7.15 ± 0.23	7.2± 0.24	0.381
Glucose, mg/dl	68.11± 1.28	69.5 ± 0.26	70.09 ± 1.94	0.581
Cholesterol, mg/dl	117.3^b ± 0.63	120.5^b ± 0.81	134.42^a ± 3.34	0.001
pH	6.41^b ± 0.11	7.15^a ± 0.6	7.26^a ± 0.02	0.001
ALT,U/L	26.76 ± 1.25	22.63 ± 1.11	26.38 ± 1.58	0.083
AST,U/L	57.32 ± 1.59	58.39 ± 1.11	61.15 ± 1.73	0.209

[a, b,c] Means of the same row in each item with different superscripts are significantly different ($P<0.05$).
T1: ewes received 1.5% sodium bicarbonate, T2: ewes received 3% sodium bicarbonate

Digestibility:

The effects of supplemented sodium bicarbonate on nutrients digestibility are shown in Table (5). The organic matter, crude protein and crude fiber digestibility coefficients were improved ($P<0.05$) for rams supplemented with 1.5 and 3% sodium bicarbonate compared with the control group. Likewise, dietary supplement of 3% $NaHCO_3$ had a significant ($P<0.05$) effect on the digestibility of DM and EE by rams as compared with those fed the diet supplemented with 1.5 % $NaHCO_3$ or the diet with no supplement (control group). The improvement in nutrients digestibility with sodium bicarbonate supplement to ram's ration may be due to the increase of the total number of ciliate protozoa as well as cellulolytic bacteria (Koul *et al*., 1998 and Santra *et al*., 2003). This would have contributed to better fiber (cellulose) digestibility in the rumen. Santra *et al*. (2003) observed that the number of total protozoa was higher ($P<0.01$) in the rumen of groups fed rations with high level of sodium bicarbonate (2.25 and 1.5%) than that fed rations with a lower level (0.75%) of $NaHCO_3$.These results are supported by the results of Santra *et al*. (2003) who found that the digestibility of organic matter, crude protein and gross energy were not affected with increasing the level of sodium bicarbonate in rations. However, Phillip (1983) reported that the digestibility of organic matter and DM was unaffected by the inclusion of $NaHCO_3$ at a rate of 3% of the diet DM, but digestibility of nitrogen tended to increase due to treatment.

Table 5. Effect of sodium bicarbonate supplement to ram's ration on nutrient digestibility, %

Item	Treatment			P- value
	Control	T1	T2	
Dry matter, DM	75.6[b] ± 0.58	76.44[b] ± 0.47	78.85[a] ± 0.64	0.003
Organic matter, OM	76.3[b] ± 0.57	78.76[a] ± 0.64	79.2[a] ± 0.61	0.009
Crude protein, CP	70.5[b] ± 0.87	74.94[a] ± 0.95	76.6[a] ± 0.74	0.005
Ether Extract, EE	66.11[b] ± 0.39	67.06[b] ± 0.79	69.7[a] ± 0.62	0.003
Crude fiber, CF	53.6[b] ± 0.89	58.18[a] ± 1.36	60.91[a] ± 1.50	0.003
Nitrogen free extract, NFE	79.38± 1.17	80.02 ± 1.07	79.89 ± 1.68	0.938

[a, b] Means of the same row in each item with different superscripts are significantly different (P<0.05).
T1: ewes received 1.5% sodium bicarbonate, T2: ewes received 3% sodium bicarbonate

Rumen fermentation indices:

Supplementation of sodium bicarbonate at a level of 1.5 and 3% of the concentrate diets increased (P<0.05) ruminal pH values, concentrations of total VFAs and total protozoa count as compared with the control diet (Table 6). Moreover, the group receiving 3% $NaHCO_3$ had significantly higher (P<0.05) ruminal pH and total VFAsthan that receiving 1.5% $NaHCO_3$. The concentration of rumen ammonia nitrogen in the present study did not differ among the groups. However, the concentration of rumen ammonia tended to be lower with supplementing $NaHCO_3$ to rations. Erdman (1988) hypothesized that rumen buffering decrease the existence of acidity produced by volatile fatty acids production in rumen and improves systemic acid base status. The same author in a previous study, Erdman *et al*. (1982) found that supplementing 1% $NaHCO_3$ increased rumen pH from 6.13 to 6.43 in early postpartum cows receiving similar diets. The addition of $NaHCO_3$ increases ruminal pH in lactating cows (Clayton *et al*., 1999), buffaloes (Koul *et al*., 1998) and goats (Cetinkaya and Unal, 1992). The supplementation of higher levels of $NaHCO_3$ increases the total VFAs concentration in the rumen of rams as a result of an increased ruminal microbial activity (Santra *et al*., 2003). The same author also reported that ruminal pH and total TVFA increased (P<0.05) with increasing levels of dietary sodium bicarbonate in the diets. While, ammonia nitrogen concentration was decreased (P < 0.01) due to the supplement of sodium bicarbonate to the diet of lambs. Wittayakun *et al*. (2015) found that supplementation of $NaHCO_3$ had an effect on osmolality and pH in the rumen. Phillip (1983) found that rumen ammonia concentration tended to decrease with the addition of $NaHCO_3$. Similarly, Harrison and McAllan (1980) reported that sodium bicarbonate improved the efficiency of synthesis of microbial protein from ammonia and reduced the level of rumen ammonia through an increased rate of absorption because of the higher rumen pH by $NaHCO_3$. The higher total protozoal count in the present study is confirmed by Santra *et al*. (2003) who observed that the number of total protozoa was higher (P<0.01) in the rumen of the groups fed rations containing sodium bicarbonate than those fed the control diet. On the other hand, Askar *et al*. (2011) found that ruminal pH and ammonia concentration were not affected by dietary sodium bicarbonate (1.5 %), but the total concentration of volatile fatty acids tended to increase with buffer supplementation.

Table 6. Effect of sodium bicarbonate supplement to ram's ration on rumen parameters

Item	Treatment			P-value
	Control	T1	T2	
pH	5.52[c]± 0.14	6.30[b]± 0.15	6.91[a]± 0.16	0.001
Ammonia, mg/100 ml	12.99 ± 0.04	12.64 ± 0. 75	11.73 ± 0.50	0.302
TVFA, mmol/100 ml	7.52[c]± 0.25	8.68[b]± 0.28	11.00[a]± 0.39	0.001
Total protozoa count, $\times 10^6$/ml	3.27[b]± 0.19	4.40[a]± 0.21	4.69[a]± 0.17	0.001

[a, b,c] Means of the same row in each item with different superscripts are significantly different (P<0.05).
T1: ewes received 1.5% sodium bicarbonate, T2: ewes received 3% sodium bicarbonate

CONCLUSION

It is concluded that sodium bicarbonate supplement in concentrate diet of ewes improve dry matter intake, milk yield and milk fat (%). Also, addition of sodium bicarbonate to rams rations modifies rumen fermentation and improve nutrients digestibility.

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تأثير اضافه بيكربونات الصوديوم على هضم العناصر الغذائيه ، انتاج اللبن ، تخمرات الكرش وخصائص الدم فى الاغنام

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اجريت هذة الدراسه لتقييم تاثر اضافه مستويين من بيكربونات الصوديوم كمعادل للحموضه الى علائق النعاج والكباش على الغذاء الماكول، محصول اللبن، مكونات اللبن، هضم العناصر الغذائيه ، تخمرات الكرش و بعض خصائص سيرم الدم . استخدم سبعه وعشرون من النعاج الناضجه المحليه تم تقسيمها بصورة عشوائيه الى ثلاثه مجاميع (٩ نعاج فى المجموعه). ايضا تم اجراء ثلاثه تجارب هضم استخدم لها ١٢ من الكباش الناضجه تم توزيعها بصورة عشوائيه على ثلاث مجاميع (٤ كباش بكل مجموعه). كل تجربه استمرت لمدة ثلاث اسابيع اسبوعين منها كمرحله تمهيديه يتبعها اسبوع لجمع العينات. مجاميع النعاج او الكباش كانت عبارة عن مجموعه المقارنه التى تم تغذيتها على عليقه مكونه من المخلوط المركز وتبن القمح بدون اضافه بيكربونات الصوديوم فى حين مجاميع المعامله تم تغذيتها على عليقه المقارنه مع اضافه بيكروبنات الصوديوم الى المخلوط المركزة بمعدل ١.٥% الى المعامله الاولى و ٣% الى المعامله الثانيه. سبعون فى المائه من احتياجاتها تم تغطيتها من المخلوط المركز بينما قدم تبن القمح حتى الشبع. اضافه بيكربونات الصوديوم بمعدل ١.٥% و ٣% ادى الى زيادة معنويه من الماكول من المادة الخشنه والغذاء الكلى المأكول . بيكربونات الصوديوم زادت معنويا محصول اللبن. نسبه الدهن فى اللبن تحسنت معنويا مع اضافه ٣% من بيكروبنات الصوديوم مقارنه ببقيه المجاميع. اضافه بيكروبونات الصوديوم بمعدل ١.٥% و ٣% ادى الى زيادة معنويه فى درجه الحموضه فى سيرم الدم والكوليسترول. معامل هضم كل من المادة العضويه والبروتين الخام والالياف الخام تحسن بصورة معنويه مع اضافه اضافه بيكروبونات الصوديوم بمعدل ١.٥% و ٣% مقارنه بمجموعه المقارنه. اضافه بيكروبونات الصوديوم الى علائق الكباش ادت الى زيادة معنويه فى درجه الحموضه فى الكرش و تركيز الاحماض الدهنيه الطيارة و عدد البروتوزوا الكلى فى الكرش بالمقارنه بمجموعه المقارنه.بينما تركيز الامونيا فى الكرش لم يتاثر. نستنتج من هذة الدراسه ان اضافه بيكربونات الصوديوم خاصه بتركيز ٣% الى المخلوط المركز حسن من الغذاء الكلى المأكلول ، محصول اللبن ، نسبه الدهن فى اللبن ، هضم العناصر الغذائيه وتخمرات الكرش فى الاغنام .