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EFFECTS OF SODIUM BICARBONATE SUPPLEMENT ON THE NUTRITIVE VALUE, RUMEN FERMENTATION AND PERFORMANCE OF GROWING FRIESIAN CALVES RATIONS.

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ABSTRACT

Twelve 7 month old male Friesian calves with an average body weight of 111± 8.4 kg were used is this study. Calves were distributed into three groups similar in number. The experimental rations were formulated as follows : ration 1 (R1) 64% concentrate feed mixture (CFM) + 36% clover hay (CH) (control), ration 2 (R2) : 64.12% CFM + 34.36% CH + 1.52% sodium bicarbonate (SB) and ration 3 (R3) : 60.61% CFM + 36.19% CH + 3.2% SB.

The digestibility coefficients of DM, OM, CP, NFE, NDF and ADF and the value of TDN, ME, (Mj / kg), NE (Mcal / kg), DDM% and RFV were higher ($p<0.05$) for R2 than R1 and R3, while there was no significant difference between R1 and R3. The CF and NFC digestibility coefficients were increased ($p<0.05$) when feeding on R2 compared with R1, while there was no significant difference between R1 and R3 or between R2 and R3.

The predicted values for starch and sugar fermentations using CNCPS were (640 and 274 g/d, respectively) with feeding R1,(475.8 and 276.8 g/d, respectively) for R2 and (431.7 and 267 g/d, respectively) for R3 , and the total microbial protein was 815 , 825 and 775 g/d when feeding on R1 , R2 and R3 , respectively.

The DM intake was increased when feeding on R2 than R1 or R3 because the passage rate was higher when feeding on R2 (8.5 %/h) than feeding on R1 (7.6 %/h) or R3 (7.8 % g/h).

The mean values for total VFA were higher ($p<0.05$) with feeding R1 or R2 than R3. The mean values were 9.67, 9.88 and 8.05 ml eq / 100 ml RL for R1, R2 and R3, respectively. The mean values for NH_3-N concentration decreased ($p<0.05$) when feeding R2 than R3, but without significant effect with feeding R1. the mean values were 10.96, 9.36 and 13.5 mg/100ml RL when feeding on R1, R2 and R3, respectively.

The mean values of blood parameters were not significantly affected by feeding R1 or R2 or R3.

The mean values of ADG were 0.62, 0.69 and 0.66 kg for steers fed on R1, R2 and R3, respectively. Concerning to the amino acids composition of the tested rations, the AAs composition were less than the requirements except for tryptophan. The mean balance AA values (% of requirement) were 70.45 , 68.14 and 71.73 with feeding on R1, R2 , R3 , respectively. The production efficiency was lower when feeding on R2 than feeding on R1 or R3 (16.77, 18.74 and 18.85% respectively), and the economic efficiency, was also lower when feeding on R2 than feeding on R1 or R3.

In general, the data indicated that feeding ration at a level 64.12% CFM + 34.36% CH + 1.52% sodium bicarbonate for growing Friesian calves increased the nutritive values of the ration than using 3.0% sodium bicarbonate.

Keywords: Friesian steers, sodium bicarbonate, daily gain and economic efficiency.

INTRODUCTION

Weaned calves will not eat much feed right after being removed from their dams. Consequently, the feed needs to be very palatable and highly nutritions. Quality is much more important than price when starting calves on feed. A successful ration used is 30 % chopped hay, 18 % soybean meal, 50 % crashed corn, plus vitamins and minerals (Yohn, 2007). On cattle production operations, a forage diet often will not provide the necessary nutrients to meet the demands of grazing cattle throughout the year (Winger et al, 2006). They found that average daily gain was greater for growing cattle fed supplements of corn and soybean meal, wheat middling or soybean hulls than cattle fed no supplement. As a result, it may be economically advantageous to feed high energy corn based diets when intakes are limited (Loerch et al, 1995). They recommended to feed 4.1 kg shelled corn (1.3 % of body weight) plus 1.0 kg per head per day of a 37 % protein supplement. Limit feeding strategies have two potential applications for cattle feeders (Loerch, 1995). The some feeding systems limit intake of a high grain diet to achieve any desired rate of gain. This strategy should be considered when corn is a less expensive source of energy than hay. Growing cattle, such as calves can be safely fed up to 2.0 to 2.25 % of their weight concentrates. Roughage should be given at 1.8 to 2.2 kg as hay daily (Schreder, 2002). In ruminants, acidosis is defined as the biochemical and physiological stresses by rapid production and absorption of (volatile fatty acids VFA and lactic acid) which arise from the over consumption of readily fermentable carbohydrates (RFC) (Britton and Stock,1986). Heat and pressure processing of RFC as steam flaking , rolling or propping can increase starch availability for fermentability, which in turn increase the propensity for acidosis (Owens *et al*, 1998). In forage fed animals, ruminal pH is generally near neutrality (pH 7.0) and as well buffered by bicarbonate and phosphate from saliva, protein, and forage walls (Russell and Hino, 1985). Normally, when grain is added to ruminant diets, luminal protozoa adapt by increasing their numbers and adequately removing the additional starch (Mackie et al., 1978). However, if the grain levels ingested exceed protozoal capacity to remove starch, protozoa population will decline (Hristov *et al*., 2001), a drastic increase in bacterial count will occur, fermentation to VFA and Lactic acid will proceed and luminal pH will decline.

Buffer supplementation of high concentrate diets has been shown to improve or stabilize food intake and increase animal performance in some studies (Zinn, 1991), but not in others (Ghorbani *et al*., 1989).

One of the best management strategies for reducing foodcosts and improving grain utilization is the use of food additives. Buffers are sometimes used to modulate pH changes in the lumen (Stock and Modes, 1985). Buffers can be used when adapting cattle to high grain diets and when feeding concentrates such as wheat at high levels. Various buffering agents include sodium bicarbonate, limestone, sodium bentonite and magnesium oxide. Sodium bicarbonate (SB) and limestone can be fed at about 1% of the diet dry matter.

Sodium bicarbonate was provided either free choice or mixed into total mixed ration the (TMR) in an attempt to minimize subacute luminal acidosis. For cattle receiving SB as part of the TMR, the supplementation rate was within the recommended range of 0.6 to 0.8% of DMI (NRC, 2001). When SB was offered free choice, the Jersey steers consumed SB free choice at levels (129.1 g/d) that exceeded NRC, (2001) recommendation (Paton, 2005). Hart and Polan (1984) reported for calves fed a corn based diet with added SB (1.5, 3.0 and 4.5% of DM), ruminal pH was not effected. Similarly, Russell *et al* (1980) reported luminal pH of steers fed a finishing diet based on corn supplemented with 0.9% SB averaged 6.5 and did not differ from control.

The utilization of sodium bicarbonate has been reported to result in increases in digestibility, rate of passage and in changes in the proportion of VFA (Hart and Doyle, 1985). It has also been suggested that it may improve the amount and efficiency of ruminal microbial protein synthesis, which occurs independently of changes in ruminal fluid dilution rates (Mees *et al*, 1985), and enhance bacterial uptake of NH_3 (Newbold *et al*, 1988), these effects being eventually associated to a higher feed intake and a subsequent increased daily gain (Tripathi *et al*, 2004).

Therefore, this experiment was conducted to study the effects of supplementing different levels of sodium bicarbonate in growing Friesiam calves rations on nutrient digestibility, ruminal fermentation and performance.

MATERIALS AND METHODS

This study was conducted at El-Karada Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

Experimental animals:

Twelve male Friesian steers, were distributed into three similar groups (Four for each) according to live body weight. The average live body weight was 111$\pm$ 8.4 kg and 7 month of age. The animal of each group were housed in a well-ventilated pens. The animals of each group were weighed individually at the morning before morning feeding every four weeks throughout the experimental feeding period, which lasted 6 months (from 7 to 13 months of age).

The groups were assigned at random to receive the three experimental rations.

The experimental rations were formulated as follows:

R1: ration 1: 64% concentrate feed mixture (CFM) + 36% clover hay (CH) (as a control ration).

R 2: ration 2 : 64.12% CFM + 34.36% CH + 1.52% sodium bicarbonate (SB)

R 3: ration 3: 60.61% CFM + 36.19% CH + 3.20% SB.

The calculated CP concentration of tested rations ranged from 16 to 16.6% according to Hunter et al (1999). Calves were individually fed the experimental rations. Animals were fed to cover the requirements of growing calves (Ghoneim, 1967) and were adjusted monthly according to their body weight changes.

The concentrate feed mixture (CFM) used contained 44% yellow corn , 23% soybean meal (44% protein), 14% wheat bran, 11.5% rice bran , 4.5% molasses, 2%, limestone and 1% salt.

The clover hay was made from the 3rd cut of Egyptian clover.

Management of feeding:

The intake from tested rations by calves were fixed to satisfy their maintenance and production requirements (Ghoneim, 1967) at similar roughage: concentrate ratio. The offered amount was adjusted according to the change in their live body weight at the beginning of each period (4 week intervals). The offered amount of feed on dry matter basis was calculated to be 3.0% of the live body weight of each group.

The CFM fed with or without SB and was offered to calves at morning. While clover hay (CH) was given after consumption of the concentrate. Drinking fresh and clean water was available at all times.

Digestibility trails:

After about 5 months of experimental feeding period, three digestibility trials were conducted using three animals chosen randomly from each group to determine nutrients digestibility coefficients and nutritive values of the experimental rations.

Acid insoluble ash (AIA) was used as a natural marker *(*Van Keulen and Young*,* 1977). Fecal samples were grabbed from the rectum of each animal twice daily for 5 successive days. Nutrients digestibility was calculated from the equations stated by Schneider and Flatt (1975).

Chemical analysis:

Samples of CFM and CH, were taken at the beginning of the trials and every 4 weeks and composited. The composite samples were dried in a forced air oven at 65^{o}C for 48 hours, then ground for running the chemical analysis for each. Feces samples were taken from the rectum of each calve twice daily with 12 hours interval during the collection period and dried in a forced air oven at 65^{o}C for 48 hours. Dried samples were composted for each animal and representative samples were taken, ground and kept for chemical analysis.

Chemical analysis of CFM, CH and feces were carried out according to the methods of AOAC (1990), Fiber fractions (NDF,ADF ADL, hemc. and cell.) was determined according to method of Van Soset, (1982).

At the end of each collection period ruminal fluid samples were taken using rubber stomach tube before offering the morning feed and at 2, 4 and 8 hrs post- feeding from three animals in each treatment. The collected rumen fluid samples were filtered through three layers of gauze without squeezing for the determination of pH, buffering capacity (BC), ammonia-N and total volatile fatty acids (TVFA's) concentration. Ruminal pH was immediately estimated by pH meter (Orion Research, model 201 digital pH meter). Buffering capacity is the milli-equivelaents of HCl required to bring the pH of 100 ml rumen liquor to pH 4.5 (Nickolson *et al*, 1963) was determined immediately after sampling. Ruminal NH_3-N was determined according to Conway (1957). Ammonia-N is released under alkaline conditions from the outer chamber of the Conway plate, absorbed by the boric acid in the center unit and then titrated after 24 hrs using 0.01 N sulfuric acid. The TVFA's were determined by the steam distillation method as described by Warner (1964).After acidification of rumen liquor samples using concentrated orthrophosphoric acid and 0.1 N hydrochloric acid (HCL), the volatile fatty acids were determined by steam distillation method by using the Kjeldahl apparatus.Distilate was collected within 7 to 10 minutes. The concentration of the amount of 0.01 N NaOH needed to neutralize the VFA in the distillate.

Blood samples were taken from each animal individually during the experimental periods of the tested rations. These samples were taken at 3 hrs post-feeding from jugular vein. Blood samples were immediately separated by centrifugation at 4000 r. p. m. for 10 minutes. The serum samples were stored at (–20^{o}C) until analyses were done. The analysis included total protein (Gornall *et al*, 1949), albumin, (Hill and Wells, 1983); globulin, (calculated by differences between the total protein and albumin concentrations), urea, (Patton and Crouch, 1977); creatinine, (Ullmann, 1976), Glucose, (Teuscher and Richterich, 1971), GOT and GPT, (Reitman and Frankel, 1957).

Production efficiency:

The ME can be concerted to an NEm requirement with an efficiency of 0.576 (NRC, 1996), and NEp will equal (ME-NEm).

The retained energy (RE, Mcal/d) = (live weight$^{0.2955}$×0.544)×(ADG)$^{1.262}$

Where ADG is in kilograms (Overton, 1999).

Production efficiency = RE/NE$_p$ × 100

Economic efficiency :

Economic efficiency was calculated according to the following formula:

$$\text{Economic efficiency} = \frac{\text{(price of daily gain – daily feed cost)}}{\text{Daily feed cost}}$$

The nutritive analysis:

The mechanistive sub models as published by Russell *et al* (1992); Snieffen et al (1992), O'Connor *et al* (1992) and Pitt *et al* (1996) was applied on the experimental rations to predict microbial growth from their carbohydrate and protein fractions and their digestion and passage rate using the net carbohydrate and protein system (CNCPS) programme version 3.0.

Statistical analysis:

The statistical analysis was performed using the least squares method described by Likelihood programmer of SAS (1994). The obtained data for nutrients digestibility, nutritive value, effective NDF (eNDF) and blood parameters, were subjected to one way analysis of variance according to the following model:

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

Where:

Y = Observation of the tested factor

μ = Overall mean

T_i = Treatment effect

e_{ij} = Error

The data of rumen liquor parameters were subjected to way analysis of variance according to the following model:

$$Y_{ijk} = \mu + T_i + p_j + tp_{ij} + e_{ijk}$$

Where :

Y = Observation of the tested factor

μ = Overall mean

T_i = Treatment effect

p_j = time effect

tp_{ij} = interaction effect of the treatment) × time

e_{ij} = Error

The differences among means were carried out according to Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The chemical composition of the ingredients and experimental rations:

The chemical composition of concentrate feed mixture, clover hay (CH) and the total mixed rations are detailed in table (1). The CF , NDF , ADF, cellulose and ADL were higher in CH than CFM , while the NFE and NFC were higher in CFM than CH . The CP was similar in both.

The summative analysis of the tested ingredients used to formulate the experimental rations were presented and discussed by Ead and Maklad, (2006).

The total mixed rations for early weaned contain about 16% protein. In the present study, the three experimental rations were formulated at the commonly, practiced ratio being:

R1 (control): 64 % CFM + 36 % CH

R2 : 64.12% CFM + 36.36 % CH+ 1.52 % sodiumbicorbonate (SB).

R3 : 60.61 % CFM + 36.19 % CH + 3.20 % SB.

These proportions were chosen to achieve is nutrients diets containing about 16 % CP, 44% NDF and 27% NFC. The NDF / NFC was about 1.6.

There are two main types of carbohydrates. The first is fiber (roughage) , and the second is starch and sugars (concentrate). The most common fiber source is hay, which is also rich in other nutrients. Sugars and starch in concentrates provide high amounts of energy. Concentrates are the grains (corn, barley and oats) that make up animal’s feed. They are also good sources of vitamins, protein and minerals. Although concentrates provide a readily available source of energy, too much concentrate without enough fiber can throw animal’s digestive system out of balance and cause acidosis (Burrell, 2000). Hay quality (fair) contains 14 -16 % CP, 47 – 53 % NDF and 36 - 40 % ADF (NRC, 2001).

These observations are in agreement with the results of The present study for the chemical composition of the tested ingredients and formulation of total mixed rations offered to calves during the trial as shown in Table (1).

Dietary fiber levels (neutral and acid detergent fibers) increased while available energy deceased as roughage in the diet increased form 8 to 32% (Schreder , 2002) . Two needs must be considered when formulating the protein requirements of growing cattle. One is the requirement of the host animal for metabolizable protein (amino acids) and the second is the requirement of the microorganisms for available nitrogen in the rumen. If metebolizable protein is inadequate, growth of the animal will be limited. If nitrogen available to the microorganisms is inadequate , growth of the microbes will be reduced, presumably limiting digestion in the rumen and reducing the supply of metablizable protein form the microorganisms (Trenkle and Barrett , 2003). Hay without any supplemental feed will not work for early weaned calves (Yohn, 2007). Calves will no gain enough weight to justify early weaning. Calves that are early weaned can be fed a typical high grain feedlot rations . Ration for calves that are early weaned should contain 70% or greater TDN and 16 to 18 % protein. Calves should consume 3 to 3.5 % of BW of this ration once they are adapted to the diet. The association between fiber and non-structural carbohydrate (NSC) is a complicated and dynamic relationship (Hoover and Stokes, 1991). Therefore a balance of these two components is necessary to achieve stable fermentation in the rumen. Poor *et al* (1993) investigated the effect of the ratio of forage NDF to ruminally degradable starch (FNDF : RDS) . They proposed that an NDF : RDS ratio of at least 1.

Table (1): The chemical composition of the ingredients and experimental rations :

Item	DM	Chemical composition (% as DM)											
		OM	CP	EE	CF	NFE	Ash	NDF	ADF	Heni	Cell	ADL	NFC
Concentrate feed mixture (CFM)	90.86	93.07	16.54	2.14	15.17	59.22	6.93	40.34	17.58	22.76	10.00	7.58	34.05
Clover hay (CH)	88.89	87.71	16.61	2.29	27.76	41.03	12.29	53.29	29.58	23.74	13.96	15.62	15.52
Experimental rations (calculated):													
R 1	88.44	91.15	16.57	2.20	19.70	52.68	8.85	45.01	21.90	23.11	11.43	10.47	27.37
R 2	88.49	89.80	16.31	2.16	19.26	52.07	10.2	44.17	21.43	22.74	11.21	10.22	27.16
R 3	88.56	88.16	16.04	2.13	19.24	5075	11.84	43.74	21.36	22.38	11.11	10.25	26.25

R1 : 64 % CFM + 36 % CH
R 2 : 64.12 % CFM + 34.36 % CH + 1.52 % sodium bicarbonate (SB)
R 3 : 60.61 % CFM + 36.19 % CH + 3.20 % SB
*** Non fiberous carbohydrates%= OM% - (CP%+NDF%+EE%), (Calsamiglia *et al.,* 1995).**

The average daily dry matter intake during the digestion trials :

Data in table (2) showed that the daily DM intake form CFM was 4.84, 5.46 and 4.54 kg/h/d for R1, R2, R3, respectively, while the corresponding DM intake form CH was 2.71 kg/h. The supplements SB were 0.12 and 0.24 kg/h/d for R2and R3 respectively. The total DM intake was 2.83, 3.18 and 2.83 % of BW for R1, R2, R3, respectively , while the average BW was 266 , 260 and 264 kg in experiments R1, R2, and R3, respectively .

Nutrient digestabilities and feeding values of tested rations:

Table (3) shows the nutrient digestion coefficients and feeding values of tested rations. The digestibility of DM , OM , CP , NFE, NDF, ADF , TDN, ME (Mj / kg) , NE (Mcal / kg), DDM% and RFV were higher (P< 0.05) for R2 than R1 and R3 , while there was no significant difference between R1, and R3 .

Table (2): Average daily dry matter intake of concentrate, clover hay and sodium bicarbonate by Friesian calves during the digestion trials:

Items`	R	`R2	R3
Average body weight (kg)	266	260	264
Concentrate : Roughage :SB	64.1: 35.9	65.8 : 32.7 : 1.5	60.6: 36.2 : 3.2
Intake of DM from :			
Concentrate feed mixture (CFM)			
Kg / h/ d	4.84	5.46	4.54
AS % BW	1.82	1.96	1.72
Clover hay (CH)			
Kg / h / d	2.71	2.71	2.71
AS % BW	1.02	1.05	1.02
Sodium bicarbonate (SB)			
Kg / h / d	-	0.12	0.24
AS % BW	-	0.05	0.09
Total DM intake			
Kg / h / d	7.55	8.29	7.49
AS % BW	2.83	3.18	2.83

Table (3): Effect of feeding the experimental rations on the digestion coefficients and feeding values by Friesian calves:

Items	R 1	R 2	R 3	± SEM	*P*
DM	83.06 ^{b}	87.82 ^{a}	84.33 ^{b}	0.452	0.0008
OM	84.05 ^{b}	90.72 ^{a}	86.22 ^{b}	0.729	0.0018
CP	82.26 ^{b}	87.12 ^{a}	83.45 ^{b}	0.449	0.0006
EE	92.64	91.58	91.41	2.443	0.9290
CF	82.51 ^{b}	90.81 ^{a}	87.20 ^{ab}	2.148	0.0877
NFE	83.53 ^{b}	90.39 ^{a}	85.64 ^{b}	0.765	0.0019
NDF	84.53 ^{b}	88.79 ^{a}	85.97 ^{b}	0.619	0.0076
ADF	74.62 ^{b}	83.81 ^{a}	77.36 ^{b}	0.900	0.0010
Hemicelluloses	93.93	93.49	94.19	0.967	0.8784
Cellulose	97.62	98.73	96.43	1.227	0.4621
ADL	49.50 ^{c}	67.43 ^{a}	56.68 ^{b}	1.569	0.0006
NFC	81.35 ^{b}	93.33 ^{a}	86.23 ^{ab}	2.501	2.0377
Feeding value (%)					
TDN	78.46 ^{b}	83.23 ^{a}	77.99 ^{b}	0.557	0.0010
DCP	13.60 ^{b}	14.21 ^{a}	13.38 ^{b}	0.067	0.0003
ME(MJ / Kg)	11.68 ^{b}	12.39 ^{a}	11.61 ^{b}	0.083	0.0010
ME (Mcal / kg)	2.79 ^{b}	2.96 ^{a}	2.77 ^{b}	0.019	0.0010
*NE (Mcal / kg)	1.80 ^{b}	1.92 ^{a}	1.79 ^{b}	0.012	0.0007
**DDM %	73.46 ^{b}	77.71 ^{a}	74.68 ^{b}	0.403	0.0008
***RFV	161.53 ^{b}	184.36 ^{a}	163.96 ^{b}	4.263	0.0170

a, b and c : Means within the same raw with different superscripts are significantly different (P<0.05).
*** NE (Mcal / kg) = (TDN% x 0.0245) – 0.12 (NRC, 2001)**
**** DDM% of DM = 88.9 - 0.779 x (ADF% of DM) (Schroeder , 1996)**
***** RFV = DMI x DDM / 1.29 (Schroeder , 1996)**

The CF and NFC digestibility coefficients were increased (P< 0.05) when feeding on R2 compared with R1, while there was no significant difference between R1, and R3 or between R2, and R3. The ADL digestibility was higher (P< 0.05) when feeding on R2 than R1 and R3 or feeding on R3 than R1.

The DCP % was increased (P< 0.05) when feeding on R2 than R1, or R3 or when feeding or R1, than R3.

The CNCPS predict values of ME, MP, and amino acid supplies from feeds, based on variations in DMI, feed composition and feed fiber characteristics. The analysis using CNCPS version 3.0 for the presented experimental rations could be summarized in table (9).

These parameters could explain the effects of the tested rations during the digestion trails. As shown in table (2), the DM intake was increased when feeding on R2 than R1, or R3 because the passage rate was higher when feeding on R2 (8.5 % / h) than feeding on R1 (7.6 % / h) or R3 (7.8 % / h). The digestibility trials shown in (table 3), revealed that ME (m cal / kg) was higher (p < 10.05) when feeding on R2 (2.96 Mcal / kg) than feeding on R1 (2.79 Mcal / kg) or R3 (2.77 Mcal / kg). The prediction values for starch and sugar fermentations were increased when feeding on R2 than R1 or R3 in (table 9) and total microbial protein production (g/d) was affected with the same pattern. Concerning to NDF digestion , it was higher (P <0.05) with R2 that feeding on R1 or R3 as shown in table (3), although the bacteria fiber fermentation was decreased when feeding on R2 or R3 than R1 as shown in table (9). The addition of buffer SB can improve fiber digestion by reducing the period of time during the day that ruminal PH is less than 6 (Hutjens , 1992) Previous studies have shown that the use of sodium bicarbonate may result an increased rates of passage of the liquid phase of digesta (Bodes *et al* 2009). Stokes (1983) reported a quadratic increase in the dilution rate from the rumen of sheep fed diets supplemented with increasing levels of sodium bicarbonate. Whereas some authors have attributed the changes in rate of passage to a rise in acetic acid production (Hadjipanoyiotou *et al* 1982), while others have suggested a mode of action related to a higher osmolality and water intake (Cooper *et al*, 1996).

Rumen fermentation:

The effects of feeding the three tested rations on some rumen liquor (RL) parameters are presented in total (4).

The effects of feeding sodium bicarbonate (SB) on ruminal pH have been inconsistent in previously published literature. Hart and Polan (1984) reported for calves fed a corn based diet with added SB 1.5, 3.0 and 4.5 % of DM.

There were no significant effects by dietary treatments, sampling time and their interactions on pH and buffering capacity (BC) (ml eq/ 100 ml RL). The mean values for total VFA were higher (P<0.05) with feeding on R1 or R2 than R3. The mean values were 9.67, 9.88 and 8.05 ml eq / 100 ml RL for R1, R2 and R3 respectively. The mean values for NH_3 – N concentration were decreased (P<0.05) when feeding R2 than R3, and without significant effect with feeding R1. The mean values were 10.96, 9.36 and 13.5 mg/100 ml RL when feeding on R1, R2 and R3, respectively.

There was no significant effect on the effective NDF (eNDF %) when feeding on R1, R2 and R3. The wean values were 32.75, 30.58 and 28.51 % for R1, R2 and R3 respectively.

Table (4): Effect of feeding experimental rations on some rumen liquor parameters at different time after feeding:

Items		R1	R2	R3	±SEM	*P*
pH	0	7.78	7.75	7.73	0.236	0.9948
	2	6.83	6.76	6.65		
	4	6.37	6.27	6.02		
	8	6.26	6.10	6.13		
	means	6.81	6.72	6.63	0.118	0.5704
Buffering capacity (BC) ml eq/100 ml	0	13.33	13.93	13.17	0.809	0.9662
	2	11.30	11.93	11.33		
	4	10.07	10.33	8.97		
	8	9.73	9.13	9.03		
	means	11.11	11.33	10.63	0.404	0.4609
Total VFA's (ml eq /100 ml)	0	6.78	6.40	6.72	1.025	0.2527
	2	11.08	10.08	8.27		
	4	10.43	12.72	7.77		
	8	10.37	10.30	9.35		
	means	9.67 [a]	9.88 [a]	8.05 [b]	0.512	0.0339
NH_3 – N (mg / 100 ml)	0	13.51	8.77	10.53	1.483	0.0266
	2	9.65	7.54	16.14		
	4	11.40	10.09	12.03		
	8	9.29	12.11	13.51		
	Means	10.96 [ab]	9.63 [b]	13. 05 [a]	0.741	0.0114
% eNDF*		32.75	30.58	28.51	4.192	0.7827

a, b and c : Means within the same raw with different superscripts are significantly different (P<0.05).
*** % eNDF = (pH - 5.425) / 0.04229 (Fox *et al.*, 2000)**

The rumen is the primary fermentations vat , muscular contractions aid in the constant mixing of feed materials' with bacteria laden fluids to promote fermentation and in the regurgitation of feed materials , which results in particle size reduction from chewing and stimulates copious production of saliva . Salivary bicarbonate ion is primarily responsible for maintaining only a slightly acid pH in the rumen (6.7 – 7.2 optimum), despite the tremendous amount of acids being produced during fermentation (Beharka *et al* 1998). The critical key to modeling rumen fermentations processes and applying this information's to practical dietary formulations understands what nutrients become available in the rumen. In forage fed animals, ruminal pH is generally near neutrality (pH 7.0) and is well buffered by bicarbonate and phosphate from saliva, proteins, forage cell walls and VFA (Russell and Hino, 1985). However, if the grain levels ingested exceed protozoal capacity to remove starch, protozoa populations will decline (Hristov *et al* , 2001) ; drastic increase in bacterial counts will occur , fermentation to VFA and lactic proceed and ruminal PH well decline (Mackie *et al*, 1978) . No differences in ruminal PH in vivo due to buffer addition were observed, in agreement with other results reported by (Khorasane and Kennelly, 2001; Kawas *et al*, 2007). Some authors have observed higher acetate and lower propionate molar proportions respectively, related, to greater fiber degradation (Van soest *et al*, 1991) , and to an increased ruminal dilution rate and resulting washout of soluble carbohydrates form the rumen (Russell and Chow, 1993). Published results about changes in VEA production in response to SB administration are inconsistent, with some showing increases (Khorasani and Kennelly, 2001) and others decreases (James *et al* 1985) or no changes (Kawas *et al* 2007).

Although some studies have suggested that sodium bicarbonate can enhance the rate of ammonia utilization by the rumen bacteria (Newbold *et al* 1988), other researches working with cattle (Khorasani and Kennelly, 2001) , have shown no effect an ruminal ammonia levels, which is in line with the results observed in this experiment.

Generally, dietary sodium bicarbonate acts as a buffer in the some way as endogenous sodium bicarbonate found in saliva, sodium bicarbonate works in an optimal pH range of 6.2 to 6.5. Not all studies have shown an increase in rumen pH in sodium bicarbonate treatment groups. There may be two reasons for this finding. Firstly, if the initial rumen pH was leas than 6.0 the buffering capacity of sodium bicarbonate is less. Secondly, studies with diets containing greater than 30% dry matter form forage show less pronounced effects by dietary buffers on rumen pH (Erdman, 1988). Currently, the Cornell Net carbohydrate and protein system (CNCPS) uses eNDF to adjust ruminal pH and passage rate (Sniffen *et al*, 1992). Factors other than particle size that influence eNDF include the degree of lignifications of the fiber, degree of hydration, and bulk density. The importance of eNDF can be seen in the reduced growth rate of structural carbohydrate – fermenting microorganisms and the reduction in total microbial yield when pH is lower than 6.2 (this being related to a dietary eNDF of 20 %).

Blood parameters:

Concerning blood metabolites, data in table (5) shows the values obtained when feeding the tested rations. There were no significant effects of feeding R1, or R2 or R3 on the blood parameters, but urea tended to increase with supplemented (SB) and glucose (mg / 100 ml) was increased with feeding on R3 than feeding on R1 or R2.

Table (5): Effect of experimental rations on some blood parameters :

Items	R1	R2	R3	±SEM	*P*
Total protein, g / 100 ml	5.45	5.45	5.07	0.323	0.3982
Albumin, g / 100 ml	3.47	3.00	2.72	0.191	0.0831
Globulin, g / 100 ml	2.27	2.45	2.35	0.221	0.8508
Creatinine, mg / 100 ml	6.58	0.72	0.71	0.123	0.6831
Urea-N , mg / 100 ml	18.48	20.98	22.44	2.574	0.5763
GOT, IU / L	58.3	51.6	59.6	7.125	0.7107
GPT, IU / L	21.6	13.3	17	2.860	0.1998
Glucose, mg / 100 ml	64.4	63.9	73.9	2.805	0.0774

Concerning blood metabolism, the presented data shows that the values were in the normal range of healthy animals as described by Mohamed and Selim (1999).

Body weight (kg) and daily gain (kg).

Table (6) shows the effect of feeding tested rations on ABW (kg) and average daily gain (kg / d). The average daily gain (ADG) from 7 to 8 month was increased ($P<0.05$) with feeding on R1, than R2 and R3, however the average daily gain form 13 to 14 month was increased ($P< 0.05$) when feeding on R2 or R3 than R1 (0.67, 1.12 and 0.99 kg / day for R1, R2 and R3 respectively) . The mean values for ADG from 7 to 15 month were 0.62, 0.69 and 0.66 kg / d when feeding with R1 , R2 , and R3 respectively). There was no significant effect on the production efficiency (18.74, 16.77and 18.85 % for R1, R2 and R3 respectively) as show in table (7), but the economic efficiency was decreased (5.88 %) when feeding on R2 than R1 or R3 (15.13 and 14.71% respectively), but without significant effects as show in table (8).

Actual age and birth date are very important. Steers and heifers are placed on feed between ages of 6 to 10 months . Most calves are weaned at about 6 to 7 month old (Boleman *et al*, 2001) .

During the last decade the interest of meat producers has shifted from obtaining maximum growth of the animal to productions of lean meat and an increase in the efficiency of nitrogen utilization (Gerrets *et al*, 1997) . Depending on dietary treatment, average daily gain of the empty body varied between 640 and 1340 g/d and 420 and 1370 g/d for the growth ranges of 80-160 and 160-240 kg live weight, respectively. The average daily gain of the present results were 0.60, 0.47 and 0.47 kg/ d when feeding R1. R2, R3, respectively from 7 to 10 months old , and 0.63 , 0.80 and 0.80 kg / d when feeding the same rations from 11 to 15 month , old . The production efficiency results were 18.74, 16.77 and 18.85 %, while the economic efficiency results were 15.13 , 5.88 and 14.71 % when feeding R1, R2 and R3 rations , respectively. Ingested true protein may either be degraded by ruminal microorganisms, or may escape degradation and pass to the lower gut to be digested or excreted in the faces. The amount of true protein that escapes degradation may vary considerably, on escape rate of 40% for the dietary protein probably represents an acceptable average. The remaining 60% of dietary protein is degraded almost entirely to NH_3 (Satter and Rofflei, 1977). Feeds high in TDN are more fermentable than those low in TDN. Therefor more NH3 – N can be utilized when feeds high in TDN are needed. Mean ruminal NH_3 concentrations was found to be positively related to percent CP in the ration dry matter. As dietary CP increased above 13 % (DM basis), ruminal NH_3 increased rapidly and was in excess of 5 mg NH_3 – N / 100 rumen liquor. Thus, when ration CP content is greater then 13% more NH_3 is present in the rumen than can be converted to microbial protein.

The following multiple regression equation, which considers both CP and TDN was found to improve the precision of predicting mean rumnial NH_3-N concentration (Satter and Rofflei, 1977).

$$Y = 38.73 – 3.04 x_1 - 0.490 x_2 + 0.171 x_1^2 + 0.0024 x_2^2$$

Where Y = Ruminal NH_3 – N / 100 ml rumen fluid

X1 = % CP in ration DM

X 2 = % TDN in ration DM

Table (6): The effect of feeding tested rations on the average body weight (kg) and daily gain (kg).

Items	BW					ADG				
	R1	R2	R3	+SEM	*P*	R1	R2	R3	+SEM	*P*
Initial BW (7mo)	112	106	115	4.152	0.356	-	-	-	-	-
7-8 mo	135	118	126	4.593	0.074	0.77 [a]	0.40 [b]	0.39 [b]	0.046	0.0003
8-9 mo	149	137	147	6.430	0.420	0.47	0.65	0.69	0.084	0.1929
9-10 mo	165	149	157	7.238	0.3098	0.54	0.37	0.33	0.072	0.1566
10-11 mo	194	186	195	7.075	0.6411	0.97	1.25	1.25	0.103	0.1375
11 – 12 mo	206	198	206	7.606	0.7089	0.39	0.38	0.40	0.042	0.9567
12 – 13 mo	226	221	227	7.326	0.8416	0.67	0.77	0.75	0.040	0.2139
13 – 14 mo	246	255	257	8.681	0.6739	0.67	1.12	0.99	0.091	0.0202
14 – 15 mo	261	271	274	9.336	0.6051	0.48	0.47	0.57	0.067	0.6918
Mean 7- 15 mo	-	-	-	-	-	0.62	0.69	0.66	-	-

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

Table (7): Production efficiency of growing calves fed the experimental rations :

Items	R 1	R 2	R 3	SEM	*P*
DMI kg / d	7.56	7.98	7.5	0.389	0.5626
ME Mcal / kg	2.79	2.96	2.77	1.042	0.1953
ME Mcal / d	21.14	23.63	20.83	1.042	0.1953
NE_P Mcal /d	8.96	10.02	8.83	0.442	0.1952
Live weight (kg)	266	260	264	6.179	0.7636
ADG kg / d	0.66	0.66	0.66	0.022	0.9789
Retained energy (Mcal /d)	1.67	1.67	1.66	0.081	0.9862
Production efficiency	18.74	16.77	18.85	0.669	0.1213

Table (8): Economic efficiency of the experimental ration :

Items	R 1	R 2	R 3	SEM	*P*
Price / kg fresh (LE)	8.59	9.35	8.5163	0.572	0.6545
ADG kg / d	0.66	0.66	0.66	0.022	0.9789
Price of daily gain (LE)	9.9	9.9	9.9	0.341	0.97989
Profit (LE)	1.30	0.55	1.27	0.439	0.5775
Economic efficiency %	15.13	5.88	14.71	0.270	0.6221

Market price pt. / kg fresh of : concentrate feed mixture = 1.4; Clover hay = 70; Kg body weight gain = 1500
*** was calculated according to the DMI from all ingredients during the digestion trails.**

The predicted ruminal NH_3-N concentrations when feeding the presented tested rations were 11.63, 10.47 and 10.34 mg/100 ml RL with feeding R1, R2 and R3, respectively. The corresponding actually determined mean values were 10.96, 9.63 and 13.05 mg/100 ml RL (table 4). The values were almost identical for the control ration. However, the predicted values for the tested rations including SB were somewhat higher than those determined, since the prediction system relies only on CP and TDN with no account for SB.

Remond *et al* (2002) observed significant net influx of N into the rumen when ruminal NH_3 – N fell below 9.5 mg / 100 ml, which would be expected to occur at approximately 14% dietary protein.

Concepting to the amino acids composition of the tested rations, the AAs composition were less than the requirements except for tryptophan. The mean balance AA values (% of requirement) were 70.45, 68.14 and 71.73 with feeding on R, R2, R3, respectively as shown in table (9). Proteins are composed of 20 amino acids, many of which the calf can synthesize in adequate amounts to meet its needs . But several amino acids must be consumed in the diet because the calf cannot synthesize these amino acids. These amino acids are lysine, histidine, leucine, iso- leucine, valine, methionine, threonine, tryptophan, tyrosine and phenylalanine. Amino acid imbalances result in reduced animal performance (Abe *et al*, 2001).

Table (9): The metabolizable energy (ME), metabolizable protein (MP), microbial growth, passage rates and amino acids of the tested rations :

Items	R1	R2	R3
DMI (kg/d)	7.6	8	7.5
MEI Mcal / d	14.9	15.5	14.2
CP %	17.7	17.5	17.1
MP from bacteria (g/d)	306	310	291
MP from UIP (g/d)	421	461	402
Fiber Fermentation (g/d)	81.6	73.1	76.8
Sugar Fermentation (g/d)	274	276.8	267
Starch Fermentation (g/d)	640	475.8	431.7
Total microbial protein (g/d)	815	825	775
Total passage rate (%/h)	7.6	8.5	7.8
Balance AA (% of requirement)			
Methionine.	61	59	62.1
Lysine	57.7	55.8	58.8
Arginine	47.5	46	48.4
Threonine	64.2	62.1	65.4
Leucine	49.9	48.3	50.7
Isoleucine	91.6	88.6	93.2
Valine	67.7	65.5	68.9
Histidine	49.1	47.5	50.0
Phenylalanine	65.9	63.7	67.1
Tryptophan	149.9	144.9	152.7
Total AAL % of reqeumnt	70.45	68.14	71.73

Conclusion:

The experimental diets were found to affect ruminal pH, volatile fatty acid production, rate of passage, voluntary feed intake and nutrient digestibility. In the present study, dry matter intake, nutrient digestibility and feeding values were increased using a lower dose of sodium bicarbonate (1.5 % of DM) . However the mode of action of this buffer additive remains unclear. Further studies are necessary to test the effect of SB to diets of higher proportions of concentrates which are usually fed during fattening period rather than growing period.

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تـأثير إضـافة بيكربونـات الصـوديوم لعلائـق عجـول الفريزيـان الناميـة علـى القيمـة الغذائية وتخمرات الكرش والاداء الانتاجى.

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أجرى البحث بهدف دراسة تأثير إضافة نسبتين من بيكربونـات الصـوديوم (١.٥ ، ٣%) من المادة الجافة المأكولة الكلية على كل من معاملات الهضم والقيمة الغذائية وبعض المعايير لسائل الكرش وبعض قياسات الدم ومعدل النمو للعجول الفريزيان والأستفادة الغذائية والكفاءة الإقتصادية وتم تكوين ثلاث علائق على النحو التالى:
(عليقة أولى) ٦٤% علف مصنع + ٣٦% دريس برسيم (عليقة مقارنة)
(عليقة ثانية) ٦٤.١٢% علف مصنع + ٣٤.٣٦% دريس برسيم + ١.٥٢% بيكربونات الصوديوم
(عليقة ثالثة) ٦٠.٦١% علف مصنع + ٣٦.١٩% دريس برسيم + ٣.٢% بيكربونات الصوديوم

وكانت الخلطات الثلاثة متماثلة من حيث نسبة البروتين حيث تراوحت بين (١٦.٠٤ – ١٦.٥٧%) ومستخلص الألياف المتعادلة (٤٣.٧٤ – ٤٥.٠١%).

استخدم اثني عشر عجل فريزيان متوسط وزن ١١١كجم عند متوسط عمر ٧ اشهر وموزعة فى ثلاث مجاميع (أربعة عجول لكل مجموعة) وتم أخذ عينات الروث لاجراء التحاليل المطلوبة لتجارب الهضم وأخذ عينات سائل الكرش بواسطة اللى المعدى قبل الأكل وبعد الأكل ٢، ٤ ، ٨ ساعات لتقدير تركيز ايون الهيدروجين (pH) ، السعة التنظيمية للكرش ، وتركيز الاحماض الدهنية الطيارة وتركيز الأمونيا وتم تسجيل أوزان الحيوانات شهريا لتقدير معدل الزيادة اليومية عند التغذية على العلائق المختبرة وحساب الكفاءة الاقتصادية لها.

وقد استخدم برنامج CNCPS لتقييم الخلطات العلفية من حيث معدل سرعة مرورها ودرجة تخمر ميكروبات الكرش للمركبات الكربوهيدراتية ومعدل نموها خلال اليوم وضبط الاحتياجات الغذائية وذلك لتفسير النتائج المتحصل عليها.

وكانت أهم النتائج المتحصل عليهاكما يلى :

١- زادت كمية المأكول من المادة الجافة (٣.١٨ % من وزن الجسم الحى) بالتغذية على العليقة الثانية مقارنة بالتغذية على العليقة الاولى والثالثة حيث كانت ٢.٨٣% من وزن الجسم فى كل منهما وكان سرعة مرور الكتلة الغذائية للعليقة الثانية ٨.٥% / ساعة أعلى من التغذية على العليقة الاولى أو الثالثة حيث كانت ٧.٦ ، ٧.٨%/ ساعة على التوالى .
٢- تحسنت معنويا معاملات هضم المكونات الغذائية على مستوى (٠.٠٥) لكل من المادة الجافة ، المادة العضوية ، البروتين الخام ، ومستخلص الخالى من الأزوت ، ومستخلص الألياف المتعادل ومستخلص الألياف الحامضى عند التغذية على العليقة الثانية مقارنة بالعليقة الاولى أوالثالثة بينما لم تظهر فروق معنوية بين العليقة الأولى أو الثالثة . وقد أشارت نتيجة التحليل

الغذائى الى زيادة البروتين المتكون بالتغذية على العليقة الثانية (٨٢٥ جم / يوم) مقارنة بالتغذية على العليقة الأولى أو الثالثة (٨١٥ ، ٧٧٥ جم / يوم على التوالى).

٣- ظهر تحسن فى مجموع المركبات الغذائية المهضومة % والبروتين المهضوم معنويا (٠.٠٥) عند التغذية على العليقة الثانية مقارنة بالعليقة الأولى أو الثالثة .

٤- لم تظهر تأثيرات معنوية على قياسات الكرش لكل من درجة الحموضة ، السعة التنظيمية للكرش للعلائق المختبرة بينما زادت كمية الأحماض الدهنية الطيارة معنوي (٠.٠٥) عند التغذية على العليقة ا؟لأولى أو الثانية (٩.٦٧ ، ٩.٨٨ مليمكافىء / ١٠٠ مل سائل كرش على التوالى) مقارنة بالتغذية على العليقة الثالثة (٨.٠٥ مليمكافىء / ١٠٠ مل سائل كرش) ، كما إنخفض تركيز الأ؟مونيا معنويا (٠.٠٥) أيضا بالتغذية على العليقة الأولى أو الثانية (١٠.٩٦ ، ٩.٦٣ مللجم /١٠٠ مل سائل كرش على التوالى) مقارنة بالعليقة الثالثة (١٣.٠٥ مللجم /١٠٠ مل سائل كرش).

٥- لم يتأثر معدل نمو الحيوانات خلال فترة التجربة معنويا بالتغذية على العلائق الأولى أو الثانية أو الثالثة (٠.٦٢ ، ٠.٦٩ ، ٠.٦٦ كجم /يوم على التوالى) وكانت كمية الأحماض الأمينية المتاحة هى ٧٠.٤٥ ، ٦٨.١٦ ، ٧١.٧٣ % من الأحتياجات المطلوبه للعلائق الأولى والثانية والثالثة على الترتيب.بينما زادت الكفاءة الاقتصادية عند التغذية على العليقة الأولى أو الثالثة ١٥.١٣ ، ١٤.٧١ % على الترتيب) مقارنة بالتغذية على العليقة الثانية ٨٨و٥%.

مما سبق يتضح أن إضافة بيكربونات الصوديوم بمعدل ١. % من المادة الجافة كان له تأثير معنوى على زيادة معاملات هضم المركبات الغذائية ، والبروتين المهضوم ، كمية المأكول ونقص مستوى الأمونيا بالكرش بينما لم تظهر هذا التأثير على الانتاج للعلائق المختبرة مما يستوجب إجراء بعض الدراسات المستقبلية عند التغذية على نسبة مركزات أعلى فى المراحل المتقدمة من النمو مع توفير بعض الأحماض الأمينية الضرورية للانتاج.

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