J. of Animal and Poultry Production, Mansoura Univ., Vol . 15 (12): 209 - 217 ,2024

Journal of Animal and Poultry Production

Journal homepage & Available online at: www.jappmu.journals.ekb.eg

Efficacy of Dietary Supplementing Zeolite or Sodium Bicarbonate for Lactating Buffalos on Nutrient Digestibility, Milk Production and some Blood Minerals status

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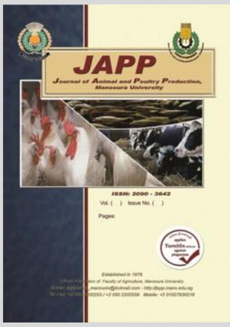
Abou-seri, H. S.*; Nashwa M. Kamel; H. B. Mohamed and M. M. E. Ibrahim

Animal Production Research Institute (APRI), Agricultural Research Center (ARC), Dokki, Giza, Egypt



ABSTRACT

This study aimed to evaluate the effects of Zeolite or Sodium bicarbonate in lactating buffalo's diet during pre and post-partum period on milk yield and composition, blood Ca, P, and Mg profiles. Eighteen multiparous pregnant buffaloes in dry period were divided into three equal treatments; the control received a basal diet without supplementation and the 2nd dietary treated group (Z) supplemented with 200g/head/day of Zeolite while, the 3rd group (SB) addition of 200g/h/day Sodium bicarbonate. The experimental lasted two months before the expected delivery date and three months post-partum. The results indicated that Z and SB treated groups improved ($P<0.05$) of total DM intake, nutritive values and digestibility of OM, CF, CP as compared to control Likewise, SB group had the highest DM and EE digestibility ($P<0.05$) compared to Z or control group. Actual milk and 4% FCM yields, milk fat percentage increased ($P<0.05$) in supplemented groups than control group especially during the end of the experimental period. However, there was no effect supplementation on milk Ca, P, and Mg concentration and other milk constituents. Conversely, blood Ca concentration and Ca: P ratio were significantly higher ($P<0.05$) in treated groups after calving at the last month of treatment than control. While, there was no treatment effect on plasma P and Mg levels between groups. Dietary supplementations of Z or SB did not produce any clinically disorders in the animal's metabolism or abnormal change in blood minerals homeostasis, but higher cost and low economic milk efficiency.

Keywords: buffaloes, zeolite, $NaHCO_3$, milk, minerals

INTRODUCTION

Egyptian buffaloes are higher source in grade milk, but their productive potential has not in fully utilized. Dam fertility, milk yield, milk quality and calf health of dairy cattle are major impressed by diet (Ilić et al., 2011), the transition period is the key phase in lactation cycle associated with important physiological, metabolic changes and go through a high rapidly demanding nutrition and management programs due to increased fetal growth and synthesis of milk, (Grummeret al., 2010). Thus, improving management during the transition period important way for prevention post-calving reproductive and health metabolic disorders and losses economic of dairy animals (Overton and Waldron, 2004). Minerals (Calcium, Phosphorus, and Magnesium) act an important role during milk synthesis to form and stability of casein micelles and milk protein aggregate (Horne 2016). It is common that the animal metabolism of the most nutrients are in negative balance during the last weeks of gravidity, especially Ca blood as related to decrease in dry matter intake (DMI) with increased in fetal growth, colostro - genesis and milk Ca production demand, then the risk of developing hypocalcemia increases within 24-48 hours following parturition in dairy animals when blood Ca drops below normal ranges (Martinez et al., 2012). Fed dairy animals in early lactation on high concentrate diet one of program to properly demand ration balance, but these can be lead to acidosis disorders, (Khan et al., 2006). Interaction between parathyroid hormone (PTH) and calcitonin hormone and vitamin D3 are regulate blood Ca homeostasis, so that, hypocalcaemia incidences when Ca increased in diet before parturition, also fed higher levels of K and Na in diet during dry period animals increased blood metabolic alkalosis (Hesam and Samuel, 2018). Dietary Ca as supplementation during prepartum one of the most common strategies to control Ca imbalance and to preventing hypocalcemia related to slight decrease Ca in blood to stimulate (PTH) hormone secretion and mobilizes skeletal Ca with higher Ca absorption and re-absorption efficiency from small intestine and kidney (Goff, 2006). However, Ca binding agent can be controlled dietary of Ca bioavailability (Horst et al., 2005). The natural Zeolite (Z: sodium aluminum silicate) is complex mineral compounds and high water affinity because it has large number of cations, such as Ca2+, K+, Mg2+, and NH4+ which can be osmotic activity by regulate ruminal pH values buffering and facilitate ruminal micro environment fermentation, (Bosi et al., 2002). Z has the capacity to bind Ca, P, and Mg in rumen fluid at varying pH levels (Thilsing et al., 2007). Also it is used as feed additive in dairy rations to increases feed efficiency and milk production and reduces mastitis (ETS, 2013). The dietary inclusion of Z improves Ca turnover and energy status during the periparturient period. It has beneficial effects on productive performance and maintains animal's health by binding mycotoxins in dairy cattle (Katsoulos et al., 2006). Sodium bicarbonate (SB) is one of the most promised additives material which enhances the feed intake in early lactation, it has availability abundant and economical increase dairy animal DMI and productivity by counteracting rumen acidosis systemic. Also sodium bicarbonate was used in dairy cattle diets as an exogenous rumen buffer particularly under stress conditions and

* **Corresponding author.**
E-mail address: hesham6924@yahoo.com
DOI: 10.21608/jappmu.2024.329997.1135

improvement dietary fiber digestibility by ameliorate rumen environment pH within (6.6 to 6.8) for cellulolytic microorganisms and increased acetic acid production (Clark et al., 2009). Similarly, added SB to cow diet prevents digestive disorders and increases feed intake, milk yield and milk fat synthesis in early lactation dairy cows (John Moran, 2005; Baucells et al., 2009; Nguyen Thanh Hai et al., 2019). This study aimed to investigate the effect of dietary supplementation of Z or SB during pre and post-parturient period on DMI, nutrients digestibility, milk production and composition as well as some blood mineral profiles in lactating buffaloes.

MATERIALS AND METHODS

Animals:

This study was carried out at Mahalet Mousa Experimental Buffalo Station, Animal Production Research Institute (APRI), Agriculture Research Centre, Egypt. Eighteen multiparous buffaloes pregnant at last two months, between the 2nd and 5th parities and weighing 583 ± 21 kg were used in this study to evaluate effect of using zeolite (Z) or sodium bicarbonate (SB) as fed supplementation on milk production and composition as well as blood Ca, P, and Mg status. Buffaloes classified into similar three groups (6 animals/ group) according to age, body weight and parity, dams were kept one week postpartum on maternity unit with their calves after delivery. Thereafter buffalo dams were transferred to the milking unit and individually house in a separated semi open free-stall barn and free access to water.

Feeding system:

Animals in all groups were fed basal diet consisted of 35% corn silage (CS), 25% rice straw, and 40% concentrate feed mixture CFM). The basal diet was formulated to meet established nutrient requirements of pregnant and lactating based on body weight, milk production, and stage of lactation according to Kearl (1982). The amount of feeds was adjusted weekly and animals were individually fed concentrate twice daily at 7 a.m. and 3 p.m. Also, feed offered and refused was recorded daily to determine DM intake. Chemical composition and calculated feeding values of the basal diet are shown in Table 1.

Table 1. Chemical composition of feed ingredients and feeding values calculated (basal ration)

Item	CFM*	Corn silage	Rice straw
Dry matter (DM)	91.2	28.42	90.5
Chemical composition (%DM)			
Organic matter (OM)	90.08	93.81	84.36
Crude protein (CP)	13.37	8.64	2.96
Crude fiber (CF)	24.66	23.61	38.83
Ether extract (EE)	3.2	2.45	1.23
Nitrogen-free extract (NFE)	48.85	59.11	41.34
Ash	9.92	6.19	15.64
Feeding value% of DM			
Total digestible nutrients (TDN %) **	60.151	51.476	53.878
Digestible crud protein (DCP %) **	9.423	4.884	-0.710
Digestible energy (DE)(M Cal/kg DM)*	2.652	2.270	2.375
Metabolizable energy (ME)(M Cal/kg DM)*	2.229	1.842	1.949
Net energy (NE) (M Cal/kg DM)*	1.357	1.141	1.200

***Concentrate feed mixture (CFM) consisted of yellow maize (41%), wheat bran (24%), uncorticated cottonseed meal (26%), molasses (4%), Mineral and vitamin mix (premix) (1.5%)* and salt (0.5%) (Nacl),) *composition of premix, (18 % CaCO3, 6 % calcium mono phosphate, 6.5% Nacl, 3 % Mgo, 80.000 IU and vitamin D3 /kg, 450,000 IU Vitamin A/kg, 2.125 mg vitamin E/kg.**TDN%= 129.39-0.9419(CF+NFE); (DCP %) = 0.9596*CP-3.55; (DE) = 0.04409*(TDN %); (ME) = 1.01*(DE)-0.45; (NE) = 0.0245*(TDN %) - 0.12 (NRC, 2001).**

Experimental groups and the tested diets:

Animals in the control group (n=6) were fed on a basal diet without any treatment, while the 1st treated group (n=6) was fed the basal diet well mixed with 200g /head/day sodium bicarbonate (SB) and the 2nd treated group was supplemented with 200g/head/day of zeolite (Z: sodium alumino silicate; Zeolite assured by Gordes Clinoptilolite Mining, Izmir, Turkey). Chemical composition of Z (w/v) is presented in Table 2.

The feeding trial was initiated two months before the expected calving date till three months of lactation. Animals had one month before receiving any experimental diets as adapted period

Table 2. Chemical composition of zeolite (w/v).

Content	(%)
Silicon dioxide	67.11
Aluminum oxide	11.84
Ferric oxide	1.44
Magnesium oxide	1.15
Calcium oxide	2.18
Sodium oxide	0.38
Potassium oxide	3.44
Loss on ignition	12.5
ion exchange capacity of NH4 (meq/g)	1.7-2.1

Digestibility trial:

To determine nutrient digestibility and nutritive values of the experimental rations, three dams from each group randomly assigned and maintained individual in digestibility cages at the end of treatment using grap sample method an internal marker (acid insoluble ash method AIA) according to (Van Keulen and Young, 1977). Twice daily samples of feces collected from rectum at 9a.m. and 9p.m. for seven successive day's collection period. Feed intake was recorded daily once at 8.00 a.m. Samples of 10 % of daily faces and food weight were taken daily and dried at 60°C for 24hrs and ground to chemical analysis.

Chemical analysis and digestibility coefficients:

Fecal samples from each animal were compo sited and grounded for chemical analysis. Feed samples, residuals and feces carried to chemical analysis (on dry matter basis) Crude fiber (CF), Ether extract (EE), Crud protein (CP), and ash were analyzed while, nitrogen-free extract (NFE) was calculated by the differences according to **(A.O.A.C, 2005).** Digestibility coefficients of nutrients were calculated (nutrients in feed intake - nutrients in feces) as percentage of its intake.

Milk sampling:

Daily milk yield was recorded after calving immediately until 90 days' post-partum. Morning and evening samples were mixed by ratio 1% weight (100 ml) of milk samples from each dam after composite, representative and stored at −20°C to analyzed biweekly for protein, fat, lactose and ash according to method 972.16 of A.O.A.C (1990), using (Milkoscan apparatus 6000; FOSS, Denmark), while total solids (TS) and solid not fats (SNF) were calculated. Additionally, milk minerals (Ca, P, and Mg) were determined using spectrometric method by flame atomic absorption after samples mineralization and dilution with nitric acid (AFNOR NF ISO 8070 2007).

Blood sampling:

Blood samples were collected individually before the morning feeding from the jugular vein into heparin zed vacutainer tubes (all animals in each group) at 60, 30 and 10 days before expected date of the calving, and at the 1st and 5th days post-partum. Thereafter blood samples were collected biweekly. Blood plasma was carefully separated after centrifugation at 4000 r.p.m. for 20 minutes, and then immediately stored at -20ºC until analysis.

Mineral profile:

The concentrations of plasma Ca, Pi, and Mg were assayed on an automatic Beckman Coulter AU 680 analyzer (Beckman Coulter Biomedical Inc., 250 S. Kraemer Blvd. Brea, CA 92821, USA), using commercial standard kits (Beckman Coulter Biomedical®., O'Callaghan's Mills, Co. Clare, Ireland). Calcium concentration (OSR 6113) was measured by photometric o-cresolphthale method at 340 nm. Phosphorous inorganic concentration (OSR 6122) was determined by UV-test photometric at 340 nm, while magnesium concentration (OSR 6189) was estimated using the photometric xylidyl blue method at 660 nm.

Statistical analysis:

All data were analyzed using General Linear Model procedures GLM according to SAS, User's Guide (2003). The differences between treatments were tested using Duncan's multiple test (Duncan, 1955) at a level of P<0.05. In this study the statistical model used was as follows:

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

Where: **Y_{ij} = observed response, μ = overall mean, T_i = effect of treatment (i= from1to 3) 1= control (no addition), 2= zeolite addition and 3= sodium bicarbonate addition and e_{ij}= error the experimental**

RESULTS AND DISCUSSION

Nutrients Digestibility:

Results in Table 3 showed that the digestibility of crude protein, and crude fiber as well as nutritive values as TDN were improved (P<0.05) in treated buffalo groups as compared with the control group. Likewise, DM and EE digestibility were increased significantly (P<0.05) by SB as compared to those in Z and control groups.

Table 3. Effect of Zeolite and sodium bicarbonate supplemented to lactating buffalo's ration on nutrient digestibility and nutritive values.

Item	Treatment			SEM	P-value
	CG	SB	Z		
Nutrient digestibility (%)					
Dry matter	65.95[b]	70.21[a]	67.51[b]	0.52	<0.01
Organic matter	68.83[b]	70.55[ab]	72.32[a]	0.50	0.02
Crude protein	58.22[c]	61.36[b]	63.93[a]	0.67	0.04
Ether Extract	86.53[b]	91.34[a]	88.8[b]	0.61	0.03
Crude fiber	52.12[c]	55.73[b]	57.51[a]	0.66	0.02
Nitrogen free extract	70.56	74.81	77.82	0.73	0.56
Nutritive value (%)					
TDN	61.59[c]	66.18[b]	68.53[a]	0.81	0.02
DCP	8.26[b]	8.74 a[b]	9.52[a]	0.15	0.03

a, b, c: Means bearing different superscripts in the same raw are significantly different (P < 0.05).

The improvement in nutrients digestibility with SB ration group may be related to increase of the total number of cellulolytic bacteria and ciliate protozoa which enhance rumen fiber digestibility Santra et al. (2003). These result agreed with Doaa et al. (2021) in dairy cows and Ghoniem et al. (2018) in lactating buffaloes, they found an increase in OM, CF, CP, and NFE digestibility, while EE digestibility was not affected with bentonite addition. Santra et al. (2003) observed a higher number of rumen total protozoa with feeding lambs on high level of SB (2.25 and 1.5%) than in those fed lower level (0.75%). Karatzia et al. (2013) found that added Z to fed rations of dairy cattle increased nutrients digestion, rumen acetate molar percentage, rumen liquid dilution rate, and acetate: propionate ratio, rumen pH value, and energy status with a decrease in propionate associated with more favorable environmental microbial rumen fermentation. However, adding 1.0 or 2.0% SB to diets finishing beef steers did not affect DM and CP digestibility (Cole et al., 2007).

Feed intake

Adding SB and Z to buffalo diets significantly increased daily rice straw intake (on DM basis) and total DM intake as compared to the control diet (Table 4). Nutrient digestibility and nutritive values improvement for the experimental rations (Table 3) might be due to increasing DM intake from rice straw. Similar results were reported by several authors (Wittayakunet al., 2015; Aguilera-Soto et al., 2008). Also, Baucells et al. (2009) found that supplementing 250g of SB in diet of lactating cows improved DMI. Adding SB to high concentrate rations of buffaloes controlled rumen acidity and improved feed intake by acid base balance (Shahzad et al., 2007). In this way, Sarwar et al. (2007) found that 1.5% addition of SB increased dry matter intake by 29% in Nili Ravi buffaloes. Furthermore, adding SB for growing lambs fed grass silage increased DMI from 8 to 20% (Sormunen et al., 2006). Regarding, similar results of Z effect were obtained by Ural, (2014) and Sulzberger et al. (2016).

On the other hand, inclusion of low level of Z (1–1.4% on a DM basis) in the diet of cows showed a reduced feed intake and hypo-phosphataemia (Thilsing-Hansen et al., 2002; Cole et al., 2007; Migliorati et al., 2007; Grabherr et al., 2009). Also, daily DMI was not affected in cows by increasing SB at levels from 0.75 to 2.25% in the rations (Santra et al., 2003; Clark et al., 2009). There are relationship among SB level in the diets and negative energy balance (increased lipolysis) postpartum (Sulzberger et al., 2016). However, Thilsing-Hansen et al. (2002) and Khouloud et al. (2018) reported that the high dosage of Z (>400 g/d/cow) resulted in rapid reduction in DMI and negative energy as related to poor palatability of feed for cows fed higher quantity of Z and increased ruminal osmolality. Kennelly et al. (1999) found that DM, CP, and NDF intakes were not affected by SB addition on high- or low-forage cow's diet.

Table 4. Effect of sodium bicarbonate and zeolite supplemented to lactating buffalo's ration on dry matter intake.

Items	Treatment				P-value
	CG	SB	Z	SEM	
Daily DM intake (kg /head/day):					
Concentrate	5.6	5.6	5.6	-	-
Corn silage	3.78	3.99	4.01	0.016	0.41
Rice straw	2.35[c]	2.57[b]	2.86[a]	0.013	0.02
Total DMI	11.73[b]	12.16[a]	12.47[a]	0.132	<0.01

a, b, c Means bearing different superscripts in the same raw are significantly different (P < 0.05). Ns= non- significantly

Milk yield

Daily milk yield as actual, 4% fat corrected milk yield (4% FCM), and milk energy (Kcal / Kg milk) were higher significantly in Z group as compared to control one. However, only actual daily milk yield was significantly higher in BS group than in control group (Table 5). Improving milk yield in buffaloes fed treated diet may be due to the increased DM intake (Table 4). Milk yield improved of lactating cows fed inclusion diet of Z or BS was obtained by Ilić et al., 2011; Cruywagen et al., 2015). Similarly, cows fed diet supplemented with Z were more efficiently feed into milk (Ural, 2014; Sulzberger et al., 2016; Khouloud et al., 2018). Moreover, Katsoulos et al. (2006) reported that the administration of 2.5% of Z to lactating cows had positive responses on milk yield relation to the increase in rumen propionate production or increased post-ruminal digestion of starch that may hence influence on energy status or microbial protein synthesis and increased by-pass protein. Hu et al. (2007) indicated that Z increased dietary cation-anion difference (DCAD), through enhancement of diets acid-base balance regulation that increased DMI and milk yield production of dairy cows. Similar results to BS impacts were reported by Wittayakun et al. (2015), John Moran, (2005), Baucells et al. (2009), and Hu and Murphy, (2005), who found positive responses in productivity when added buffer on high concentrate and low roughage fed cow rations.

In contrary, Thilsing-Hansen et al. 2002; Migliorati et al. 2007; Grabherr et al. (2009) found that milk yield was not affected by inclusion diet with low level of Z (1–1.4% on a DM basis). Also, Dschaak et al. (2010) reported that milk yield and its composition in cows were not influenced by dietary supplementation of 1.4% SB and 1.4% Z. Bosi et al. (2002) also attributed the declaim of DMY of cows administered wit Z at 1.25 and 1.0% to reduced DMI and digestibility of nutrients. The differences between results might be due to the level of additions, diet composition, feed intake, buffering capacity, secretion saliva stimulating, diet particle size, and DCAD (Iwaniuk and Erdman, 2015).

Table 5. Effect of sodium bicarbonate and zeolite supplemented to lactating buffalo's diet on Milk production (Kg/day) and composition

Item	Treatment			SEM	P-value
	CG	SB	Z		
Milk parameters					
Actual milk yield (kg / day)	8.43[c]	9.25[b]	9.88[a]	0.32	0.03
4% fat correct milk yield (FCM), kg/day[1]	12.22[b]	13.60[ab]	14.90[a]	0.43	0.02
Milk composition (%)					
Total solids	17.32	17.51	17.71	0.54	0.58
Fat	7.00[b]	7.14[a]	7.39[a]	0.24	0.02
Protein	4.63	4.65	4.96	0.24	0.19
Lactose	4.98	5.08	5.06	0.22	0.62
Solid not-fat (SNF)	10.32	10.38	10.32	0.41	0.51
Ash, (g/kg)	6.62	6.66	6.67	1.02	0.44
Milk Minerals content					
Ca (mg/kg)	2168.6	2014	1950.2	24.0	0.43
P (mg/kg)	1270.6	1293.9	1281.5	23.7	0.28
Mg (mg/kg)	190.8	185.9	209.2	2.0	0.37
Milk energy (Kcal / kg milk)[2]	1096.50[b]	1112.65[ab]	1141.47[a]	33.69	0.03

Means bearing different superscripts in the same raw are significantly different (P < 0.05). (1) Fat milk corrected (FCM 4%) calculated by using Gaines (1928) equation as follows: - FCM = (0.4 × milk yield + 15 × fat yield).(2) Milk energy (Kcal) = ((115.3 (2.51 +fat %)) according to Overman and Sanmann, (1926). Ns= non- significantly

Milk composition

As shown in Table (5) milk fat % was significantly higher affected (P<0.05) in Z and SB treated group than control one. However, no significant differences were obtained among buffalo groups in other milk constituents. These finding are in agreement with (Clark et al., 2009; Đuričić et al., 2017; Sarwar et al., 2007). Also, Cruywagen et al. (2015) reported gradually enhancement in milk production and milk fat percentage by increasing levels of SB in rations due to improvement microbial growth environmental and consequently leads to an increase rumen acetate production which represented for 60% of milk fat. Similarly, Sulzberger et al. (2016) noticed a significant increase in milk fat percentage with added 2% of SB or Z to the diet leading to increased rumen acetate production. In contrast to our findings, fat milk yield was unaffected by buffer supplementation when using different sources of buffers (Migliorati et al., 2007). It seems likely that the milk fat yield was affected by feeding system as a consequence of increasing in milk yield in addition groups.

In the present study, results in Table (5) showed that addition Z and SB to the diet did not affect the constituent of milk protein percentage than that from the control one. Our results were in agreement with Katsoulos et al. (2006) and Clark et al. (2009). In the same line, Dschaak et al. 2010 reported that protein percentage of milk did not affect by adding 1.4% SB and 1.4% Z on cow's diets. Also, Đuričić et al. (2017) found that the dietary buffers unaffected protein metabolism and milk protein yield and percentage during early or mid-lactation. Contrary to our results, milk protein percentage was increased with Z supplementation during the complete lactation (Dschaak et al., 2010). Also, Wittayakun et al. (2015) found that supplemented SB and $CaCO_3$ of lactating cows improved milk protein percent and daily milk yield due to promoting crude protein digestibility and neutral detergent fiber thus increased amino acid to mammary gland. However, Sarwar et al. (2007) found that, milk protein and lactose remained unaltered while, milk fat percentage and total milk solids improved with increasing the SB diet level, when fed lactating Nili Ravi buffaloes on diets contained 0.50, 1.0 and 1.50% SB.

Table (5) showed that Ca concentration in buffalo milk of Z and SB addition groups did not affected by treatment as compare with the control one although there was increased in milk production and decreased milk protein (casein) content in treated groups; Variations in milk Ca content have related to the breed, season, stage of lactation, parity, and feed strategy (Gaignon et al., 2018). About 66% of Ca is main associated with casein so that there are a liner correlation positive response among casein content (milk protein) and milk Ca this can explain non-notable improvement of milk Ca content, and its slightly dropped during the first days post calving for all groups (Bijl et al., 2013; Gulati et al., 2018).. Similar results were obtained by Gabryszczuk et al., (2010) who found that the majority of cows remain under a negative Ca balance after calving and early lactation. In addition, Boudon et al., (2016) and Gaignon et al., (2018) mentioned that, regulated milk Ca secretion by mammary gland is associated with parathyroid hormone related protein (PTHrP), dynamics digestive tract and kidneys of bone reabsorption. On the other hand, Hu et al. (2007) signaled that milk Ca content was highly correlated with DCAD, and decreased in the amount of Ca excreted in urine which was enhanced by Z supplementation. In spite of blood Ca concentration in the current experimental of lactating buffalo was increased by Z and SB supplementation groups (see blood mineral section

Table 7 and Figure 1), it means that under our experimental conditions, blood Ca determinant was not availability for Ca uptake by the mammary gland

Data in Table (5) indicated that milk Phosphorus (P) and magnesium (Mg) concentration was unaffected by added Z and SB to ration, and it remained stable over the most trial period. This result was expected because milk casein content was not affected by adding rations in our study and since about 50% of P is associated intimately by casein (Petrera et al., 2016). Also, Bijl et al. (2013) and Gulati et al. (2018) found that the milk Mg concentration had a positive correlation with milk casein micelle.

Feed efficiency:

Results in Table 6 show that the feed efficiency of dietary groups supplemented with Z and SB was significantly better (P<0.05) in 4% FCM / kg DMI, TDN and DCP than the control while, daily feed cost and feed cost (LE)/ 4%FCM was higher with dietary SB treatment as related to higher price of SB and Z. These results with add of Z were agreement with several authors (Ural, 2014; Sulzberger et al., 2016; Doaa et al., 2021). Similarly, Aguilera-Soto et al. (2008) found that fed lamb diets on SB addition increased DMI and feed efficiency. Ghoniemet al. (2018) reported that increased feed efficiency in dairy buffalos fed Bentonite. In contrast to our results, Dschaak et al. (2010) reported that milk yield efficiency was not influenced with dietary addition of 1.4% SB and 1.4% Z diet on DM basis for Holstein cows.

Table 6. Effect of sodium bicarbonate and zeolite supplemented to lactating buffalo's ration on feed efficiency

Items	Treatment				P-value
	CG	SB	Z	SEM	
Total DMI (kg /head/day)	11.730[b]	12.165[a]	12.470[a]	0.132	0.02
TDN (%)	61.59[c]	66.18 [b]	68.53[a]	0.81	0.04
DCP(%)	8.26 [b]	8.74 [ab]	9.52 [a]	0.15	0.02
Daily actual milk yield kg/day	8.43[c]	9.25[b]	9.88[a]	0.32	0.03
Daily 4% fat correct milk yield (FCM), kg/day	12.22 [b]	13.60[ab]	14.90 [a]	0.43	0.02
4% FCM efficiency					
4% FCM (kg) / kg DMI	1.042[c]	1.118[b]	1.195 [a]	0.08	0.03
4% FCM (kg)/ kg TDN	1.692	1.689	1.744	0.09	0.35
4% FCM (kg)/ g DCP	126.14 [b]	131.99 [b]	144.68[a]	0.16	0.02
Economic evaluation:*					
Daily feed additive cost (LE)	--	56	20	-	-
Daily feed cost (LE) without additive	73.19	74.7	75.08	-	-
Price daily milk yield as 4%FCM (LE)[1]	73.19	130.7	95.08	-	-
Feed cost (LE)/kg 4%FCM	5.99	9.61	6.38	-	-
Price daily milk yield as 4%FCM (LE)[2]	244.4	272	298	-	-
Economic efficiency*	3.34[a]	2.08[b]	3.13[b]	0.09	0.04
Economic efficiency %	100	62.28	93.71	-	-

a, b,c Means of the same row in each item with different superscripts are significantly different (P<0.05).* Economic efficiency was calculated as (1/2)Price of one-ton corn silage, rice straw, and CFM was 6000, 1000, and 8600 LE, respectivelyAlso, one kg of Zeolite was 100 LE and sodium bicarbonate 280 LE and milk fat correct FCM 4% was 20 LE (Egyptian marketing prices of year 2022).

Blood minerals

In the current study results in Table (7) revealed that there were no significant differences in blood Ca concentrations during pre-calving between the experimental groups of buffaloes, plasma Ca concentration showed a linear decreased in all buffaloes groups before calving until time of parturition as compeer with starter values recorded, plasma Ca level was more pronounced drop in control group than treated groups, decreased blood Ca around calving time in all buffalo groups may be due to insufficient Ca intake and heavy demand of Ca quantity to sufficient needed rapidly of growing fetus in dry period and milk production during early lactation. However, it was noticeable that Ca concentration of blood supplemented fed groups after the first month of lactation, was significantly higher (P<0.05) also, blood Ca in Z group had more stabilizing effect during calving period than other groups (Figure1). Further, Ca blood level over in buffalo groups than which considered by Roche and Berry (2006) who reported that 2mmol/L of concentration blood Ca was a limited value range without physiological disorder symptoms. Similar result was obtained with Thilsing-Hanhsen et al.,(2002) stated that Z treated cows increased calcium plasma concentration closing to calving as related to an activation of Ca homeostatic mechanisms before calving. Grabherr et al. (2009) observed higher blood Ca concentrations of cows fed higher doses of Z being helpful to prevent hypocalcaemia development. In addition, drop blood Ca concentration stimulates release of parathyroid hormone, that hence activity Ca absorption from intestinal also, reabsorption from bone and kidneys also, renal metabolism promotes synthesis vitamin D_3 (Goff, 2006). Fed Z as supplementation before calving can be avoid hypocalcaemia in lactation period due to dietary cation-anion difference (DCAD) promotes by stimulates mechanisms of calcium homeostatic (Boudon et al., 2016; Goff and Koszewski, 2018).

Table 7. Mean concentration of Calcium Phosphorus and Magnesium in plasma of buffaloes as affected by SB and Z during prepartum and postpartum.

Item	Group			SEM	P-value
	CG	SB	Z		
	Prepartum				
Ca (mg/dL)	88.38	90.18	90.32	3.12	0.06
P (mg/dL)	59.17	58.18	60.61	1.14	0.11
Ca:P ratio	1.49	1.55	1.49	0.08	0.06
Mg ((mg/dL)	18.37	18.54	18.66	0.11	0.43
	Postpartum				
Plasma Ca (mg/dL)	88.08[b]	90.81[ab]	91.38[a]	4.73	0.03
Plasma P (mg/dL)	59.85	60.08	58.53	2.08	0.18
Ca:P ratio	1.47[c]	1.51[b]	1.56[a]	0.06	0.02
Plasma Mg (mg/dL)	18.40	18.33	18.15	0.80	0.26

a, b, c: Means of the same row in each item with different superscripts are significantly different (P<0.05).Ns= non- significantly

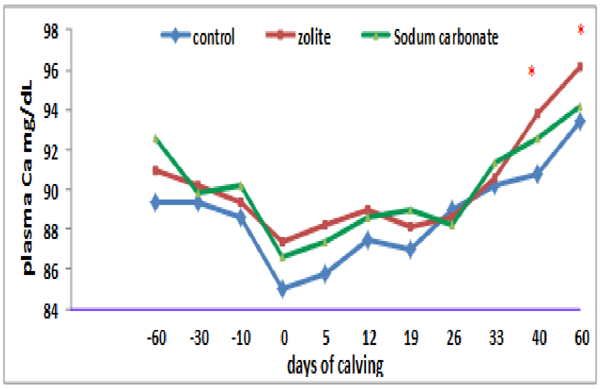


Fig. 1. Mean values of blood calcium (Ca) concentration of buffaloes treated with Zeolite or Sodium bicarbonate as supplementation feed during late pregnancy and postpartum period.

In contrast to our results, Bosiet al. (2002) found that blood Ca concentration around calving and next day postpartum did not significant difference when fed cows on different quantities of Z. However, Katsoulos et al. (2005) reported that blood Ca concentration in two months after parturition was significantly lower in cows received 2.5% of dietary Z in comparison to control group as related to higher amount of fed Z changed palatability and decreased feed intake.

In our study, Plasma phosphorus (P) values in all groups was decreased close to calving and up till the first week post calving as compared to the start of the study, then P level become higher to normal level within two weeks after calving, plasma P content did not differ among treatments groups around parturition. Furthermore, Z -fed group tented to enhanced blood P concentration after calving as compeer with SB and control group (Table 7 and Figure2).

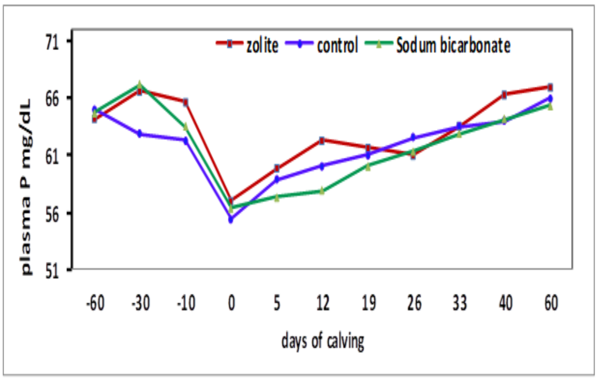


Fig. 2. Mean values of blood Phosphorus (P) concentration of buffaloes treated with Zeolite or Sodium bicarbonate as supplementation feed during late pregnancy and postpartum period.

As shown in Fig. 3 showed that improved Ca: P ratio ($P<0.05$) in post calving of dietary buffaloes on Z could be related to increase Ca reabsorption from the intestines. Similar to our results Katsoulos et al. (2005) observed that cows fed groups on diet supplementation with a Z did not show significant differences in P concentrations. However, Khachlouf et al. (2019) reported that P concentration decreased significantly around parturition in both groups of cows within three weeks before calving, and back again to normal level post parturition. Also higher concentrations of circulating PTH stimulates around parturition increased renal and saliva phosphate excretion and decreased blood P concentration (Kaneko et al., 1997) Conversely, decreased in plasma P concentration was a result to reduced bio availability of phosphate level in rations and reduced P reabsorption after parturition in cows fed Z due to binding P thus forming insoluble complexes structure in rumen Thilsing-Hansen et al., (2002).

Magnesium (Mg) concentration was relatively decreased in blood around parturition without any significant differences obtained between treated group and control group (Table 7 and Figure 4). The mean plasma Mg level during the entire experimental period in all groups stayed normal

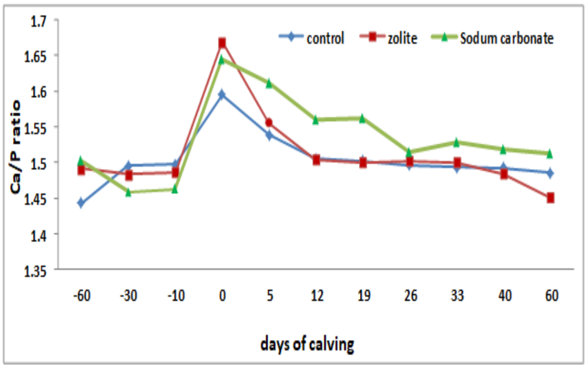


Fig. 3. Mean values of blood calcium vs. Phosphorus (Ca : P) ratio of buffaloes treated with Zeolite or Sodium bicarbonate as supplementation feed during late pregnancy and postpartum period.

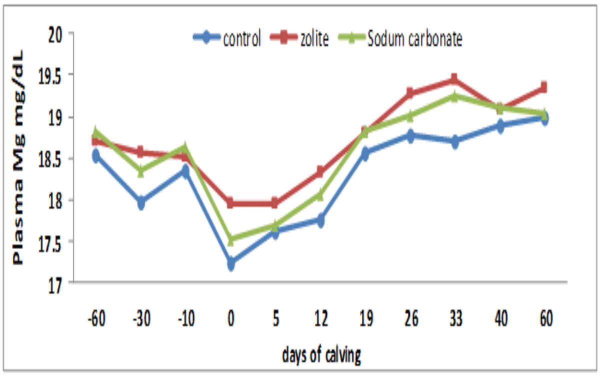


Fig. 4. Mean values of blood Magnesium (Mg) concentration of buffaloes treated with Zeolite or Sodium bicarbonate as supplementation feed during late pregnancy and postpartum period.

and within the reference interval (18–24 mg/dL) observed by Kaneko et al. (1997), blood Mg level decreased in the day pre-calving and increased on parturition day recorded by (Katsoulus et al., 2005). Also, Thilsing-Hansen et al. (2002) recorded that blood Mg concentration decreased from zero to two days after calving in cows fed Z supplemented compared to control group. Increased PTH releases lead to reduced plasma Ca concentration around parturition so that Ca and Mg consequently attributed to the correct dietary magnesium feed intake by increased intestinal absorption and renal reabsorption according to (Goff and Koszewski, 2018). In contrast to our results Khahchouf et al. (2019) noticed decreased blood Mg concentrations after parturition.

CONCLUSION

It may be concluded that dietary 200 g/h/d Zeolite or 200 g/h/d sodium bicarbonate during pre and post parturition could improve dry matter intake, milk yield and consequently enhanced FCM 4%, milk fat percentage, and feed efficiency without any adverse effects on milk composition or milk minerals in dairy buffaloes. Furthermore, sodium bicarbonate addition modifies rumen fermentation and improved digestibility of nutrients. Additionally, prepartum dietary Zeolite activated blood mineral profiles especially plasma Ca and Ca: P ratio homeostatic mechanisms before calving and thus can prevent parturient hypocalcaemia after calving. These findings indicate promising prospects for dietary utilization of Zeolite and sodium bicarbonate in dairy buffaloes without any produce clinically visible disorders in the metabolism which is often more economical than traditional buffer sources for prevent homeostasis disorder

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تاثيراضافة الزيوليت او بيكربونات الصوديوم للجاموس الحلاب على كفاءة الهضم وانتاج اللبن وتركيز بعض املاح الدم " تاثيراضافة الزيوليت او بيكربونات الصوديوم للجاموس الحلاب على كفاءة الهضم وانتاج اللبن وتركيز بعض املاح الدم "

هشام ابوسريع سعيد، نشوه محمود كامل حسين، حسن بيومي محمد و محمد محمد السيد ابراهيم

معهد بحوث الانتاج الحيواني، مركز البحوث الزرعية، الدقي، جيزة، مصر

الملخص

تهدف هذه الدراسة لتقيم اداء الجاموس الحلاب عند التغذية بالزيوليت او بيكربونات الصوديوم كاضافات غذائية خلال الفترة الاخيرة للحمل وبعد الولادة على انتاجية اللبن ونسب مكوناته وتاثيراتها على تركيزات الكالسيوم والفوسفور والماغنسيوم بالدم وكذلك على هضم المركبات الغذائية وقد تمت هذه التجربة باستخدام 18 جاموسة عشرخلال المرحلة الاخيرة للحمل قسمت لثلاث مجاميع متساوية الاولى مقارنة تتغذى بعليقة كونترول وبدون اضافات والمجموعة الثانية تتغذى بعليقة الكونترول بالاضافة ل200جم/راس/يوم زيوليت والثالثة تتغذى بعليقة الكونترول مضاف اليها 200جم/راس/يوم بيكربونات الصوديوم وكانت بداية التجربة قبل الولادة بشهرين واستمرت لثلاثة اشهر بعد الولادة وقد اظهرت النتائج ان اضاقة الزيوليت وبيكربونات الصوديوم كان له تاثيرا معنويا على زيادة الماكول اليومى وهضم المادة العضوية والبروتين الخام والالياف الخام والمركبات الكلية المهضومة. كما كان لمجموعة بيكربونات الصوديوم تاثير على زيادة هضم المادة الجافة ومستخلص الاثير بالقياس بمجموعة الزيوليت ومجموعة المقارنة. وكان للاضافات زيادة معنوية لمتوسطات انتاج اللبن اليومى وانتاج اللبن المعدل ل4% دهن بالنسبة لمجموعة المقارنة خاصة خلال الفترة الاخيرة للتجربة. بينما لم يكن للاضافات اى تاثير معنوى على بقية نسب مكونات اللبن وكذلك تركيزات الكالسيوم والفوسفور والماغنسيوم باللبن. على الرغم من ان تركيزات الكالسيوم وكذلك النسبة بين الكالسيوم والفوسفور بالدم قد اظهرت تحسن وزيادة معنوية لمجموعات الاضافة خاصة بعد الشهر الاول للولادة وكانت مجاميع الاضافات اكثر كفاءة غذائية ولم يكن لها اى تاثيرضارعلى الحالة الصحية للحيوان الا ان الكفاءة الاقتصادية لانتاج اللبن لمجاميع الاضاقة كانت اقل من المقارنة نظرا لارتفاع التكلفة الاقتصادية.