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EFFECT OF SUPPLEMENTING RATIONS WITH THIAMIN AND / OR SODIUM BICARBONATE ON MILK YIELD AND COMPOSITION OF LACTATING COWS.

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SUMMARY

The purpose of the present study was to evaluate the effect of vitamin B_1 (thiamin) and/or buffer ($NaHCO_3$) supplementation to the rations of lactating cows on some production performance and milk composition. Four lactating Baladi cows were used in 4x4 Latin Square design experiment. Each experimental period lasted 30 days. Cows received daily ration supplemented with 0, 340 mg thiamin, 340 mg thiamin + 160g $NaHCO_3$, and 160g $NaHCO_3$ for the control and treatment groups I, II and III, respectively. The control diet was Darawa and concentrate feed mixture (as 1:1 on DM basis). The results indicated that feeding lactating cows with daily ration supplemented with 340mg thiamin; 340 mg thiamin + 160 g $NaHCO_3$ or 160 g $NaHCO_3$ resulted an increase of milk yield up to 12.28% ($P>0.05$), 16.49% ($P<0.05$) and 17.34% ($P<0.05$), respectively, compared to the control diet. Milk fat and protein yields were significantly ($P<0.05$) increased by addition of 340 mg thiamin and 160 g $NaHCO_3$ (II) or 160 g $NaHCO_3$ (III) compared to the control. However, the milk composition was not significantly ($P>0.05$) affected by thiamin or $NaHCO_3$ or combination, except fat content. The serum nitrogen metabolites of lactating cows were not significantly different by feeding cows with the ration supplemented with thiamin, $NaHCO_3$ or combination. Moreover, differences in serum glucose and cholesterol, and activities of AST and ALT were not significantly ($P>0.05$) different among the groups. Furthermore, thiamin content of milk did not differ significantly among the experimental groups. However, serum thiamin concentration increased significantly as effect of the supplementations comparing to the unsupplemented diet (control). It could be concluded that $NaHCO_3$ with or without thiamin increased the milk production of Baladi cows.

***Keywords:** thiamin, $NaHCO_3$, cows, milk, serum*

INTRODUCTION

Recently, some studies have been showed positive effects of the addition of some of vitamins of the B-complex to the diets of ruminants. For example; folic acid, choline, riboflavin and biotin were added by Girard (1998) and Santschi *et al.* (2005) to the ration of dairy cows.

Thiamin (vitamin B_1) is one of the vitamin B group, and it was propose to add to the rations of ruminants containing high level of concentrate based on the role of thiamin as co-enzyme for certain enzymes in Krebs cycle and pentose pathway. Actually thiamin is necessary for carbohydrates metabolism (Mc Dowell, 2000).

It is well known that thiamin presents in the forms of thiamin monophosphate (TMP), thiamin diphosphate (TDP) and thiamin triphosphate (TTP). In animal tissues, the main form of thiamin is diphosphate, commonly known as thiamin pyrophosphate (TPP). Extracellular fluids (serum, milk and cerebrospinal fluid) contain only free thiamin and TMP (MC Dowell, 2000).

When rations of lactating cows were supplemented with (i) rumen – protected thiamin at 40, 70 or 100 mg $head^{-1}day^{-1}$ or with (ii) rumen – unprotected thiamin at 100 mg $head^{-1}$ day^{-1}, it was found that milk yield increased by 8.0, 8.50, 13 and 7%, respectively, above the control levels (Bonomi, *et al.*, 2000). Moreover, Shaver and Bal (2000) suggested that thiamin supplementation (150 and 300 mg $head^{-1}$ day^{-1}) tented to increase milk production and have effect on the milk composition.

It is of interest to point out that thiamin as a co-enzyme is necessary for cattle fed high concentrates and $NaHCO_3$ as a buffer is necessary to regulate the rumen fluid pH. Holstein Friesian dairy cows were fed ration containing 25% roughage and 75% concentrates with or without $NaHCO_3$ (1.2% of DM) and it was found that both milk yield and milk fat yield increased as effect of $NaHCO_3$ addition Kennelly *et al.* (1999). Similar trend was obtained by Schmidely *et al.* (2005).

The purpose of the present study was to study the effect of diets supplemented with thiamin and/or $NaHCO_3$ on the some productive performance and milk composition as well as some blood biochemical parameters of lactating Baladi cows.

MATERIALS AND METHODS

This experiment was carried out at the experimental farm of the Faculty of Agriculture, Cairo University and at the Dairy Science Department of National Research Center.

Animals and Nutrition:

Four uniparity Baladi cows after two weeks of parturition were used in 4x4 Latin Square design. Cows were assigned randomly to experimental groups and the feeding period lasted for 30-days. The first 15-day of each period was an adaptation period to the diet, and the next 15-day was for samples collection. At the end of each period, experimental diets were switched according to preplanned assignments.

The experimental diets were the control, control plus 340 mg thiamin (treatment I), control plus 340 mg thiamin and 160 g $NaHCO_3$ (treatment II), and control plus 160 g $NaHCO_3$ $head^{-1}$ day^{-1} (treatment III), respectively. The control diet consisted of Darawa

and concentrate feed mixture (CFM) as 1:1 on DM basis. Thiamin was (imported from China) obtained from ADWIA Company, Egypt. All animals were fed twice daily. The nutrients requirements were calculated according to N.R.C. (2001), and drinking water was available ad libitum.

The nutrient content of the diets is shown in Table (1). The analysis was done according to A.O.A.C. (1995).

Milk Samples:

Cows were milked manually twice daily. Milk yield was recorded at each milking. Fat corrected milk (4% FCM) was calculated using the formula: FCM = Milk (kg) x (0.3925 + 01510 x fat %) according to Gaines and Davidson (1923).

During each collection period, milk samples were collected from two consecutive milking of each cow and used to determine the percentage of total solids (TS), total protein, fat and ash by the methods of Ling (1963). Lactose content was determined according to Barnett and Abd El-Tawab (1957). Solids not fat (SNF) was calculated by difference. Milk thiamin content was determined according to Ndaw *et al.* (2000).

Table (1): Nutrient content of feed ingredients and control diet.

Item	DM	DM composition %					
	%	OM	CF	CP	EE	NFE	Ash
CFM*	90.25	93.50	11.10	14.92	4.33	63.15	6.50
Darawa	22.2	89.64	30.00	12.60	2.70	44.34	10.36
Control diet**	56.23	91.57	20.55	13.76	3.51	53.75	8.43

* CFM: Concentrate feed mixture consisted of 49% maize, 24% wheat bran, 24% undecorticated cotton seed meal, 2% limestone and 1% sodium chloride.
** Calculated.

Blood sampling:

Blood samples were taken from the jugular vein, 4 hours after morning feeding. Serum samples were stored at –20 °C until analysis for total protein (Gornal *et al.*, 1949), albumin (Doumas, *et al.*, 1971), urea (Fawcett and Scott, 1960), total cholesterol (Allian *et al.* 1974), glucose (Trinder, 1969), and activities of transaminases (AST and ALT) (Reitman and Frankel, 1957), Globulin content and albumin to globulin ratio (A/G) were calculated. Serum thiamin content was determined by the method of Ndaw *et al.* (2000).

Statistical analysis:

Analysis of variance was conducted according to Snedecor and Cochran (1982) using Latin Square design, where the model was:

$Y_{ijK} = \mu + T_i + P_J + A_k + E_{ijK}$

Where y_{ijK} is the observation, μ is the overall mean, Ti is the treatment (i = 1, 2, 3 and 4), P_J is the period (J= 1,2,3 and 4), A_k is the cow (k= 1,2,3 and 4) and E_{ijk} is the residual error. Differences among means were tested using Tukey test.

RESULTS AND DISCUSSION

Milk yield and composition:

Data on Table (2) showed that cows which were fed ration supplemented with thiamine and/or $NaHCO_3$ yielded more milk by 12.28, 16.49 and 17.34% and had more 4%

FCM by 12.97, 21.28 and 22.54% for treatments I, II and III, respectively as compared to the control. Statistically, effects of $NaHCO_3$ with or without thiamin (groups II and III) on milk yield or 4% FCM were significant ($P < 0.05$), however, effect of thiamin alone (group I) did not reach statistical significance neither for milk yield, nor for FCM compared to the control. Obviously, there was not significant ($P > 0.05$) difference between treatment II and III on the milk yield. The present results are in line with those reported by Kholif (1989), Bonomi, *et al.* (2000) and Shaver and Bal.(2000).

Table (2): Effect of supplementing daily rations with thiamin and/or $NaHCO_3$ to lactating cows on milk yield and milk composition.

Item	Control	Treatments (head day^{-1})			±SE
		I	II	III	
		340 mg thiamin	340 mg thiamin + 160 g $NaHCO_3$	160 g $NaHCO_3$	
Milk yield (kg head^{-1} day^{-1})	8.55^{b}	9.60^{ab}	9.96^{a}	10.03^{a}	0.19
4% FCM (kg head^{-1}day^{-1})	7.94^{b}	8.97^{ab}	9.63^{a}	9.73^{a}	0.06
Milk composition					
Fat %	3.53^{b}	3.56^{b}	3.48^{a}	3.78a	0.05
Fat yield (g head^{-1}day^{-1})	301.82^{b}	341.16^{ab}	376.49^{a}	381.14^{a}	10.33
Protein %	3.15	3.26	3.22	3.34	0.09^{ns}
Protein yield (g head^{-1}day^{-1})	269.33^{b}	312.96^{a}	320.71^{a}	335.00^{a}	9.6
Lactose %	4.42	4.58	4.59	4.59	0.24^{ns}
TS %	12.00	12.30	12.50	12.52	0.76^{ns}
SNF%	8.47	8.74	8.72	8.72	0.33^{ns}
Ash%	0.89	0.88	0.89	.79	0.26^{ns}

$^{n.s}$ not significant ($P > 0.05$)

^{a,b} Different superscripts in the same row means significant difference at $P < 0.05$ level.

With regard to the milk composition, it could be reported that daily ration of lactating cows supplemented with 340 mg thiamin (group I), 340 mg thiamin and 160 g $NaHCO_3$ (group II) or 160 g $NaHCO_3$/h/d did not affect ($P > 0.05$) significantly the milk composition, treatments II and III where milk fat content increased significantly ($P < 0.05$) as it is shown in Table (2).

However, remarkable increases were noticed in the yield of milk fat and protein up to 13.23 ($P > 0.05$); 24.14 ($P < 0.05$); 26.28% ($P < 0.05$) and 16.20 ($P < 0.05$); 19.08 ($P < 0.05$); 24.38% ($P < 0.05$) for treatments I, II and III, respectively comparing to the control (Table 2). The present results are in line with those obtained by Kholif (1989) and Shaver and Bal. (2000).

Serum Parameters:

Data of Table (3) indicated that feeding lactating cows on diets supplemented with 340 mg thiamin (I), 340 mg thiamin and 160 g $NaHCO_3$ (II) and 160g $NaHCO_3$ head^{-1} day^{-1} (III) slightly ($P > 0.05$) increased the levels of serum glucose and cholesterol comparing with the unsupplemented diet (control).

Table (3): Effect of supplementing rations with thiamin and/or $NaHCO_3$ to lactating cows on some serum biochemical parameters.

Item	Control	Treatment (head day^{-1}) I: 340mg thiamin	II: 340mg thiamin + 160g $NaHCO_3$	III: 160g $NaHCO_3$	±SE
Glucose mg/L	753.5	806.3	790.0	777.5	64.3^{ns}
Cholesterol mg/L	2740.0	3194.0	2927.5	3088.8	642.0^{ns}
Total protein g/L	63.0	63.3	63.5	68.5	3.0^{ns}
Albumin (A) g/L	36.5	39.8	39.0	35.3	3.4^{ns}
Globulin (G) g/L*	26.5	23.5	24.5	33.2	3.5^{ns}
A/G ratio**	1.44	1.69	1.59	1.06	0.25^{ns}
Urea mg/L	180.0	183.8	147.3	175.0	30.4^{ns}
AST U/L	38.65	32.60	37.30	38.70	1.75^{ns}
ALT U/L	27.85	29.53	25.45	24.70	2.71^{ns}

$^{n.s}$ not significant (P>0.05), * calculated value, ** calculated value

Moreover, data of Table (3) illustrated that no significant differences were detected among the control and the three treatments in serum concentrations of total protein, albumin (A) urea, globulin (G), and A/G ratio.

Obviously, data of Table (3) clearly showed that neither AST nor ALT activity was statistically affected (P>0.05) by adding thiamin or $NaHCO_3$ to the basal diet.

The present results of serum parameters are in line with the findings of Kholif (1989), Quigley, *et al*, (1992) and Majee *et al*, (2003).

Thiamin content:

Data of Table (4) indicated that the overall means of milk thiamin were 0.072, 0.099, 0.069 and 0.066 mg/100 g milk. Statistically, differences among these means were not significant (P>0.05). The present thiamin levels in milk cow are higher than that reported by for cow milk (0.034 mg / 100g) and are around the thiamin content of buffalo milk (0.082 mg / 100g) as reported by El-Arab, *et al.* (2004).

Table (4) : Effect of supplementing rations with thiamin and/or $NaHCO_3$ to lactating cows on thiamin contents in milk and serum.

Thiamin content	Control	Treatments (head day^{-1}) 340mg thiamin	340mg thiamin +160g $NaHCO_3$	160g $NaHCO_3$	±SE
Milk (mg / 100g)	0.072	0.099	0.069	0.066	0.008^{ns}
Serum (mg / 100ml)	0.050^{d}	0.106^{a}	0.082^{bc}	0.079^{ab}	0.004

$^{n.s}$ not significant (P>0.05).

^{a,b,c,d} Different superscripts in the same row means significant difference at level of P<0.05

Regarding to the serum thiamin content, data of Table (4) showed that this was 0.050, 0.106, 0.082 and 0.079 mg/100 ml serum of cows in control, treatments I, II and III, respectively. Obviously, all supplemented diets significantly (P<0.05) increased the thiamin level in serum comparing to the cows in the control group. However, difference between treatments II and III (340 mg thiamin plus 160g $NaHCO_3$ and 160g $NaHCO_3$ g head^{-1} day^{-1} the difference was not significant (P>0.05).

between treatments II and III (340 mg thiamin plus 160g $NaHCO_3$ and 160g $NaHCO_3$ g $head^{-1}$ day^{-1} the difference was not significant (P>0.05).

Economic efficiency:

First of the all data of milk yield and FCM (Table 2) and the data of feed intake (Table 5) clearly indicated that although feed intake was the same all over cows in control and treatments, milk yield and FCM increased (P<0.05) by treatments II and III. This finding may be possibly related to proper utilization of dietary carbohydrates producing additional energy for increasing milk yield and milk fat production.

Table (5): Economical efficiency of the experimental diets.

Item	Control	Treatments (head day^{-1})		
		I	II	III
		340mg thiamin	340mg thiamin 340 +160g $NaHco_3$	160g $NaHco_3$
Intake as fed				
CFM (kg $head^{-1}day^{-1}$)	4.00	4.00	4.00	4.00
Darawa (kg $head^{-1}day^{-1}$)	20.00	20.00	20.00	20.00
Thiamin (mg $head^{-1}day^{-1}$)	0.00	340	340	0.00
$NaHCO_3$ (g $head^{-1}day^{-1}$)	0.00	0.00	160	160
Milk yield (kg $head^{-1}day^{-1}$)	8.55	9.60	9.69	10.03
Feeding Cost				
CFM L.E. kg $head^{-1}day^{-1}$	4.00	4.00	4.00	4.00
Darawa L.E. kg $head^{-1}day^{-1}$	3.00	3.00	3.00	3.00
Thiamin L.E. kg $head^{-1}day^{-1}$	0.00	0.0612	0.0612	0.00
$NaHCO_3$ L.E. kg $head^{-1}day^{-1}$	0.00	0.00	0.12	0.12
Total Cost L.E. kg $head^{-1}day^{-1}$	7.00	7.06	7.18	7.12
Price of milk[1], L.E. kg $head^{-1}day^{-1}$	21.38	24	24.9	25.08
Return over feeding cost, L.E day^{-1}	14.38	16.94	17.72	17.96
Relative economic efficiency %	100	117.8	123.23	124.90

[1]on the basis that the price of 1 kg milk was 2.50 L.E.

Data of Table (5) also illustrates that the relative economic efficiency was increased by 17.8, 23.23 and 24.90% for the treatments I, II and III, respectively as compared to the control.

From all the above mentioned facts, it can be concluded that the effect of $NaHCO_3$ (160 g $head^{-1}$ d^{-1}) for cows fed concentrates up to 50% of DM intake on milk yield and milk fat was numerically better than that of thiamin and $NaHCO_3$ (340 mg and 160g $head^{-1}$ day^{-1}), while from the statistical point of view, both had significant (P<0.05) effects comparing to the control. However, the not significant effects of adding thiamin alone (340 mg $head^{-1}$ day^{-1}), suggest that addition of $NaHCO_3$ to diets of lactating cows fed a daily ration containing roughage and concentrate at 1:1 ratio would be the best supplementation.

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تأثير تدعيم عليقة الأبقار الحلابة بالثيامين مع أو بدون بيكربونات الصوديوم على محصول اللبن و مكوناته

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تهدف هذه الدراسة إلى تقييم تأثير تدعيم عليقة الأبقار الحلابة بالثيامين والمادة المنظمة على الأداء الإنتاجي. لذا استخدم ٤ من الأبقار البلدي الحلاب بعد الولادة بأسبوعين باستخدام تصميم المربع اللاتيني ٤×٤ .

استغرقت كل فترة ٣٠ يوماً وغذيت الحيوانات في مجموعات الكنترول والمعاملة (١) والمعاملة (٢) والمعاملة (٣) على عليقة الكنترول مضاف إليها صفر أو ٣٤٠ ملليجرام ثيامين (فيتامين ب١) أو ٣٤٠ ملليجرام ثيامين + ١٦٠ جرام بيكربونات الصوديوم أو ١٦٠ جرام بيكربونات صوديوم / رأس / يوم على التوالي. وتكونت عليقة الكنترول من دراوة و علف مركز بنسبة ١: ١ على أساس المادة الجافة.

ولقد أوضحت النتائج أن الإنتاج اليومي للأبقار من اللبن زاد في كل من المعاملة (١) و(٢) و(٣) بنسبة ١٢.٢٨ و١٦.٤٩ و١٧.٣٤٪ على التوالي مقارنة بالكنترول وكانت الزيادة معنوية لكل من المعاملة (٢) و(٣) فقط ولقد أحدثت المعاملتان (٢) و(٣) زيادة معنوية في كمية دهن وبروتين اللبن أما نسب مكونات اللبن (فيما عدا نسبة الدهن) فلم تتأثر معنوياً بأي من الإضافات.

أما عن تأثير هذه الإضافات على بعض مكونات سيوم الدم فلم تلاحظ فروق معنوية في البروتين الكلي – الألبيومين – الجلوبيولين – اليوريا – الجلوكوز – الكوليسترول – الإنزيمات الناقلة للأمين GOT و GPT.

وفيما يتعلق بتركيز الثيامين باللبن والسيرم فلقد كان تركيز الثيامين بالسيرم أعلى منه للبن ولم تحدث الإضافات تأثيراً معنوياً على تركيز الثيامين باللبن إلا أنها أدت إلى زيادته في السيرم مقارنة بسيرم حيوانات مجموعة الكنترول.

ويمكن استنتاج أن تدعيم علائق الأبقار بالثيامين مع بيكروبونات الصوديوم أو تدعيمها ببكربونات الصوديوم فقط يؤدي إلى تحسين إنتاج اللبن.