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EFFECT OF DIFFERENT LEVELS OF ZINC SUPPLEMENTATION ON UTILIZATION OF NONPROTEINOUS NITROGEN FOR LACTATING BUFFALOES

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ABSTRACT

Sixteen lactating buffaloes in four groups were fed on rations, consisted of concentrate feed mixture and rice straw, provided with 1% urea and zinc sulfate with different levels: 0, 40, 80 and 120 mg/kg DM intake, respectively. Results showed that the addition of zinc improved the digestiblities of DM, OM, CP, CF, EE and NFE. Feeding values as TDN and DCP appeared the same previous trend. In addition, 80 and 120 mg zinc/kg DM intake improved the serum total protein and globulin but only 120 mg Zn/kg DM intake improved the serum zinc concentration, while it reduced the concentration of both albumin and urea in blood serum of buffaloes. The data revealed that zinc addition with the two concentrations (80 and 120 mg Zn/kg DM intake) did not affect the milk yield, fat correct milk 7% and milk compositions, but the addition of 40 mg zinc improved the fat correct milk, fat and total solids of milk and milk energy. Generally, the addition of zinc with different concentrations did not affect feed intake as DM, TDN or DCP intake and feed efficiency as kg 7% fat correct milk/DM or TDN or DCP. Addition of 40 mg zinc significantly increased either of birth and weaning weights and daily gain of calves.

Keywords: Lactating buffaloes -Zinc - Feed intake – Digestibility – Blood parameters – Milk composition – Calves.

INTRODUCTION

Use of inorganic trace minerals for supplementation of ruminant diets has increased in recent years. Zinc is one of the important element in the practical nutrition of animals. Requirements for dairy cattle from zinc are listed as 40 mg/kg (NRC, 1978), so the maximum safe dietary intake is considerably higher than the requirement (NRC, 1978 and Miller, 1979). Feeding 1279 ppm Zn as zinc oxide (DM basis) for 6 weeks had no adverse effects on lactating dairy cows (Miller *et al.*, 1965).

Few data were available on the influence of long-term feeding of high Zn diets to lactating and gestating dairy cows. High concentrations of Zn sulfate denatures proteins and can be used to increase the amount of rumen bypass protein (Britton and Klopfenstein, 1986). Also, Zn supplementation at a concentration of 250 ppm may increase the likelihood of urea toxicity and increase energetic efficiency of ruminal fermentation (Arelovich *et al.*, 2000). The buffalo population in Egypt is about three million heads (A.E.R.I. 2003). On the other hand, buffaloes are considered the principal milk yielding animal in Egypt. They produce about 65% of the total milk production in Egypt. (El-Ashry *et al.*, 2003b). Average milk yield ranged between 1404 and 1836 kg/head in lactation season (Saleh *et al.*, 2003). The objective of the present work was to evaluate the effects of different levels of zinc (which was added to 1% urea) in the concentrate feed mixture diets on performance, milk yield and milk composition of lactating buffaloes.

MATERIALS AND METHODS

This work was carried out at Sids Animal Production Experimental Station, Animal Production Research Institute, Ministry of Agriculture, during 2003, (this station is located in middle Egypt, 150 km. South of Cairo), to investigate the effects of different levels of zinc supplementation on utilization of non-proteinous nitrogen for ration using lactating buffaloes.

Feeding trial:

Sixteen lactating buffaloes in second to five lactation seasons (Average mean = 584 ± 4 kg), were used in a feeding trial which extended for 12 weeks. Animals were chosen randomly during the peak of lactation (two months after parturition) and divided into four groups, four animals in each, according to lactation season, milk yield and live body weight. The experimental animals were weighed at the beginning of the trial, then every four weeks during the experiment to adjust their nutritional requirements and at the end of the experiment as well. The average annual atmospheric maximum temperature at Sids area during the period of this work was about 35°C, and the annual mean of relative humidity was 62%. The feeding of lactating buffaloes on the tested rations was continued after the feeding trial to study some productive traits as weight of calf, weight of weaning and the mortality percentage.

Experimental rations:

Four experimental rations (control + 3 treatments) were used in this study. Ration 1 (control): In which animals were fed on concentrate feed mixture at a rate of 2% of body weight, with 1% urea/kg DM intake, then 1% of body weight as rice straw was added to the mixture. Ration (2): Animals were fed on the ration of control + 40 mg zinc (0.11 g of zinc sulfate)/kg DM intake. Ration (3): Animals were fed on the ration of the control + 80 mg zinc (0.22 g of zinc sulfate)/kg DM intake. Ration (4): Animals were fed on the ration of the control + 120 mg zinc (0.33 g of zinc sulfate)/kg DM intake. All groups of animals were fed individually twice daily on the experimental rations to cover energy and protein requirements according to NRC (1990). Concentrate feed mixture and rice straw were offered twice daily at 8.00 a.m and 3.00 p.m. The roughage: concentrate ratio was 40:60. All animals were watered all the time, buffaloes were hand milked twice daily (8.00 a.m. and 3.00 p.m.) and daily milk yield was individually recorded and corrected to 7% fat correct milk (FCM) according to Raafat and Saleh, (1962) by the following equation: FCM = 0.265 milk yield + 10.5 fat yield.

Two milk samples were individually collected every two weeks at 8.00 a.m. and 3.00 p.m. from each buffaloe according to milk yield, then the two samples were mixed together. Chemical analyses of milk (fat, protein, lactose, total solids, solids not fat and ash) were determined using milko scan apparatus. Energy of milk was calculated by using the formula suggested by Overman and Sanmann (1926).

Digestion trial:

At the middle of trial period, four digestion trials (3 buffaloes in each) were carried out to determine the nutritive value of the experimental rations; the digestion trial was extended for 15 days as a primary period and 4 days as a collection period Nutrient domesticities were determined by acid insoluble ash (A.I.A.) method using 4N HCl procedure (vanKeulen and Young, 1977). Proximate analyses of ration and faece samples were carried out according to the methods of A.O.A.C. (1980).

Blood parameters:

Two blood heparinzed samples were collected from the jugular vein. They were taken at the beginning and at the end of feeding trial using three fasted animals from each group and serum was separated by centrifugation of the uncoagulated blood samples for 15 minutes at 3500 rounds per minute. Blood parameters such as total protein (Gornal *et al.*, 1949), albumin (Dumas and Biggs, 1972), urea (Coulomboe and Favreau 1963) and zinc (Homsher and Zak, 1985) were determined in serum. The data were analysed by the general linear models using ANOVA procedures of SAS (1985). Significances among means were calculated using Duncan Multiple Test when the mean effect was significant (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of feedstuffs and experimental rations:

The chemical analysis of concentrate feed mixture and rice straw showed that CP and CF contents of the concentrate mixture were 16.40 and 11.89%, respectively, while CP and CF contents of the rice straw were 4.03 and 35.21%, respectively (Table 1). These results are in agreement with Salem *et al.* (2002); Fouad *et al.* (2003) and Abdel Salam and Mousa, (2003). On the other hand, all the experimental rations had nearly the same content of OM,CP,CF, EE, NFE and ash percentage.

Table (1): Proximate analysis of feed ingredients and experimental rations:

Item	DM%	Chemical composition on DM basis, (%)					
		OM	CP	CF	EE	NFE	Ash
CFM*	89.31	91.28	16.40	11.89	3.11	59.88	8.72
Rice straw.	89.69	84.59	4.03	35.21	1.19	44.16	15.41
Rations:							
R_1	89.43	89.12	13.11	19.42	2.49	54.10	10.88
R_2	89.43	89.17	13.18	19.26	2.50	54.23	10.83
R_3	89.43	89.09	13.06	19.53	2.48	54.02	10.91
R_4	89.43	89.23	13.29	19.02	2.52	54.40	10.77

: Concentrate feed mixture consisted of 30% decorticated cotton seed cake, 25% corn grains, 30% wheat bran, 6% rice bran, 5% molasses, 2% lime stone, 1% salt and 1% minerals and vitamins.

Digestibility coefficients and feeding values:

Results in Table (2) indicated that the addition of different levels of zinc slightly increased the digestibilities of DM, OM, CP, CF, EE and NFE for experimental rations compared with control ration being no significant differences. This might be attributed to the increase of protein and energy utilization as indicated by the increase improvement of rumen traits (Valdes *et al.*, 2000 and Salem, 2003). These data are in harmony with those of Grace and Gooden (1980); Reid *et al.* (1987) and Arelovich *et al.* (2000) who found that the digestibility of dry matter was not significantly altered by zinc supplementation to sheep or cattle. As shown in Table (2), the nutritive values as TDN and DCP were significantly ($P < 0.05$) increased by the addition of the highest level of Zn. Improving of TDN may be due to increasing digestibilites of most nutrients when Zn was added to rations. Moreover, in the present study the DCP increased when Zn was added to the concentrate ration may be due to increase CP digestibility for these groups. Zn supplementation decreases ruminal NH_3 concentration in buffaloes fed urea-supplemented, through decreasing rate of NH_3 release from urea, supplemental Zn may decrease the incidence of urea (ammonia) intoxication and thereby may reduce ammonia loss associated with absorption from the rumen. This, in turn, could help maintain microbial activity (Arelovich *et al.*, 2000).

Table (2): Digestion coefficients and nutritive value of lactating **buffaloes fed on the experimental rations.**

Item	Groups			
	G_1	G_2	G_3	G_4
Digestibility %				
DM	60.99^a	61.62^a	62.08^a	62.30^a
OM	63.24^a	63.99^a	64.35^a	64.59^a
CP	63.67^a	63.85^a	64.27^a	64.96^a
CF	53.84^a	53.96^a	55.36^a	55.25^a
EE	62.87^a	64.47^a	64.22^a	65.24^a
NFE	66.42^a	67.41^a	67.50^a	67.64^a
Nutritive values:				
TDN	58.00^b	58.75^{ab}	59.01^{ab}	59.38^a
DCP	8.34^b	8.42^{ab}	8.39^{ab}	8.63^a

a,b: means in the same row followed by different superscripts are significantly ($P < 0.05$) different.

Performance of lactating buffaloes:

1- Effect of Zn addition on some blood parameters:

Results in Table (3) indicate that the addition of 80 and 120 mg Zn improved total protein and globulin, but only 120 mg Zn/Kg DMI improved Zn concentration in blood serum, while it decreased the albumin and urea concentrations in blood serum of lactating buffaloes. Reid *et al.* (1987) found that there was a significant increase in serum Zn concentration in lambs fed Zn-treated alfalfa and they concluded that the increase in Zn content resulted from a higher availability of Zn in the inorganic form. While, Swenson *et al.*

(1996), Grings *et al.* (1999). Olson *et al.* (1999) and Salama *et al.* (2003) reported that dietary addition of Zn did not affect concentration of Zn in serum of cattles or goats. King (1990) reported that concentration of Zn in plasma did not reflect true Zn status in the body because metabolic conditions unrelated to Zn status cause it to change. Also, Campbell *et al.* (1999) found that plasma urea nitrogen was not different between the control group and tested groups of cows which were added to their diet Zn. At the same time, data of serum parameters in (Table 3) for feeding lactating buffaloes on ration (2) containing 40 mg Zn are in the normal range found by Saleh *et al.* (1999), Kholif *et al.* (1999) and Youssef *et al.* (2001) with lactating buffaloes.

Table (3): Blood parameters of lactating buffaloes fed on the experimental rations:

Item	Groups			
	G_1	G_2	G_3	G_4
Total proteins, g/dl:				
Initial trail	8.72^{ab}	7.49^{b}	9.62^{a}	9.38^{a}
Final trial	9.15^{ab}	8.66^{b}	10.15^{a}	10.20^{a}
Albumin, g/dl:				
Initial trail	2.50^{a}	2.62^{a}	1.97^{b}	2.15^{ab}
Final trial	3.37^{a}	2.27^{b}	2.38^{b}	2.47^{b}
Globulin, g/dl:				
Initial trail	6.22^{ab}	4.88^{b}	7.65^{a}	7.23^{a}
Final trial	5.78^{b}	6.39^{ab}	7.77^{a}	7.73^{a}
Albumin/Globulin ratio:				
Initial trail	0.40^{b}	0.54^{a}	0.26^{c}	0.30^{c}
Final trial	0.58^{a}	0.36^{b}	0.31^{b}	0.32^{b}
Urea, mg/100 ml:				
Initial trail	18.59^{a}	15.41^{a}	26.81^{a}	21.66^{a}
Final trial	38.96^{a}	30.55^{a}	32.48^{a}	35.25^{a}
Zinc, mg/100 ml:				
Initial trail	55.13^{a}	15.35^{c}	27.48^{b}	32.76^{b}
Final trial	57.99^{a}	19.29^{c}	34.78^{b}	66.15^{a}

a,b,c: means in the same row followed by different superscripts are significantly ($P < 0.05$) different.

2- Effect of Zn addition on feed Intake and feed efficiency:

Results in Table (4) indicate that the addition of Zn to tested rations did not affect on feed intake as(DM, TDN and DCP) and feed efficiency (as kg 7% FCM/Kg DM or TDN or DCP) when compared with the control ration. Similar findings were obtained by several authors (Miller *et al.*, 1989; Olson *et al.*, 1999 and Salama *et al.*, 2003) who found that dry matter intake did not affect by Zn addition of lactating cows or goats. Also, Arelovich *et al.* (2000) reported that supplemental Zn did not alter DMI of prairie hay supplemented with urea by heifers. On the other hand, results in Table (4) indicated that slightly improve feed efficiency for ration (2) containing 40 mg Zn. This might be attributed mainly to the milk production, Feed intake, nutrient digestibility and Feeding values (Abou-El-Fotouh *et al.*, 2000 and El-Garhy and Abdel-Azeem, 2003).

Table (4): Feed intake and feed efficiency of lactating buffaloes fed on the experimental rations.

Item	Groups			
	G_1	G_2	G_3	G_4
Daily feed intake (as fed), Kg:				
Concentrate feed mixture	8.25[a]	8.08[a]	8.25[a]	7.92[a]
Rice straw	3.92[a]	3.75[a]	4.00[a]	3.50[a]
Daily feed intake (as DM basis), Kg:				
Concentrate feed mixture	7.37[a]	7.22[a]	7.37[a]	7.07[a]
Rice straw	3.51[a]	3.36[a]	3.59[a]	3.14[a]
Daily nutrients intake, (kg/head)				
DM.	10.88[a]	10.58[a]	10.96[a]	10.21[a]
TDN.	6.31[a]	6.21[a]	6.47[a]	6.06[a]
DCP.	0.91[a]	0.89[a]	0.92[a]	0.88[a]
Daily 7% FCM* yield, kg.	5.53[a]	5.57[a]	4.54[a]	4.76[a]
Feed efficiency:				
Kg 7% FC M*/kg DM.	0.51[a]	0.53[a]	0.41[b]	0.47[ab]
Kg 7% FCM*/kg TDN.	0.88[a]	0.90[a]	0.70[b]	0.79[ab]
Kg 7% FCM*/kg DCP.	6.08[a]	6.26[a]	4.93[b]	5.41[ab]

*: Fat corrected milk.

a,b: means in the same row followed by different superscripts are significantly ($P<0.05$) different.

3- Effect of Zn addition on milk yield and composition:

Data in Table (5) showed that the addition of Zn to rations did not affect actual milk yield and 7% fat corrected milk of lactating buffaloes. These results are in agreement with those of Miller *et al.* (1989); Whitaker *et al.* (1997); Campbell *et al.* (1999) and Salama *et al.* (2003) who reported that milk yield did not differ between treatments by Zn in lactating cows or goats.

A non-significant difference in milk composition was observed in favour of the Zn supplemental group than that of the control lactating buffaloes (Table 5). On the other hand, the low concentration (40 mg) of Zn increased percentages of the fat, protein, lactose, solids not fat total solids as well as milk energy than that of the other groups, where the values were insignificant. Similar results were reported by Miller *et al.* (1989) who found that milk fat, protein and solids not fat percentages were not affected by the feeding of 1000 ppm zinc. In addition, Kellogg and Lane (1996) and Campbell *et al.* (1999) found that milk components were not affected by Zn treatment of lactating Holstein.

Effect of Zn addition on some productive traits:

Results in Table (6) showed that the addition of zinc (40 mg) significantly increased the weight of dam at calving, weaning weight of calves ($P \leq 0.05$), daily gain ($P \leq 0.05$) and percentage weaning of calf/dam ($P \leq 0.05$) when compared to the control.

Table (5): Average of actual daily milk yield, 7% fat correct milk yield and milk composition of lactating buffaloes fed on the experimental rations.

Item	Groups			
	G_1	G_2	G_3	G_4
Actual milk yield, kg	5.63[a]	5.36[a]	5.25[a]	4.91[a]
7% fat correct milk yield, kg	5.53[a]	5.57[a]	4.54[a]	4.76[a]
Milk composition (%):				
Fat	6.84[ab]	7.37[a]	5.71[b]	6.71[ab]
Protein	4.60[a]	4.67[a]	4.58[a]	4.17[a]
Lactose	4.67[a]	4.82[a]	4.99[a]	4.84[a]
Solids not fat	9.97[a]	10.19[a]	10.28[a]	9.72[a]
Total solids.	16.81[ab]	17.56[a]	15.99[b]	16.43[ab]
Ash.	0.70[a]	0.70[a]	0.71[a]	0.71[a]
Milk energy (Kcal/Kg milk)* .	1078.06[ab]	1139.16[a]	947.77[b]	1063.07[ab]

a,b: means in the same row followed by different superscripts are significantly ($P < 0.05$) different.

* Milk energy (Kcal/Kg milk) = 115.3 (2.51 + % fat).

Table (6): Average of some productive traits.

Item	Groups			
	G_1	G_2	G_3	G_4
No. of dam.	4	4	4	4
No. of calves	4	4	4	4
Weight of dam at calving, kg	600	589	580	585
Weight of calf at birth, kg.	35.50[b]	41.00[a]	34.00[b]	33.00[b]
Weaning period of calf, days.	105	105	105	105
Weaning weight of calf, kg	99[b]	110[a]	99[b]	100[b]
Daily gain of calf, kg.	0.605[b]	0.657[a]	0.619[ab]	0.638[a]
Improvement percentage of daily gain.	-	8.60[a]	2.31[c]	5.45[b]
Mortality (%)	0	0	0	0
Percentage weaning of calf per dam.	16.50[b]	18.68[a]	17.07[ab]	17.09[ab]
Improvement (%) weaning of calf per dam.	-	13.21[a]	3.45[b]	3.58[b]

a,b,c: means in the same row followed by different superscripts are significantly ($P < 0.05$) different.

While, the addition of high levels of zinc (80 and 120 mg) did not affect all the measured parameters. In addition, there was no observed mortality between the four groups. The same mortality rate was obtained by El-Serafy *et al.* (1980) and Khattab *et al.* (1989) for buffalo calves. These data are in accordance with Grings *et al.* (1999) who reported that the supplementation of zinc (30.5 ppm) to rations increased the average daily gain of calves when compared to the control group. Also, Olson *et al.* (1999) found that the addition of zinc (360 mg) to the rations has no effect on calf gain from birth to weaning, cow weights and body condition scores at any of the dates measured, and calf health or performance.

The present value of average birth weight and weaning weight of buffalo-calves was confirmed by several reported results (Sadek, 1984, El-Bedawy *et al.*, 1989, Salama and Mohy El-Deen, 1997, Kholif *et al.*, 1999 and El-Ashry *et al.*, 2002) on native buffalo-calves (34-41 kg and 99-105 kg, respectively) which fed whole milk. On the other hand the present result of average daily gain of calves is higher than that reported by Ghoneim (1958), Fahmy, (1972), El-Serafy *et al.* (1980), Khattab *et al.* (1980), El-Bedawy *et al.* (1989), Nigm, (1996), Salama and Mohy-El-Deen, (1997), Helal *et al.* (1999), Aly *et al.* (1999) and El-Ashry *et al.* (2002) on native buffalo-calves (300, 500, 470, 526, 597, 565, 552, 389, 427 and 412 g/head, respectively) which fed whole milk. Improvement in present result may be due to Zn additive in lactating buffaloe rations. This might be attributed to the increase of protein and energy utilization.

From this study it could be concluded that buffalo group fed ration containing 40 Zn/kg DMI showing good milk composition, increased birth and weaning weight and daily gain of calves without adverse effect on health of lactating buffaloes.

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تأثير إضافة مستويات مختلفة من الزنك على معدل الاستفادة من المواد الآزوتية غير البروتينية فى الجاموس الحلاب

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يهدف هذا البحث إلى دراسة تأثير مستويات مختلفة من الزنك على معدل الاستفادة من اليوريا باستخدام ستة عشر جاموسة حلابة قسمت إلى أربع مجاميع غذيت على علائق تحتوى على علف مركز مضاف إليه ١% يوريا/كيلو جرام مادة جافة مأكولة بجانب قش الأرز، وتم إضافة الزنك بتركيزات (٠، ٤٠، ٨٠، ١٢٠ ملليجرام/كيلو جرام مادة جافة مأكولة) لهذه العلائق.

ولقد أدت إضافة الزنك إلى تحسين معاملات الهضم المختلفة وكذلك القيم الغذائية لهذه العلائق كمركبات كلية مهضومة وبروتين خام مهضوم، بينما خفضت من نسبة الالبيومين واليوريا في دم هذه الحيوانات. أدى التركيز العالى للزنك (٨٠، ١٢٠ ملليجرام) الى زيادة نسبة البروتين الكلى والجلوبيولين فى الدم ولكن ١٢٠ ملليجرام زنك فقط أدت إلى زيادة نسبة الزنك فى دم الجاموس الحلاب.

وتشير النتائج إلى عدم وجود أى تأثير لاضافة الزنك على إنتاج اللبن أو اللبن المعدل نسبة دهنه ٧%، وإن كان التركيز المنخفض للزنك أدى إلى تحسين نسبة مكونات اللبن وطاقته. وكذلك لا يوجد للزنك أى تأثير على كمية المأكول كمادة جافة أو مركبات كلية مهضومة أو بروتين خام مهضوم وكذلك الكفاءة الغذائية (كجم لبن معدل ٧% دهن/كجم مادة جافة أو مركبات كلية مهضومة أو بروتين خام مهضوم). أدى إضافة ٤٠ ملليجرام زنك إلى زيادة معنوية فى وزن المواليد ووزن الفطام وكذلك نسبة العجول المولودة بالنسبة للأمهات.