Effect of Oxytocin Administration on Certain Minerals in the Milk of Buffaloes (*Bubalus bubalis*)

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ABSTRACT : To study the secretion of trace elements during early lactation, twelve lactating Murrah buffaloes were selected from the herd of the institute. The buffaloes were divided into two groups of six each. Buffaloes of group I were not injected and served as control. Buffaloes of group II received oxytocin injection (2.5 I.U.) intramuscularly for a period of five days for let down of milk. Milk samples were collected from both groups of buffaloes five days before, during and after the administration of oxytocin. Aliquots of milk samples from each buffalo were composited in proportion to their milk yield and used for analysis of trace elements in milk. In both the groups of buffaloes Cu, Mg, Fe, Zn and Mn contents did not vary significantly between animals. However, Ca levels varied significantly ($p<0.01$) between animals. Administration of oxytocin influenced ($p<0.01$) Cu, Mg, Zn, Fe and Mn secretion in milk. However, Ca secretion was not affected by oxytocin administration. Secretion of these elements also varied significantly during different days of the study. Zinc content of milk in the control group also varied significantly ($p<0.01$) during different days and periods of study indicating thereby no effect of oxytocin. The study indicated that administration of oxytocin increases Cu and Mn content and decreases Mg, Fe and Zn content without altering the Ca concentration of milk. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1523-1526)***

Key Words : Milk, Oxytocin, Trace Minerals, Buffaloes, Early Lactation

INTRODUCTION

Oxytocin hormone plays an important role in eliciting milk ejection in dairy cattle and buffaloes (Sagi et al., 1980) and administration by injection has increased milk production in cows (Nostrand et al., 1991; Ballou et al., 1992). The assumption that oxytocin increases milk production led to wide spread use of oxytocin for let down of milk as well as for more milk production by the dairy men. However, some reports indicate no effect of oxytocin on milk production and composition in cattle and buffaloes (Ludri and Singh, 1987; Allen et al., 1988; Maurya and Ludri, 1992; Bansode et al., 1996). The clinical effects of the practice of use of oxytocin for milk let down or milk production are a delay in the duration of placenta expulsion and ovulation interval, but shorter the postpartum estrus interval under field conditions (Qureshi, 1998). Though oxytocin hormone has successfully been used to let down milk its effects on the secretion of minerals in milk have not been investigated in buffaloes. Therefore, the present study was undertaken to determine the effect of oxytocin, if any, on copper (Cu), magnesium (Mg), zinc (Zn), manganese (Mn), iron (Fe) and calcium (Ca) concentrations in milk of buffaloes.

MATERIALS AND METHODS

Selection and management of buffaloes

Twelve healthy lactating Murrah buffaloes in early lactation were selected from the herd of the Institute. The buffaloes were in their first to eighth lactation period at the time of start of the experiment and were managed as per the feeding and management practices followed in the farm. They were fed green fodder and concentrate during the period of experiment. Green fodder consisted of *ad libitum* berseem (*Trifolium alexandrinum*) while concentrate mixture was based on milk production (1 kg for each 2.5 kg of milk above 5 kg, table 1) and was offered only before the start of milking. The buffaloes were hand milked twice daily at 5:30 A.M. and 6:00 P.M. Maximum and minimum ambient temperatures, dry and wet bulb temperatures were recorded during the experiment period. The temperature humidity index was calculated using the formula THI = 0.72 (dry bulb temp. + wet bulb temp.) + 40.2, as described by Mc Dowell (1972)

Experimental treatment and sampling of milk

The buffaloes were divided into two groups of six each. Buffaloes of group I did not receive any injection and served as control while another group of buffaloes (group II) received 2.5 IU oxytocin intramuscularly at each milking for a period of 5 days to let down the milk. Once the milk let down was complete, hand milking was accomplished by expert milker. Milk samples were collected from both groups of buffaloes 5 days before (-5, -4, -3, -2, -1 days), during (1, 2, 3, 4, 5 days) and after (+1, +2, +3, +4, +5 days) oxytocin administration. Aliquots of milk samples from individual buffaloes was composited in proportion to their milk yield and were used for mineral analysis. Milk samples were digested according to Sandall (1959) and concentrations of Zn, Mn, Fe, Cu, Ca and Mg were analyzed with an atomic spectrophotometer (Pye Unican Model, 1991). The udders were tested for mastitis using

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Table 1. Composition of concentrate mixture

Ingredients	Percent
Maize	35
Groundnut cake	35
Wheat bran	27
Mineral mixture	2
Salt	1
CP content=20.2%	
TDN content=70.3%	

modified California mastitis test and only those samples found negative were used in the study.

Statistical analysis

The statistical analysis of the data was carried out using two way analysis of variance (ANOVA) with interactions as described by Snedecor and Cochran (1980). Mean and standard error for the all the parameters were calculated. Averages were compared using Duncan's multiple range test for significance difference and correlations among the various minerals were also calculated to find the effect of the oxytocin.

RESULTS

During the experimental period the maximum and minimum temperatures varied from 17.42 to 22.0°C and 3.5 to 10.6°C, respectively. The values of morning and evening THI were 49.38 to 57.16 and 58.88 to 66.52. In control group of buffaloes, during the period of 15 days, the variation in values of Cu, Mg, Mn, Fe and Ca were not significantly different (tables 2 and 3). However, between periods effects were significant for Fe and Mn ($p<0.05$) and Zn concentrations ($p<0.01$). The trace minerals did not vary significantly between buffaloes, however the changes in Ca content of milk was significant ($p<0.01$) between the buffaloes. The zinc ($p<0.01$) and Ca content of milk varied significantly ($p<0.05$) during different days of study. The period × days interaction was significant for Zn. Copper content of milk varied from 0.80 to 1.60 ug/ml during the different days of experiments. Fe content of milk during the different periods of the study were significant ($p<0.05$), the respective values being 1.23, 1.09 and 1.57 ug/ml. The changes in values of Zn and Mn were significant ($p<0.01$) during the different periods; Zn content decreased from 3.28 to 2.11 ug/ml during period 2 and to 1.33 μg/ml during period 3 ($p<0.05$). However, Mn content increased from 5.00 to 5.11 μg/ml and subsequently to 5.32 μg/ml during those periods. The significant variations in Fe, Zn and Mn content of milk indicated day to day variations in values of these minerals during different periods. However, such changes were not observed for Cu, Mg and Ca content of milk.

The secretion of Cu, Mg, Fe, Zn and Mn varied non significantly in oxytocin administered buffaloes but the change in levels of Ca was significant ($p<0.01$). The values of minerals varied significantly ($p<0.01$) during the different periods, except Ca concentration which remained unchanged (tables 2 and 3). Further, secretion of Cu, Mg and Zn ($p<0.01$) and Fe, Mn and Ca ($p<0.05$) varied between days. All effect interaction was also significant for Zn ($p<0.01$) as observed in the control group of buffaloes, and also for Mg ($p<0.05$). Cu and Mn contents were increased during the treatment period, and after the oxytocin administration. However, Mg, Fe and Zn contents decreased during the treatment period, the respective values being 7.53 to 7.25, 1.42 to 1.07, 3.56 to 2.18 μg/ml, respectively. Mg and Zn contents continue to decrease even after the cessation of oxytocin treatment. The secretion of Ca in milk remained unaffected by oxytocin treatment. In control group of buffaloes, Zn was negatively correlated ($r = -0.2627$, $p<0.05$) with Cu content; other minerals were not correlated. In oxytocin administered buffaloes Zn was negatively correlated ($r = -0.4257$, $p<0.01$) with Mg content of milk but no correlation were found in concentrations of other minerals studied.

Table 2. Least square means ± S.E. of minerals in milk of control group of buffaloes

Attri-	Before						During						After					
butes	-5	-4	-3	-2	-1	Av.	1	2	3	4	5	Av.	+1	+2	+3	+4	+5	Av.
Cu	1.06	1.08	1.10	1.17	1.23	1.13^{a}	1.15	1.10	1.10	1.63	1.17	1.23^{a}	1.35	1.23	1.30	1.30	1.27	1.29^{a}
(μg/ml)	±0.09	±0.08	±0.06	±0.11	±0.03		±0.05	±0.06	±0.06	±0.40	±0.11		±0.15	±0.03	±0.04	±0.04	±0.04	
Mg	5.97	4.48	7.38	8.17	11.65	7.53^{a}	9.07	8.08	5.90	7.61	5.65	7.25^{a}	9.08	6.57	9.08	6.47	6.76	7.59^{a}
(μg/ml)	±0.04	±0.71	±1.22	±0.76	±3.08		±1.45	±1.35	±0.43	±1.74	±0.54		±1.46	±0.64	±3.60	±0.64	±0.57	
Fe	1.67	1.25	1.12	1.07	1.07	1.23^{a}	1.32	0.80	0.97	0.83	1.55	1.09^{a}	1.54	1.47	1.74	1.09	1.97	1.57^{a}
(μg/ml)	±0.21	±0.31	±0.26	±0.20	±0.18		±0.35	±0.07	0.19	±0.07	±0.39		±0.39	±0.40	±0.35	±0.26	±0.30	
Zn	3.92	3.42	3.73	2.60	2.72	3.28^{a}	3.92	2.45	1.62	1.38	1.17	2.11^{b}	1.32	1.82	1.32	1.13	1.07	1.33^{bc}
(μg/ml)	±0.14	±0.28	±0.17	±0.22	±0.08		±0.38	±0.18	±0.16	±0.07	±0.06		±0.06	±0.34	±0.06	±0.07	±0.03	
Mn	5.47	5.00	4.90	4.80	4.86	5.00^{a}	5.33	4.66	4.76	5.56	5.20	5.11^{a}	5.30	5.20	5.56	5.23	5.30	5.32^{a}
(μg/ml)	±0.18	±0.17	±0.22	±0.05	±0.38		±0.19	± 0.12	±0.19	±0.22	±0.22		±0.16	±0.15	±0.13	±0.12	±0.12	
Ca (mg/	100.7	124.00	105.83	90.66	74.00	99.03^{a}	97.33	108.33	100.66	88.66	95.67	98.13^{a}	97.17	93.83	106.67	87.00	86.33	93.00^{a}
100 ml)	±3.88	±3.88	±13.35	± 11.71	± 11.29		±11.29	± 13.06	± 15.09	±15.98	±6.99		±0.49	± 13.74	±7.82	±8.27	± 2.19	

Different superscripts abc in a row differ significantly ($p<0.05$).

Table 3. Least square means ± SE of minerals in oxytocin administered buffaloes

Attri-butes	Before (Period I)						During (Period II)						After (Period III)					
	-5	-4	-3	-2	-1	Av.	1	2	3	4	5	Av.	+1	+2	+3	+4	+5	Av.
Cu	0.76	0.80	0.96	1.30	1.00	0.97^{a}	1.15	1.05	1.05	1.43	1.05	1.15^{a}	1.33	1.27	1.23	1.23	1.20	1.25^{a}
(μg/ml)	±0.05	± 0.04	± 0.08	±0.06	±0.06		± 0.05	± 0.06	± 0.06	± 0.23	± 0.06		± 0.16	± 0.04	±0.03	± 0.03	± 0.00	
Mg	9.80	4.95	7.48	7.83	7.11	7.44^{a}	8.34	5.93	6.76	5.23	5.85	6.96^{a}	5.76	6.20	4.86	5.55	6.35	5.75^{a}
(μg/ml)	± 1.09	± 0.37	± 0.56	±0.49	± 0.35		± 2.75	± 0.48	± 0.77	± 0.27	± 0.52		± 0.65	± 0.77	±0.59	± 0.56	± 0.64	
Fe	1.37	1.96	1.19	1.52	1.04	1.42^{a}	1.41	1.52	0.80	0.77	0.84	1.07^{a}	1.18	1.74	2.06	1.36	1.28	1.52^{a}
(μg/ml)	± 0.20	± 0.24	± 0.28	±0.36	± 0.16		± 0.26	± 0.27	± 0.07	± 0.07	± 0.33		± 0.08	± 0.39	±0.25	± 0.31	± 0.13	
Zn	4.92	3.48	3.43	2.85	3.13	3.56	3.27	3.11	1.61	1.58	1.30	2.18^{b}	1.38	1.48	1.22	1.33	1.12	1.31^{cd}
(μg/ml)	± 0.68	± 0.24	± 0.24	±0.24	± 0.17		± 0.19	± 0.31	± 0.01	± 0.15	± 0.06		± 0.05	±0.10	±0.04	± 0.08	±0.09	
Mn	5.48	4.70	5.10	4.93	5.36	1.52^{a}	5.27	4.50	4.87	4.70	5.30	4.93^{b}	5.00	5.37	5.43	5.17	5.33	5.26^{bc}
(μg/ml)	± 0.30	± 0.24	± 0.19	±0.25	± 0.25		± 0.32	± 0.12	± 0.16	± 0.19	± 0.14		± 0.07	± 0.08	±0.14	± 0.02	± 0.12	
Ca mg/	117.54	85.00	117.50	112.7	107.33	108.0	149.00	103.66	86.67	108.66	143.00	118.2	126.00	115.00	120.00	115.50	99.00	115.1^{a}
100 ml	± 6.08	±12.63	±14.21	±10.2	±9.76		±11.06	±15.33	±13.26	±16.88	± 12.37		±11.45	±10.49	±16.47	±13.87	±13.34	

Different superscripts in a line differ significantly ($p<0.05$).

Table 4. Summary of ANOVA of complete data on minerals in control and treatment group of buffaloes

Source effect	d.f.	Mean Sum of Squares											
		Control						Oxytocin Treatment					
		Cu	Mg	Fe	Zn	Mn	Ca	Cu	Mg	Fe	Zn	Mn	Ca
Between animals	5	0.05	3.02	0.77	0.42	0.13	3502.97**	0.03	7.82	0.43	0.69	0.37	2621.673*
Between periods	2	0.19	0.98	1.76*	28.72**	0.77*	317.81	0.64**	22.82**	1.69**	38.86**	0.84**	820.30
Between days	4	0.14	8.14	0.90	6.72**	0.42	1672.69*	0.23**	27.59**	1.17*	5.96**	0.75*	2207.87*
All effect interaction	8	0.10	29.59	0.37	1.97**	0.50	463.40	0.11	12.70*	0.59	1.62**	0.39	1891.60
Error	70	0.10	15.17	0.46	0.20	0.22	562.68	0.04	4.98	0.37	0.32	0.21	863.78

* $p<0.05$; ** $p<0.01$.

DISCUSSION

The present study indicated that the secretion of Fe, Zn and Mn in milk of buffaloes fluctuated from day to day during the different periods of study, concentrations of Cu, Mg, Fe, Zn and Mn were similar in different buffaloes. The significant changes in Ca content of milk between the buffaloes were probably due to differences in the level of milk production. Such significant changes in Ca content of milk and non-significant variation in Cu, Mg, Fe, Zn and Mn were also found in oxytocin administered buffaloes. Oxytocin administration influenced the secretion of Cu, Mg, Fe, Zn and Mn and not the Ca content of milk. The non-significant changes in Ca content of milk during and after oxytocin administration were probably due to a non significant increase in milk production (Jyotsana and Singh, 2000). However, some reports indicate that Ca content of milk is not affected even when milk yield increases from 16.5 to 41.2% (Bauman et al., 1985; Chalupa and Galligan, 1989; McGuffey et al., 1990; Hartnell et al., 1991). Calcium and magnesium are distributed between a diffusible low molecular weight, and non-diffusible, fractions of protein (colloidal) and only about 20% of calcium and 40% of magnesium diffusible ions of bovine milk are present as free ions and therefore changes in Mg content are more vulnerable to oxytocin. The fact that most of the diffusible Ca is present as calcium citrate and that diffusible Ca ion is highly correlated with citrate, was probably why it was not influenced by oxytocin. Exogenous oxytocin associated mechanical force of milk ejection have been found to disrupt the integrity of mammary epithelium (Singh and Dang, 2001). Further, effect of oxytocin was not uniform on all the minerals studied. Decreases in Fe and Mg and increase in Cu content of milk indicated that oxytocin in some way influences the secretion of these minerals in milk, the mechanism for which is unknown, though trace minerals are usually supplied in sufficient quantities in diet and therefore their levels in milk remain similar irrespective of levels of milk production. Further, because of the cation flux from blood plasma into the mammary gland and into the milk, their secretion increased with the milk yield in order to maintain osmoregulation and the concentration of minerals is not affected (McBride et al., 1988; Eppared et al., 1985). In cattle treated with recombinant bovine somatotropin, concentrations of nutritionally important minerals in plasma and milk remain relatively unaffected (Davies et al., 1983; Eppared et al., 1985). Singh et al. (1994) also reported no effect of rBST treatment on concentrations of minerals in milk and plasma of buffaloes.

CONCLUSION

Administration of oxytocin influences Cu, Mg, Zn, Fe and Mn secretion in milk; however, Ca secretion is not affected. Oxytocin increases Cu and Mn content and decreases Mg, Fe and Zn contents without altering the Ca concentration of milk.

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