Effect of Feeding Traditional Summer and Winter Rations on Mineral Content in Milk of Cows and Buffaloes

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Abstract: Twenty lactating Friesian cows and 20 lactating buffaloes with an average live body weight of 500 kg at 2-5 lactation seasons after the peak of lactation (60 days from parturition). Animals were fed summer ration consisted of 40% concentrate feed mixture (CFM) + 40% corn silage (CS) + 20% rice straw (RS) (10 cows and 10 buffaloes) and winter ration consisted of 40% CFM + 40% fresh berseem (FB) + 20% RS (on DM basis) (10 cows and 10 buffaloes). Milk samples were taken from each cow and buffalo three times biweekly and prepared for mineral determination. The contents of Ca, K, Zn, Mn and Fe were higher in fresh berseem, while the contents of P, Mg, Na and Cu were higher in concentrate feed mixture, however, the lower contents of all mineral were detected in corn silage and rice straw. The contents and intake of all mineral were higher in winter ration containing fresh berseem than summer ration containing corn silage. The excretion of all mineral in feces and urine as well as absorption and retention increased significantly ($P<0.05$) with increasing dietary mineral intake. The concentrations of macro and micro-elements in milk of cows and buffaloes increased significantly ($P<0.05$) with increasing dietary mineral intake. The concentrations of Ca, P, Cu, Zn and Mn in milk of cows and buffaloes fed summer ration were lower than the normal values.

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1. Introduction

The quantity of mineral, thus, present in forages may not be sufficient for optimum growth, milk yield and reproduction efficiency of dairy animals **(McDowell, 1992)**. A great deal of information has recently become available for better nutrition strategies including covering mineral to livestock, particularly lactating cows **(McDowell, 1992; 1999; McDowell and Valle, 2000).** Mineral are greatly essential for proper metabolically functioning of the animal. A problem arises when the feed intake not supply enough amount of mineral to meet the animal's requirements. This may occur because the feed is low in mineral, the bioavailability of the mineral is low, or another nutrient is interfering with the ability of the animal to absorb or utilize the mineral **(Malmberg *et al*., 2003).**

Corn silage alone is not a balanced diet. Therefore, consideration must be given to adding essential nutrients. Because it is roughage, feeding silage alone does not support optimum growth rates of beef cattle. Mineral, such as calcium, phosphorus, common salt, zinc, manganese and cobalt should be provided in a supplement mineral may be provided in a protein of the diet or by feeding in a box on a free choice basis **(Perry and Cecava, 1995).** The contents of calcium, phosphorus, sodium, zinc and manganese were deficient in whole plant corn silage and adding such mineral during using corn silage as basal ration for feeding lactating cows is very necessary **(Gaafar, 2009).** Feeding dairy cows on ration containing 40% concentrate feed mixture + 40% corn silage + 20% rice straw need to mineral additives, especially for calcium, phosphorus, copper, zinc and manganese. The premix and seaweed additives increased apparent mineral absorption and retention, mineral concentrations in hair, blood plasma and milk **(Bassiouni *et al*., 2013).**

The objective of the present study was to investigate the effect of feeding traditional summer and winter rations on mineral contents of milk of lactating Friesian cows and buffaloes.

2. Material and Methods

The current work was carried out at private farm, Kafr El-Sheikh Province, North Delta, Egypt during year 2018.

Experimental animals:

Twenty lactating Friesian cows and the same number of lactating buffaloes with an average live body weight of 500 kg at 2-5 lactation seasons were randomly divided into two similar groups (10 cows and 10 buffaloes) for each one after the peak of lactation (60 days from parturition).

Experimental rations:

All experimental animals were fed the traditional summer or winter rations to cover their recommended requirements standard according to **Kearl (1982)** for lactating cows and buffaloes. The 1st group was fed the summer ration that consisted of 40% concentrate feed mixture (CFM) + 40% corn silage (CS) + 20% rice straw (RS) and the 2nd group was fed the winter ration of 40% CFM + 40% fresh berseem (FB) + 20% RS (on DM basis). The CFM consisted of 32% undecorticated cotton seed cake, 24% wheat bran, 22% yellow corn, 12% rice bran, 5% linseed cake, 3% molasses, 1% limestone and 1% common salt.

Animal's management:

Animals were housed under sheds in semi-open backyards and their CFM portion was offered in two equal parts daily at 8 a.m. and 4 p.m., while corn silage or fresh berseem was offered one time at 10 a.m. and rice straw was offered at 3 p.m. Animals watered free choice all the day round.

Mineral metabolism:

Two metabolism trials were conducted for helping to interpret some of the data obtained from the field experiment using three cows and three buffaloes during feeding summer and winter rations. The samples of concentrate feed mixture, corn silage and rice straw were taken three times at the beginning, middle and end of the collection period. Feces samples were taken from the rectum of each cow twice daily at 12 h intervals during the collection period (7 days) and the quantity of feces was calculated from the equation given by **Schneider and Flatt (1975)** as follows:

Feces DM (kg) = [DM intake (kg) x (100 – DM digestibility %)]/100

The urine samples were taken from each cow twice daily at 12 h intervals during the collection period (7 days) by clitoral stimulation after the vaginal area was washed with warm water and the urine volume was determined from the equation stated by **Nennich *et al*. (2006)** as follows:

Urine excretion (kg/day) = (MUN × 0.563) + 17.1

Where, MUN was milk urea nitrogen and determined from the equation of **Nousiainen *et al*. (2004)** as follows:

MUN (mg/l) = -14.2 + 0.17 × dietary CP content (g/kg dry matter).

Milk samples:

Milk samples from consecutive evening and morning milkings were taken from each animal three times biweekly and mixed in proportion to milk yield of each milking.

Preparation of samples for mineral determination:

Wet ashing is primarily used in the preparation of milk samples for subsequent analysis of specific mineral according to **(AOAC, 1995).** It breaks down and removes the organic matrix surrounding the mineral so that they are left in an aqueous solution. A quantity of 0.5 gram from the samples of feedstuffs and 1 ml from milk were wet ashing. Sample put in a flask with added 10 ml of pure sulfuric acid and then heated with added some drops of hydrogen peroxide. Heating is continued until the organic matter is completely digested, leaving only the mineral oxides. After that diluted to 100 ml by distilled water and kept clean bottles for mineral determination. Mineral excretion in milk was calculated from the milk yield and the concentrations of mineral in milk of cows and buffaloes.

Mineral determination:

- Calcium was determined according to the method of **Baron and Bell (1957).**

- Magnesium, copper, zinc, manganese and iron were determined by Atomic Absorption Spectrophotometer (G.B.C. Avanta).

- Phosphorus was determined by hydroquinone reagent using Spectrophotometer (Jenway 6305 UV/vis. Spectrophotometer).

- Sodium and potassium were determined by Flame Photometer (EEL).

Statistical analysis:

The data were analyzed using general linear models procedure adapted by **IBMSPSS Statistics (2014)** for user's guide with one-way ANOVA. Significant differences in the mean values among dietary treatments were analyzed by Duncan's tests set at the level of significance $P<0.05$ **(Duncan, 1955).**

3. Results

Mineral contents of feedstuffs:

Mineral contents of the experimental feedstuffs are presented in Table (1). The data revealed that the contents of Ca, K, Zn, Mn and Fe were higher in fresh berseem, while the contents of P, Mg, Na and Cu were higher in concentrate feed mixture. However, the lower contents of all mineral were detected in corn silage and rice straw.

Mineral contents of traditional summer and winter rations:

Mineral contents of traditional summer and winter rations are shown in Table (2). The contents of all mineral were higher in winter ration containing fresh berseem than summer ration containing corn silage. Mineral calculation of summer and winter rations showed that the contents of calcium, phosphorus, copper, zinc and manganese in summer ration were lower than the recommended requirements of dairy cows.

Dietary mineral balance:

Mineral balance by Friesian cows and buffaloes fed traditional summer and winter rations are presented in Table (3). The intake of macro and micro mineral was higher significantly ($P<0.05$) with feeding winter ration containing fresh berseem compared to summer ration containing corn silage. The higher increase was detected with Ca (96.15%), medium increase was found with Na, K, Zn and Mn (59.18, 50.91, 49.33 and 45.35%, respectively), low medium increases with Mg (34.58%) and low increase with P and Cu (17.54 and 13.33%, respectively). These increases might be attributed to the higher mineral contents in fresh berseem compared to corn silage as shown in Table (1) as well as higher mineral contents in winter ration than those of summer ration (Table 2). The excretion in feces and urine as well as the absorption and retention of all mineral increased significantly (P<0.05) with increasing dietary mineral intake.

Mineral concentrations in milk of cows and buffaloes:

The effect of feeding summer and winter rations on mineral concentrations in milk of cows and buffaloes are shown in Table (4). The concentrations of macro-mineral (Ca, P, Mg, Na and K) and micro-mineral (Cu, Zn, Mn and Fe) in milk of cows and buffaloes increased significantly (P<0.05) with increasing dietary mineral intake and retention. The high significant positive correlations exist between dietary mineral retention and their concentrations in milk of cows and buffaloes being Ca = 0.90, P = 0.85, Mg = 0.80, Na = 0.88, K = 0.85, Cu = 0.86, Zn = 0.89, Mn = 0.85 and Fe = 0.80.

Mineral excretion in milk of cows and buffaloes:

The excretion of macro and micro-mineral in milk of cows and buffaloes fed traditional summer and winter rations are presented in Table (5). The amounts of all mineral excretion in milk of cows and buffaloes were significantly higher (P<0.05) with feeding winter ration compared to summer ration. These results illustrated that mineral excretion in milk increased with increasing dietary mineral intake and mineral retention in body. Average and range of mineral excretion in milk as a percentage of mineral retention in body were high for P 75.68% (66.99-84.37%) and Ca 55.31% (51.51-59.11%); medium for K 28.62% (25.94-31.29%), Na 28.43% (24.86-31.99%), Zn 23.18% (22.03-24.32%) and Mg 15.64% (14.88-16.39%); low for Cu 6.31% (5.30-7.32%) and very low for Fe 1.46% (1.38-1.54%) and Mn 0.33% (0.31-0.35%).

Table 1: Mineral contents of feedstuffs used in animal feeding.

Element	CFM	CS	FB	RS
Macro-element, %				
Ca	0.95	0.25	1.5	0.2
P	0.6	0.2	0.35	0.11
Mg	0.45	0.13	0.35	0.11
Na	0.75	0.12	0.7	0.22
K	1.3	1.1	2.5	0.7
Micro-element, ppm				
Cu	12	8	11	5
Zn	40	25	62	20
Mn	45	16	55	50
Fe	450	245	470	340

CFM: concentrate feed mixture, CS: corn silage, FB: fresh berseem, RS: rice straw.

Table 2: Mineral contents of traditional summer and winter rations.

Element	Summer ration	Winter ration
Macro-element, %		
Ca	0.52	1.02
P	0.34	0.40
Mg	0.25	0.34
Na	0.39	0.62
K	1.10	1.66
Micro-element, ppm		
Cu	9.0	10.2
Zn	30.0	44.8
Mn	34.4	50.0
Fe	346	436

Table 3: Dietary mineral balance by Friesian cows and buffaloes fed traditional summer and winter rations.

Element	Ration	Intake	Feces	Urine	Absorption	Retention
Macro-elements (g/day)						
Ca	Summer	85.80^b	47.19^b	18.02^b	38.61^b	20.59^b
	Winter	168.30^a	90.98^a	35.39^a	77.32^a	41.93^a
	SEM	12.48	6.61	2.62	5.87	3.25
P	Summer	56.43^b	31.04^b	11.29^b	25.39^b	14.10^b
	Winter	66.33^a	35.47^a	13.59^a	30.86^a	17.27^a
	SEM	1.56	0.67	0.31	0.90	0.59
Mg	Summer	41.91^b	22.21^b	7.96^b	19.70^b	11.74^b
	Winter	56.43^a	28.79^a	11.28^a	27.64^a	16.36^a
	SEM	2.22	1.01	0.48	1.21	0.74
Na	Summer	64.68^b	9.06	36.22	55.62	19.40
	Winter	102.96^a	13.38	56.63	89.58	32.95
	SEM	6.07	0.69	3.24	5.38	2.14
K	Summer	181.50^b	27.23	103.46	154.28	50.82
	Winter	273.90^a	38.35	153.38	235.55	82.17
	SEM	14.67	1.77	7.93	12.90	4.97
Trace-elements (mg/day)						
Cu	Summer	148.50^b	83.16	29.70	65.34	35.64
	Winter	168.30^a	92.57	31.98	75.74	43.76
	SEM	3.38	1.65	0.44	1.74	1.32
Zn	Summer	495.00^b	267.30	94.05	227.70	133.65
	Winter	739.20^a	391.78	133.06	347.72	214.37
	SEM	38.79	19.79	6.21	19.00	12.79
Mn	Summer	567.60^b	323.53	130.55	244.07	113.52
	Winter	825.00^a	462.00	181.50	363.00	181.50
	SEM	40.94	22.05	9.13	18.90	10.78
Fe	Summer	5709.00^b	3596.70	1370.20	2112.30	742.17
	Winter	7194.00^a	4460.30	1654.60	2733.70	1079.10
	SEM	239.77	139.95	46.48	99.86	53.59

a, b: Values in the column for each element with different superscripts differ significantly (P<0.05).

Table 4: Mineral concentrations in milk of cows and buffaloes fed traditional summer and winter rations.

Element	Type	Summer ration	Winter ration	SEM
Macro-mineral (g/kg)				
Calcium	Cows	1.08^b	1.32^a	0.06
	Buffaloes	1.48^b	1.82^a	0.08
Phosphorus	Cows	0.86^b	0.98^a	0.03
	Buffaloes	1.00^b	1.30^a	0.07
Magnesium	Cows	0.14^b	0.16^a	0.01
	Buffaloes	0.21^b	0.25^a	0.01
Sodium	Cows	0.55^b	0.65^a	0.03
	Buffaloes	0.57^b	0.68^a	0.03
Potassium	Cows	1.38^b	1.58^a	0.05
	Buffaloes	1.58^b	1.82^a	0.06
Micro-mineral (mg/kg)				
Copper	Cows	0.17^b	0.22^a	0.01
	Buffaloes	0.20^b	0.26^a	0.02
Zinc	Cows	2.70^b	3.20^a	0.13
	Buffaloes	3.64^b	4.16^a	0.13
Manganese	Cows	0.033^b	0.039^a	0.002
	Buffaloes	0.042^b	0.053^a	0.003
Iron	Cows	0.85^b	1.05^a	0.05
	Buffaloes	1.27^b	1.43^a	0.04

a, b: Value in the same row with different superscripts differ significantly (P<0.05).

Table 5: Mineral excretion in milk of cows and buffaloes fed traditional summer and winter rations.

Element	Type	Summer ration	Winter ration	SEM
Macro-mineral (g/day)				
Calcium	Cows	12.96[b]	22.44[a]	2.15
	Buffaloes	11.84[b]	20.02[a]	1.86
Phosphorus	Cows	10.32[b]	16.66[a]	1.43
	Buffaloes	8.00[b]	14.30[a]	1.41
Magnesium	Cows	1.68[b]	2.72[a]	0.24
	Buffaloes	1.68[b]	2.75[a]	0.25
Sodium	Cows	6.60[b]	11.05[a]	1.01
	Buffaloes	4.56[b]	7.48[a]	0.66
Potassium	Cows	16.56[b]	26.86[a]	2.34
	Buffaloes	12.64[b]	20.02[a]	1.67
Micro-mineral (mg/day)				
Copper	Cows	2.04[b]	3.74[a]	0.40
	Buffaloes	1.60[b]	2.86[a]	0.30
Zinc	Cows	32.40[b]	54.40[a]	5.02
	Buffaloes	29.12[b]	45.76[a]	3.76
Manganese	Cows	0.40[b]	0.66[a]	0.06
	Buffaloes	0.34[b]	0.58[a]	0.06
Iron	Cows	10.20[b]	17.85[a]	1.73
	Buffaloes	10.16[b]	15.73[a]	1.27

a, b: Value in the same row with different superscripts differ significantly (P<0.05).

4. Discussions

Corn silage alone is not a balanced diet. Therefore, consideration must be given to adding essential nutrients. Because it is roughage, feeding silage alone does not support optimum growth rates of beef cattle. Mineral, such as calcium, phosphorus, common salt, zinc, manganese and cobalt should be provided in a supplement mineral may be provided in a protein of the diet or by feeding in a box on a free choice basis **(Perry and Cecava, 1995). Gaafar (2009)** found that the contents of all mineral (Ca, P, Mg, Na, K, Cu, Zn, Mn and Fe) were higher in concentrate feed mixture compared with corn silage. **Bassiouni *et al.* (2013)** reported that the low contents of calcium, phosphorus, magnesium, sodium, copper, zinc and manganese in corn silage and also the low contents of calcium, phosphorus, magnesium, potassium, copper and zinc in rice straw.

Calcium, phosphorus, copper, zinc and manganese in summer ration were lower than the recommended requirements of dairy cows being 0.60, 0.40%, 10, 40 and 40 ppm, respectively **(NRC, 2001).** These results agreed with those obtained by **Gaafar (2009)** who found that feeding growing calves on ration containing corn silage need to mineral additive. **Bassiouni *et al.* (2013)** reported that feeding dairy cows on ration containing 40% concentrate feed mixture + 40% corn silage + 20% rice straw need to mineral additives, especially for calcium, phosphorus, copper, zinc and manganese. Mineral deficiencies likely to affect production of grazing livestock on pastures in most of the world regions include those of the major elements Ca, P, Mg, Na, S, and the trace elements Co, Cu, I, Mn, Se, and Zn **(Little, 1982; Judson *et al.*, 1987; Judson and McFarlane, 1998).**

Alfalfa has almost twice the ash content of corn silage **(NRC, 2001).** Maize silage has low concentrations of calcium, magnesium, sodium, and phosphorus. Feeding maize silage can exacerbate mineral deficiencies such as magnesium and calcium already present in pasture diets. As a general rule, if maize silage makes up 25% or more of a lactating cow diet, mineral supplementation is recommended. Depending on the individual farm, phosphorus supplementation may also be required. Requirements for trace mineral are similar when feeding maize silage or grazing pasture. A trace element supplementation or animal treatment programme should be routine 1 month before calving and 4 months after calving. Supplying the cow's copper, selenium, cobalt, iodine, and zinc requirements will cost approximately 4 cents per cow per day **(Kolver *et al.*, 2001). Gaafar (2009)** found that dietary mineral intake, excretion, absorption and retention by growing Friesian calves decreased with increasing the level of corn silage in the rations. **Bassiouni *et al.* (2013)** reported that apparent absorption and retention of mineral by dairy cows increased with increasing mineral intake by seaweed and premix supplementation.

The concentrations of Ca and P in milk of cows and buffaloes fed summer ration was lower than the normal values being 1.20 and 0.95 g/kg in cow's milk and 1.63 and 1.11 g/kg in buffalo's milk, respectively **(Soliman, 2005).** The concentrations of Cu in milk of cows and buffaloes fed summer ration were lower than the normal levels of Cu in milk of cows and buffaloes being 0.19 and 0.22 mg/kg, respectively **(Farag *et al.*, 1992).** Zinc concentration in milk of cows and buffaloes fed summer ration were lower than the normal levels of Zn in milk of cows and buffaloes being 2.96 and 3.91 mg/kg, respectively (**Merkel *et al.*, 1990).** The concentrations of Mn in milk of cows and buffaloes fed summer ration were lower than the normal levels of Mn in milk of cows and buffaloes being 0.035 and 0.050 mg/kg, respectively **(Lampert, 1975).** Corn silage alone is not a balanced diet. Therefore, consideration must be given to adding essential nutrients. Because it is roughage, feeding silage alone does not support optimum growth rates of beef cattle. Mineral, such as calcium, phosphorus, common salt, zinc, manganese and cobalt should be provided in a supplement mineral may be provided in a protein of the diet or by feeding in a box on a free choice basis **(Perry and Cecava, 1995). Bassiouni *et al.* (2013)** found that macro and micro-mineral concentration in cow's milk fed rations containing 40% corn silage increased with 25 g premix or 50 g seaweed per head per day as a source of mineral additive.

Milk is a good source of calcium, magnesium, phosphorus, potassium, selenium, and zinc. Many mineral in milk are associated together in the form of salts, such as calcium phosphate. In milk approximately 67% of the calcium, 35% of the magnesium, and 44% of the phosphate are salts bound within the casein micelle and the remainder are soluble in the serum phase. The fact that calcium and phosphate are associated as salts bound with the protein does not affect the nutritional availability of either calcium or phosphate. Milk contains small amounts of copper, iron, manganese, and sodium and is not considered a major source of these mineral in the diet. The concentration of major elements depends on the species the individual animal, the method of feeding, lactation stag and health condition of the udders **(Park and Chukwu, 1988; Cashman, 2006).**

Conclusion

From these results it could be concluded that feeding dairy cows and buffaloes on summer ration containing 40% corn silage showed lower concentrations of calcium, phosphorus, copper, zinc and manganese in milk than the normal levels. Therefore, our results can be considered useful for formulating the mineral mixtures to overcome the deficiency of different mineral in cows and buffaloes fed ration contained corn silage.

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