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Effect of feeding traditional summer and winter rations on the contents of some minerals 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 minerals 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 minerals were detected in corn silage and rice straw. The contents and intake of all minerals were higher in winter ration containing fresh berseem than summer ration containing corn silage. The excretion of all minerals in feces and urine as well as absorption and retention increased significantly (P<0.05) with increasing dietary minerals intake. The concentrations of macro and micro-elements in milk of cows and buffaloes increased significantly (P<0.05) with increasing dietary minerals 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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Introduction

The quantity of minerals, 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 for feeding minerals to livestock, including lactating cows **(McDowell, 1992; 1999; McDowell and Valle, 2000).** Minerals are essential for the proper functioning of the animal. A problem arises when the feed does not supply enough amount of mineral to meet the animal's requirements. This may occur because the feed is low in minerals, the availability 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. Minerals, 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 minerals 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 minerals 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 minerals contents of milk of lactating Friesian cows and buffaloes.

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 20 lactating buffaloes with an average live body weight of 500 kg at

2-5 lactation seasons were fed summer ration (10 cows and 10 buffaloes) and winter ration (10 cows and 10 buffaloes) after the peak of lactation (60 days from parturition).

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

Animals management:
Animals were housed under sheds in semi-open backyards. Concentrate feed mixture was offered in two equal parts daily at 8 a.m. and 4 p.m., 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.

Minerals 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 cow and buffalo three times biweekly and mixed in proportion to milk yield.

Preparation of samples for minerals determination:
Wet ashing is primarily used in the preparation of milk samples for subsequent analysis of specific minerals according to **(AOAC, 1995).** It breaks down and removes the organic matrix surrounding the minerals so that they are left in an aqueous solution. The samples 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 minerals determination. Minerals excretion in milk was calculated from the milk yield and the concentrations of minerals in milk of cows and buffaloes.

Minerals 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 **IBM SPSS 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).**

Results and Discussions

Minerals contents of feedstuffs:
Minerals contents of feedstuffs presented in Table (1) 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 minerals were detected in corn silage and rice straw. 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. Minerals, 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 minerals (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.

Table 1: Minerals 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.

Mineral contents of traditional summer and winter rations:

Minerals contents of traditional summer and winter rations are shown in Table (2). The contents of all minerals were higher in winter ration containing fresh berseem than summer ration containing corn silage. These attributed to higher Minerals 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 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 minerals 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 minerals 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).**

Table 2: Minerals 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

Dietary minerals balance:

Minerals balance by Friesian cows and buffaloes fed traditional summer and winter rations are presented in Table (3). The intake of macro and micro minerals 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 minerals contents in fresh berseem compared to corn silage as shown in Table (1) as well as higher minerals 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 minerals increased significantly ($P<0.05$) with increasing dietary minerals intake. 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 minerals 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 minerals 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 minerals by dairy cows increased with increasing minerals intake by seaweed and premix supplementation.

Table 3: Dietary minerals 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 ($P<0.05$).

Minerals concentrations in milk of cows and buffaloes:

The effect of feeding summer and winter rations on minerals concentrations in milk of cows and buffaloes are shown in Table (4). The concentrations of macro-minerals (Ca, P, Mg, Na and K) and micro-minerals (Cu, Zn, Mn and Fe) in milk of cows and buffaloes increased significantly ($P<0.05$) with increasing dietary minerals intake and retention. The high significant positive correlations exist between dietary minerals 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. 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. Minerals, 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-minerals 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 minerals 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 minerals in the diet.

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

Element	Type	Summer ration	Winter ration	SEM
Macro-minerals (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-minerals (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).

From these results it could be concluded that feeding dairy cows and buffaloes 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 minerals in cows and buffaloes fed ration contained corn silage.

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