Status of some minerals in Friesian calves fed different levels of concentrate feed mixture and corn silage

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Abstract: Twenty eight male Friesian calves with average live body weight 176.67±3.68 kg and aged 8±0.19 months were divided into four similar groups (seven in each) assigned randomly to four experimental rations containing different levels of concentrate feed mixture and corn silage during the first (winter season) and second (summer season) periods. minerals content (Ca, P, Mg, Na, K, Cu, Zn, Mn and Fe) were higher in concentrate feed mixture compared with corn silage and increased in experimental rations with increasing the level of concentrate feed mixture and decreasing the level of corn silage. The contents of Ca, P, Na, Zn and Mn in corn silage were below the recommended requirements of growing calves. Minerals balance and concentrations in hair, blood plasma and body tissues increased significantly ($P<0.05$) with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations. Calves fed all corn silage ration (R4) during the first period showed the negative absorption and retention of Ca, P, Na, Zn and Mn and were lower than the normal levels in hair and blood plasma.

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1- Introduction

Minerals are essential for the proper functioning of the animal. A problem arises when the feed does not supply enough 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 minerals may be provided in a protein of the diet or by feeding in a box on a free choice basis (Perry and Cecava, 1995).

Since mineral analyses are complicated and expensive, it is important to select and analyze the minimum number of plant and animal tissues, which are more indicative of the mineral status. Tissues used to evaluate the status of specific minerals include liver, blood, bone, milk, hair and saliva (McDowell *et al*., 1986). Animal tissues are valuable aids in detecting mineral abnormalities in livestock: Ca, Mg, P, Cu, Se and Zn in serum; Co, Cu, Mn and Se in liver; Ca, P and F in bone; I in milk and Na in saliva (McDowell, 1987). Minerals level in hair can reflect the condition and / or activity of the elements in other parts of the body and reflect minerals status to be as a tool, useful to nutritionists (Anke, 1966, Combs *et al*., 1982 and Combs, 1987). Whole blood, blood serum or plasma is more widely employed for studies in mineral nutrition than any other tissue or fluid because it invariably in some aspects of its composition the mineral status of the animals. The normal values or normal range of minerals concentrations in the blood of healthy farm animals are known (Underwood, 1981). Minerals concentrations in blood plasma have been studied as an adjunct to investigations of minerals metabolism or quantitative dietary minerals requirements (McDowell, 1992).

The objective of this study was to investigate the effects of feeding different levels of concentrate feed mixture and corn silage on some minerals intake, metabolism and concentrations in hair, blood plasma and body tissues of growing Friesian calves.

2- Materials and methods

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

Experimental animals and rations:

Twenty eight male Friesian calves with average live body weight 176.67±3.68 kg and aged 8±0.19 months were divided into four similar groups (seven in each) assigned randomly to four experimental rations during the first (winter season) and second (summer season) periods as shown in Table (1). Calves were fed individually to cover the recommended requirements of growing calves according to NRC (1996) and were adjusted biweekly according to body weight changes. Concentrate feed mixture was offered two times daily at 8 a.m. and 4 p.m., fresh berseem or hay once daily at 11 a.m. and rice straw or corn silage was given at 9 a.m. Calves were watered three times daily.

Table (1): Formulation of the experimental rations (% on DM basis) and dry matter intake by Friesian calves during the first and second periods.

Feedstuffs	The first period				The second period			
	R1	R2	R3	R4	R1	R2	R3	R4
Duration (day)	140	140	140	140	112	98	84	182
Concentrate feed mixture (CFM)	65	50	25	00	65	50	25	75
Corn silage (CS)	00	50	75	100	00	50	75	25
Fresh berseem (FB)	15	00	00	00	-	-	-	-
Berseem hay (BH)	-	-	-	-	15	00	00	00
Rice straw (RS)	20	00	00	00	20	00	00	00
DM intake (kg/head/day)	7.10	6.76	6.60	5.37	9.80	9.30	9.00	8.80

Corn silage:

Whole corn plant of hybrid *single cross 10* was harvested at dough stage of maturity, chopped into 1-1.5 cm of length and ensiled in horizontal built walls silo. Chopped corn crop stock was compressed by tractor, then covered with plastic sheet, hard pressed with 20-30 cm of soil layer and ensiled for two months.

Metabolism trails:

Eight metabolism trails were conducted with three Friesian calves chosed randomly from each group to determine minerals metabolism of the experimental rations during the first and second periods. Calves were fed individually the experimental rations in stalls for 15 days preliminary period followed by 7 days collection period. Samples of feedstuffs were taken at the beginning, middle and end of collection period. Feces was collected from each calf during the collection period using plastic pages, weighed daily and samples of 10% by weight were taken. Also, urine was collected daily from each calf during the collection period by rubber funnel adjoining with plastic hose in plastic bucket containing 100 ml sulfuric acid (10%), urine volume was measured and samples of 10% of the volume were taken in glass bottles.

Hair samples:

Hair samples were collected from the upper right or lift cage for each calf during the first and second periods, cutting (full hand) by a clean shaving tackle close to the skin surface of the animal in clean nylon bag. Each sample was thoroughly washed by tap water, and then rinsed by distilled and boiled distilled water until both the filter and filtrate appeared clear.

Blood samples:

Blood samples were taken during the first and second periods from the jugular vein by clean sterile needle in clean dry plastic tubes using heparin as an anticoagulant and centrifuged at 4000 rotations per minute for 15 minute to obtain plasma.

Body tissues samples:

At the end of the experiment (average body weight of each group was 450 kg), three calves from each group were chosen randomly, weighed after fasted for 16 hours and slaughtered. Upon completion of bleeding, animals were skinned, dressed out and samples of liver, kidneys, heart, spleen and muscle were taken for chemical analysis.

Samples preparation:

The samples of feedstuffs, feces, hair, liver, kidneys, heart, spleen and muscle were prepared for minerals determination according to the methods of AOAC (1990).

Minerals Determination:

Calcium, magnesium, copper, zinc, manganese, and iron were determined by Atomic Absorption Spectrophotometer (Perkin Elmer 2380). Phosphorus was determined using Spectrophotometer (Milton Roy Company Spectronic 20 D). Sodium and potassium were determined by Flame Photometer (Jenway PFP 7).

Statistical analysis:

The data obtained from minerals determination were statistically analyzed using general liner models procedure adapted by SPSS for Windows (2008) for user's guide with one-way ANOVA. Duncan test within program SPSS was done to determine the degree of significance between the means.

3- Results and discussion

Minerals contents of tested feedstuffs and experimental rations:

Minerals contents of tested feedstuffs and experimental rations during the first and second periods are shown in Table (2). 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. So, its contents in experimental rations increased with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations. The contents of Ca, P, Na, Zn and Mn in corn silage were below the recommended requirements of growing calves according to NRC (1996) being 0.42, 0.21, 0.10%, 30 and 30 ppm, respectively. The contents of all minerals in experimental rations contained different levels of concentrate feed mixture and corn silage were covered the recommended requirements for beef cattle according to NRC (1996). These results are in accordance with those obtained by Perry and Cecava (1995) who reported that corn silage alone is not a balanced diet. El-Nahas *et al.* (2005) found that minerals content in the rations decreased with increasing the level of corn silage.

Table 2: Minerals contents (on DM basis) of tested feedstuffs and experimental rations during the first and second periods.

Item	Macro-minerals (%)					Micro-minerals (ppm)			
	Ca	P	Mg	Na	K	Cu	Zn	Mn	Fe
Tested feedstuffs									
CFM	0.94	0.76	0.48	0.73	1.27	13.62	50.25	67.61	138.28
CS	0.29	0.18	0.21	0.02	1.18	10.20	23.50	17.70	115.00
FB	1.23	0.32	0.27	0.08	2.10	10.65	24.70	37.40	228.35
BH	1.15	0.35	0.25	0.10	1.95	10.15	21.50	35.60	215.20
RS	0.12	0.07	0.20	0.14	0.65	4.30	45.00	41.00	99.00
Experimental rations									
The first period									
R1	0.82	0.56	0.39	0.51	1.27	11.31	45.37	57.76	143.93
R2	0.62	0.47	0.35	0.38	1.23	11.91	36.88	42.66	126.64
R3	0.45	0.33	0.28	0.20	1.20	11.06	30.19	30.18	120.82
R4	0.29	0.18	0.21	0.02	1.18	10.20	23.50	17.70	115.00
The second period									
R1	0.81	0.56	0.39	0.52	1.25	11.24	44.89	57.49	141.96
R2	0.62	0.47	0.35	0.38	1.23	11.91	36.88	42.66	126.64
R3	0.45	0.33	0.28	0.20	1.20	11.06	30.19	30.18	120.82
R4	0.78	0.62	0.41	0.55	1.25	12.77	43.56	55.13	132.46

Minerals metabolism:

The intake, excretion in feces and urine, absorption and retention of macro-minerals (Ca, P, Mg, Na and K, g/day) and micro-minerals (Cu, Zn, Mn and Fe, mg/day) increased significantly ($P<0.05$) with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations (Table 3). These results may be attributed to the higher contents of all minerals in concentrate feed mixture compared with corn silage and increasing the contents and intake of all minerals in experimental rations with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations as shown in Table (2). Moreover, calves fed all corn silage ration (R4) during the first period showed the negative absorption and retention of Ca, P, Na, Zn and Mn and introducing 75% concentrate feed mixture in R4 during the second period cover the negative absorption and retention. These results could be attributed to the lower contents of these elements in corn silage than the recommended requirements of growing calves (NRC 1996). Similar results obtained by El-Nahas *et al.* (2005) who stated that minerals intake decreased with increasing the level of corn silage in the rations. Gaafar (1994) and Mehany (1999) found that dietary minerals intake, excretion, absorption and retention increased with increasing the level of concentrate feed mixture. Du *et al.* (1996) and Bannink *et al.* (1999) stated that minerals excretion increased with increasing dietary minerals intake. Khorasani *et al.* (1997) and Bannink *et al.* (1999) they found that minerals absorption and retention increased with increasing the level of concentrate in the rations.

Table 3: Minerals metabolism by growing Friesian calves fed experimental rations during the first and second periods.

Ration	Macro-minerals (g/day)					Micro-minerals (mg/day)			
	Ca	P	Mg	Na	K	Cu	Zn	Mn	Fe
The first period									
Intake									
R1	58.22^{a}	39.76^{a}	27.69^{a}	36.21^{a}	90.17^{a}	80.30^{a}	322.13^{a}	410.10^{a}	1021.90^{a}
R2	41.91^{b}	31.77^{b}	23.66^{b}	25.69^{b}	83.15^{b}	80.51^{a}	249.31^{b}	288.38^{b}	856.09^{b}
R3	29.70^{c}	21.78^{c}	18.48^{c}	13.20^{c}	79.20^{c}	73.00^{b}	199.25^{c}	199.19^{c}	797.41^{c}
R4	15.57^{d}	9.67^{d}	10.74^{d}	1.07^{d}	63.37^{d}	54.77^{c}	126.19^{d}	95.05^{d}	617.55^{d}
Excretion in feces									
R1	30.92^{a}	22.11^{a}	15.40^{a}	4.21^{a}	13.10^{a}	42.45^{a}	178.83^{a}	249.19^{a}	631.24^{a}
R2	25.01^{b}	19.75^{b}	14.00^{b}	2.67^{b}	11.26^{ab}	42.42^{a}	152.61^{b}	175.93^{b}	521.33^{b}
R3	20.55^{c}	15.62^{c}	11.83^{c}	1.66^{c}	9.95^{b}	38.73^{b}	142.56^{c}	130.03^{c}	487.35^{c}
R4	16.88^{d}	10.72^{d}	7.49^{d}	1.36^{c}	5.16^{c}	29.67^{c}	132.79^{d}	102.65^{d}	376.99^{d}
Excretion in urine									
R1	11.30^{a}	7.44^{a}	5.15^{a}	19.24^{a}	51.48^{a}	15.42^{a}	48.32^{a}	77.01^{a}	186.01^{a}
R2	8.13^{b}	5.94^{b}	4.40^{b}	15.56^{b}	49.25^{ab}	15.46^{a}	40.86^{b}	53.92^{b}	161.46^{b}
R3	5.76^{c}	4.07^{c}	3.44^{c}	7.45^{c}	47.93^{b}	14.02^{b}	30.81^{c}	29.31^{c}	150.93^{c}
R4	3.02^{d}	2.81^{d}	1.99^{d}	2.54^{d}	43.15^{c}	9.52^{c}	25.64^{d}	22.91^{d}	117.01^{d}
Apparent absorption									
R1	27.30^{a}	17.65^{a}	12.29^{a}	32.00^{a}	77.07^{a}	37.85^{a}	143.30^{a}	160.91^{a}	390.66^{a}
R2	16.90^{b}	12.02^{b}	9.66^{b}	23.02^{b}	71.89^{b}	38.09^{a}	96.70^{b}	112.45^{b}	334.76^{b}
R3	9.15^{c}	6.16^{c}	6.65^{c}	11.54^{c}	69.25^{c}	34.27^{b}	56.69^{c}	69.16^{c}	310.06^{c}
R4	-1.31^{d}	-1.05^{d}	3.25^{d}	-0.29^{d}	58.21^{d}	25.10^{c}	-6.60^{d}	-7.60^{d}	240.56^{d}
Apparent retention									
R1	16.00^{a}	10.21^{a}	7.14^{a}	12.76^{a}	25.59^{a}	22.43^{a}	94.98^{a}	83.90^{a}	204.65^{a}
R2	8.77^{b}	6.08^{b}	5.26^{b}	7.46^{b}	22.64^{b}	22.63^{a}	55.84^{b}	58.53^{b}	173.30^{b}
R3	3.39^{c}	2.09^{c}	3.21^{c}	4.09^{bc}	21.32^{c}	20.25^{b}	25.88^{c}	39.85^{c}	159.13^{c}
R4	-4.33^{d}	-3.86^{d}	1.26^{d}	-2.83^{c}	15.06^{d}	15.58^{c}	-32.24^{d}	-15.31^{d}	123.55^{d}
The second period									
Intake									
R1	79.38^{a}	54.88^{c}	38.22^{a}	50.96^{a}	122.50^{a}	110.15^{a}	439.92^{a}	563.40^{a}	1391.21^{a}
R2	57.66^{c}	43.71^{b}	32.55^{c}	35.34^{c}	114.39^{b}	110.76^{a}	342.98^{c}	396.74^{c}	1177.75^{b}
R3	40.50^{d}	29.70^{c}	25.20^{d}	18.00^{d}	108.00^{c}	99.54^{b}	271.71^{d}	271.62^{d}	1087.38^{c}
R4	68.64^{d}	54.56^{a}	36.08^{b}	48.40^{b}	110.00^{c}	112.38^{a}	383.33^{b}	485.14^{b}	1165.65^{b}
Excretion in feces									
R1	45.42^{a}	32.78^{a}	22.71^{a}	8.01^{a}	18.38^{a}	62.42^{a}	262.29^{a}	343.14^{a}	848.03^{a}
R2	36.51^{c}	28.77^{b}	20.50^{b}	5.71^{b}	18.12^{ab}	62.70^{a}	213.85^{c}	242.86^{c}	717.94^{c}
R3	30.05^{d}	22.78^{c}	17.09^{c}	2.89^{c}	17.28^{b}	55.77^{b}	173.03^{d}	164.45^{d}	664.14^{d}
R4	40.55^{b}	33.60^{a}	22.07^{a}	7.51^{a}	17.65^{ab}	63.66^{a}	240.17^{b}	294.36^{b}	781.28^{b}
Excretion in urine									
R1	15.40^{a}	10.26^{a}	7.11^{a}	31.06^{a}	74.01^{a}	17.15^{a}	78.98^{a}	108.65^{a}	264.59^{a}
R2	11.19^{b}	8.17^{b}	6.05^{b}	22.46^{b}	72.22^{b}	17.27^{a}	60.53^{c}	74.82^{c}	224.53^{b}
R3	5.86^{c}	5.55^{c}	4.29^{c}	12.35^{c}	71.25^{bc}	15.12^{b}	47.20^{d}	52.92^{d}	205.99^{v}
R4	13.32^{ab}	10.20^{a}	6.51^{ab}	29.97^{a}	70.24^{c}	17.57^{a}	66.24^{b}	92.95^{b}	220.32^{b}
Apparent absorption									
R1	33.96^{a}	22.10^{a}	15.51^{a}	42.95^{a}	104.12^{a}	47.73^{a}	177.63^{a}	220.26^{a}	543.18^{a}
R2	21.15^{c}	14.94^{c}	12.05^{c}	29.63^{c}	96.27^{b}	48.06^{a}	129.13^{c}	153.88^{c}	459.81^{b}
R3	10.45^{d}	6.92^{d}	8.11^{d}	15.11^{d}	90.72^{c}	43.77^{b}	98.68^{d}	107.17^{d}	423.24^{c}
R4	28.09^{d}	20.96^{b}	14.01^{b}	40.89^{b}	92.35^{bc}	48.72^{a}	143.16^{b}	190.78^{b}	454.27^{b}
Apparent retention									
R1	18.56^{a}	11.84^{a}	8.40^{a}	11.85^{a}	30.11^{a}	30.58^{a}	98.65^{a}	112.61^{a}	278.59^{a}
R2	9.96^{c}	6.77^{c}	6.00^{c}	7.17^{c}	24.05^{b}	30.79^{a}	68.60^{c}	79.06^{c}	235.28^{b}
R3	4.59^{d}	1.37^{d}	3.82^{d}	2.76^{d}	19.47^{c}	28.65^{b}	51.48^{d}	54.25^{d}	217.25^{c}
R4	14.77^{d}	10.76^{b}	7.50^{b}	10.92^{b}	22.11^{b}	31.15^{a}	76.92^{b}	97.83^{b}	233.95^{b}

a, b, c, d: Means in the same column for each item with different superscripts differ significantly ($P<0.05$).

Table 4: Minerals concentrations in hair (ppm on DM basis) of growing Friesian calves fed experimental rations during the first and second periods.

Ration	Macro-minerals					Micro-minerals			
	Ca	P	Mg	Na	K	Cu	Zn	Mn	Fe
				The first period					
R1	2380.50^{a}	284.50^{a}	970.93^{a}	705.10^{a}	2826.28^{a}	9.20^{ab}	142.50^{a}	14.89^{a}	95.60^{a}
R2	2215.64^{c}	265.48^{b}	930.24^{b}	670.45^{b}	2785.40^{c}	8.96^{bc}	125.40^{bc}	13.97^{b}	81.05^{bc}
R3	2150.37^{d}	225.73^{c}	895.36^{c}	635.75^{c}	2735.15^{d}	8.68^{cd}	112.60^{cd}	10.85^{c}	76.60^{cd}
R4	1930.82^{e}	170.55^{d}	855.50^{d}	575.30^{d}	2690.62^{e}	8.25^{d}	106.83^{d}	8.26^{d}	72.15^{d}
				The second period					
R1	2325.45^{a}	278.60^{a}	950.75^{a}	735.40^{a}	2730.95^{a}	8.95^{ab}	144.70^{a}	13.46^{a}	105.50^{a}
R2	2185.56^{c}	258.85^{b}	905.46^{b}	695.84^{b}	2675.60^{c}	8.82^{bc}	127.25^{bc}	12.70^{b}	94.35^{bc}
R3	2115.83^{d}	205.25^{c}	865.65^{c}	655.35^{c}	2650.75^{d}	8.45^{cd}	116.60^{cd}	9.90^{c}	81.78^{cd}
R4	2250.65^{b}	282.54^{a}	941.70^{a}	746.30^{a}	2705.40^{b}	9.20^{a}	135.55^{ab}	13.12^{ab}	99.75^{ab}

a, b, c, d and e: Means in the same column for each period with different superscripts differ significantly ($P<0.05$).

Minerals concentrations in hair:

Minerals concentrations in hair of growing calves fed rations containing different levels of concentrate feed mixture and corn silage during the first and second periods are presented in Table (4). The concentrations of all minerals (Ca, P, Mg, Na, K, Cu, Zn, Mn and Fe) in hair increased significantly ($P<0.05$) with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations. These results may be attributed to increasing minerals intake, absorption and retention with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations (Table 3). These results are in agreement with those obtained by Abdel-Raouf *et al*. (1994) and Gaafar (1994) who found that minerals concentrations in hair of cattle increased with increasing dietary minerals intake. The concentrations of Ca, P, Na, Zn and Mn in hair of Friesian calves fed R4 (all corn silage) during the first period were lower than the critical levels in black hair being 2100, 200, 600, 115 and 12 ppm, respectively (Anke, 1966, 1967, Anke *et al*., 1981 and Combs, 1987). These results might be due to the lower contents of Ca, P, Na, Zn and Mn in all corn silage ration (R4 during the first period) were below the recommended requirements of growing calves according to NRC (1996). Introducing concentrate feed mixture in R4 during the second period covered minerals deficiency detected during the first period.

Minerals concentrations in blood plasma:

Minerals concentrations in blood plasma of growing calves fed rations containing different levels of concentrate feed mixture and corn silage during the first and second periods are shown in Table (5). The concentrations of Ca, P, Mg, Na, K, Cu, Zn, Mn and Fe in blood plasma increased significantly ($P<0.05$) with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations. These results may be attributed to increasing minerals intake with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations (Table 3). The previous results are in agreement with those obtained by El-Nahas *et al.* (2005) who reported that minerals concentration in blood plasma decreased with increasing the level of corn silage in the rations. Herdt *et al.* (2000) and Knowlton and Herbein (2002) found that minerals concentrations in blood plasma of cattle increased with increasing dietary minerals intake. The concentrations of Ca, P, Na, Zn and Mn in blood plasma of Friesian calves fed R4 (all corn silage) during the first period were lower than the critical levels in blood plasma as reported by NRC (1996) and Herdt *et al.* (2000) being 9.5-12 mg/ dl for Ca, 5-7 mg/ dl for P, 325 mg/ dl for Na, 95 ug/ dl for Zn and 3 ug/ dl for Mn. Introducing concentrate feed mixture in R4 during the second period covered minerals deficiency detected during the first period.

Minerals concentrations in body tissues:

Data in Table (6) revealed the effect of feeding rations containing different levels of concentrate feed mixture and corn silage on minerals concentrations in body tissues of growing calves. The concentrations of Ca, P, Mg, Na, K, Cu, Zn, Mn and Fe in liver, kidneys, heart, spleen and muscle increased significantly ($P<0.05$) with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations. These results may be attributed to increasing minerals intake, absorption and retention with increasing the level of concentrate feed mixture and decreasing the level of corn silage in the rations (Table 3). These results are in accordance with those obtained by El-Nahas *et al.* (2005) who found that minerals content in body tissues decreased with increasing the level of corn silage in the rations. Kolb *et al.* (2001) and Arthington and Pate (2002) reported that minerals contents in body tissues increased with increasing dietary minerals intake. The concentrations of all minerals in body tissues are within the normal levels as reported by Georgievskii (1982) and McDowell (1992) indicating that introduce concentrate feed mixture in R4 during the second period covered minerals deficiency detected during the first period.

Table 5: Minerals concentrations in blood plasma of growing Friesian calves fed experimental rations during the first and second periods.

Ration	**Macro-minerals (mg/100 ml)**					**Micro-minerals (ug/100 ml)**			
	Ca	**P**	**Mg**	**Na**	**K**	**Cu**	**Zn**	**Mn**	**Fe**
					The first period				
R1	11.35^{a}	6.05^{a}	3.08^{a}	391.50^{a}	34.15^{a}	108.34^{a}	115.32^{a}	3.85^{a}	160.50^{a}
R2	10.84^{bc}	5.62^{b}	2.75^{b}	378.45^{b}	29.40^{b}	101.92^{b}	101.58^{bc}	3.45^{bc}	137.65^{bc}
R3	10.15^{c}	5.20^{c}	2.45^{c}	345.70^{c}	24.67^{c}	95.30^{b}	95.90^{c}	3.05^{cd}	124.45^{cd}
R4	9.12^{d}	4.77^{d}	2.19^{d}	310.36^{d}	20.93^{d}	91.18^{d}	91.76^{d}	2.62^{d}	113.26^{d}
					The second period				
R1	11.95^{a}	5.85^{a}	2.97^{a}	380.35^{a}	32.60^{a}	102.60^{a}	118.17^{a}	4.15^{a}	165.34^{a}
R2	11.29^{bc}	5.45^{b}	2.64^{b}	367.20^{b}	28.35^{b}	93.70^{b}	107.83^{bc}	3.64^{bc}	143.80^{bc}
R3	10.43^{cd}	5.05^{c}	2.30^{c}	332.50^{c}	22.85^{c}	89.80^{b}	92.50^{c}	3.17^{cd}	132.15^{cd}
R4	11.65^{ab}	6.15^{a}	2.92^{a}	375.38^{a}	30.45^{ab}	105.15^{a}	112.65^{ab}	3.92^{ab}	154.50^{ab}

a, b, c and d: Means in the same column for each period with different superscripts differ significantly ($P<0.05$).

Table 6: Minerals concentrations in body tissues (ppm on DM basis) of growing Friesian calves fed experimental rations.

Ration	Macro-minerals					Micro-minerals			
	Ca	P	Mg	Na	K	Cu	Zn	Mn	Fe
					Liver				
R1	464.67^{a}	6859.50^{a}	768.75^{a}	3452.50^{a}	9930.40^{a}	28.80^{c}	162.17^{a}	7.42^{a}	428.30^{a}
R2	385.83^{c}	6413.30^{b}	670.50^{c}	3285.86^{c}	9671.65^{b}	30.65^{b}	125.84^{c}	6.85^{c}	375.65^{c}
R3	348.60^{d}	6143.67^{c}	624.00^{d}	3129.17^{d}	9290.15^{d}	26.50^{d}	110.50^{d}	6.43^{d}	338.10^{d}
R4	423.32^{b}	6974.40^{a}	710.80^{b}	3344.50^{b}	9410.25^{c}	33.35^{a}	146.45^{b}	7.12^{b}	403.85^{b}
					Kidneys				
R1	276.33^{a}	1250.00^{a}	618.83^{ab}	6953.50^{a}	6965.00^{a}	6.87^{c}	58.62^{a}	4.54^{a}	204.80^{a}
R2	224.17^{c}	1131.67^{b}	523.67^{c}	6812.40^{c}	6736.55^{b}	7.57^{b}	42.92^{c}	4.05^{c}	153.33^{c}
R3	206.50^{d}	1071.65^{c}	483.80^{d}	6750.25^{d}	6251.65^{d}	6.45^{d}	35.13^{d}	3.82^{d}	132.10^{d}
R4	247.20^{b}	1285.60^{a}	570.75c^{b}	6882.30^{b}	6598.30^{c}	8.28^{a}	49.57^{b}	4.30^{b}	185.66^{b}
					Heart				
R1	344.65^{a}	1715.67^{a}	558.80^{a}	2325.50^{a}	7365.20^{a}	9.82^{c}	56.62^{a}	1.32^{a}	195.32^{a}
R2	295.80^{c}	1645.00^{b}	497.25^{c}	2210.67^{c}	7136.65^{b}	10.35^{b}	48.85^{c}	1.05^{c}	145.65^{c}
R3	274.60^{d}	1538.32^{c}	465.50^{d}	2187.40^{d}	6720.15^{d}	9.41^{d}	45.92^{d}	0.90^{d}	128.10^{d}
R4	312.30^{b}	1741.60^{a}	520.65^{b}	2264.50^{b}	6898.30^{c}	10.80^{a}	52.56^{b}	1.18^{b}	170.80^{b}
					Spleen				
R1	374.66^{a}	3735.30^{a}	298.85^{a}	7890.50^{a}	11365.90^{a}	3.98^{c}	57.28^{a}	1.08^{a}	740.33^{a}
R2	335.60^{c}	3638.50^{b}	243.67^{c}	7782.25^{c}	11085.50^{b}	4.17^{b}	47.92^{c}	0.83^{c}	681.67^{c}
R3	318.50^{d}	3585.40^{c}	223.85^{d}	7620.60^{d}	10645.45^{d}	3.71^{d}	42.05^{d}	0.69^{d}	638.00^{d}
R4	353.32^{b}	3758.35^{a}	270.65^{b}	7845.35^{b}	10805.70^{c}	4.54^{a}	51.57^{b}	0.95^{b}	712.80^{b}
					Muscle				
R1	249.67^{a}	1748.33^{a}	868.80^{a}	1598.50^{a}	13245.20^{a}	7.81^{c}	43.62^{a}	0.88^{a}	89.12^{a}
R2	210.83^{c}	1680.10^{b}	783.65^{c}	1510.83^{c}	12988.30^{b}	7.92^{b}	34.92^{c}	0.64^{c}	66.07^{c}
R3	193.65^{d}	1561.67^{c}	735.75^{d}	1472.60^{d}	12535.10^{d}	7.60^{d}	31.13^{d}	0.55^{d}	54.22^{d}
R4	228.32^{b}	1773.30^{a}	840.90^{b}	1562.40^{b}	12713.30^{c}	8.16^{a}	38.57^{b}	0.76^{b}	78.95^{b}

a, b, c and d: Means in the same column for each item with different superscripts differ significantly ($P<0.05$).

4- Conclusion

It could be concluded that feeding growing Friesian calves on corn silage alone did not covered the requirements of Ca, P, Na, Zn and Mn. Introducing concentrate feed mixture at the level of 25% with 75% corn silage, will be enough to meet minerals deficiency detected in corn silage as well as cover minerals requirement of growing calves.

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