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RESEARCH ARTICLE

Effect of Premix and Seaweed additives on minerals status of Lactating Friesian Cows

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Abstract

Eighteen lactating Friesian cows with average body weight of 534.44±13.04 kg, ranging from 450 to 660 kg, average milk production of 12.16±0.10 kg/day, ranging from 9.52 to 14.80 kg/day and average parity of 2.22±0.33; ranging from 1 to 5 were used during summer season 2011, for 150 days starting with one week after parturition, from June to November. Animals were divided into three similar groups with six cows in each group based on body weight, milk production and parity. All animals were fed the basal ration consisted of 40% concentrate feed mixture + 40% corn silage + 20% rice straw (on DM basis) without additive served as a control (group 1) or with 25 g premix / head / day (group 2) or with 50 g seaweed / head / day (group 3). The obtained results showed that the contents of calcium, phosphorus, copper, zinc and manganese in basal ration were lower than the recommended requirements of dairy cows. Minerals intake expressed as g or mg per day was nearly similar for the different groups except potassium and manganese. Seaweed group showed significantly ($P<0.05$) the highest apparent absorption and retention of different minerals followed by premix group, while the control group had the lowest values. Seaweed group showed significantly ($P<0.05$) the highest minerals concentrations in hair, blood plasma and milk followed by premix group, while the control group had the lowest contents.

Introduction

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 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).** The contents of calcium, phosphorus, sodium, zinc and manganese were deficient in whole plant corn silage **(Gaafar, 2009).** However , adding such minerals during using corn silage as basal ration for feeding lactating cows is very nessesrly.
Seaweed is a totally natural multi-mineral supplement. In contrast to conventional mineral supplements, seaweed is unique in being of plant origin containing a wide range of naturally balanced chelated minerals, trace elements, amino acids and vitamins. Seaweed contains of all the minerals and

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trace elements of animal requires for a normal healthy life **(Sykes, 2009).**

The objective of the present study was to investigate the effect of minerals additives in organic form (seaweed) or inorganic form (premix) on minerals intake and balance and mineral concentrations in hair, blood serum and milk of lactating Friesian cows.

Material and Methods

The current work was carried out at El-Karada Animal Production Research Station, belonging to Animal Production Research Institute, Agricultural research Center, Ministry of Agriculture in co-operation with Department of Animal Production, Faculty of Agriculture, Kafrelsheikh University.

Experimental animals:

Eighteen lactating Friesian cows with an average body weight of 534.44±13.04 kg, ranging from 450 to 660 kg, and average parity of 2.22±0.33; ranging from 1 to 5 were used during summer season from June to November 2011, for 150 days starting with one week after parturition. Animals were divided into three similar groups with six cows in each group based on body weight, milk production and parity.

Experimental rations:

All experimental animals were fed the basal ration consisted of 40% concentrate feed mixture (CFM) + 40% corn silage (CS) + 20% rice straw (RS) (on DM basis) without additive served as a control (group 1) or with 25 g premix / head / day (group 2) or with 50 g seaweed / head / day (group 3). Premix and seaweed additives are mixed with the ground concentrate feed mixture. The supplement seaweed meal produced by Crossgates Bioenergetics-Seaweeds Company, UK. Premix Hero-Mineral produced by Hero Pharm Company, Egypt.

Calculated chemical composition of feedstuffs of basal ration are presented in Table (1). Concentrate feed mixture consisted of 32% undecorticated cotton seed cake, 24% wheat bran, 22% yellow corn, 12% rice bran, 5% line seed cake, 3% molasses, 1% limestone and 1% common salt.

Animals management:

Animals were housed under asbestos sheds in semi-open backyards and were individually fed their rations to cover their recommended requirements according to **NRC (2001).** Concentrate feed mixture was offered in two equal parts daily at 8 a.m. and 4 p.m., corn silage was offered one time at 10 a.m. and rice straw was offered at 3 p.m. Premix or seaweed additives were added once to the ground concentrate feed mixture in the morning feeding. Animals watered in the mid day at 12 a.m. and left free in the backyards overnight.

Minerals metabolism:

Minerals metabolism was done within the digestibility trial. 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).

Hair samples:

Hair samples were collected at the end of the experiment from the upper right or lift chest cage for each cow, 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, then rinsed by distilled and boiled distilled water until both the filter and filtrate appeared clear and dry in hot oven at 60 ^oC for 48 hours.

Blood Samples:

Blood samples were taken at the same time of hair samples from the jugular vein of each cow by clean sterile needle in a clean dry plastic tubes using after 3 hours from the morning feeding and left in the refrigerator for two hours for the blood clot. Then centrifuged at 4000 rpm for 15 minutes to separate serum and stored at - 20 ^oC.

Milk samples:

Milk samples from consecutive evening and morning milkings were taken from each cow every day at the 4^{th} week of each period and mixed in proportion to milk yield.

Preparation of samples for minerals determination:

Wet ashing is primarily used in the preparation of 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, feces and hair and 1 ml from blood serum, milk and urine 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 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 **SPSS for windows (2008)** 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).**

Table 1: Calculated chemical composition of feedstuffs of basal ration.

Item	Concentrate feed mixture	Corn silage	Rice straw	Basal ration
DM %	90.45	28.15	89.76	47.93
Composition of DM %				
OM	89.02	94.45	83.93	89.78
CP	15.80	8.03	2.66	10.06
CF	8.93	22.17	37.88	20.02
EE	3.21	2.86	1.25	2.68
NFE	61.08	61.39	40.14	57.02
Ash	10.98	5.55	18.07	10.22

Result and Discussion

Minerals contents of feedstuffs and basal ration:

Minerals contents of feedstuffs and basal ration presented in Table (2) showed 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. Minerals calculated in basal ration showed that the contents of calcium, phosphorus, copper, zinc and manganese were lower than the recommended requirements of dairy cows being 0.60, 0.40%, 10, 40 and 40 ppm, respectively **(NRC, 2001).** So, feeding dairy cows on ration containing 40% concentrate feed mixture + 40% corn silage + 20% rice straw need to minerals additives, specially for calcium, phosphorus, copper, zinc and manganese. These results agreed with those obtained by **Gaafar (2009)** who found that feeding growing calves on ration containing corn silage need to minerals additive.

Minerals balance:

The effect of premix and seaweed additives on minerals balance by dairy cows are shown in Table (3). Minerals intake expressed as g or mg per day was nearly similar for the different groups except potassium and manganese. The intake of potassium and manganese were significantly higher (P<0.05) for seaweed group than those of control group, meantime the premix group was intermediate between them with insignificant differences. Macro-minerals excretion in feces (g/day) were significantly higher (P<0.05) for control group than those of seaweed group, meantime the premix group was intermediate between them with insignificant differences. While, micro-minerals excretion in feces (mg/day) were significantly higher (P<0.05) for control group than those of seaweed and premix groups. Minerals excretion in urine (g or mg/day) was nearly similar for the different groups except sodium and potassium, which urine the main route for sodium and potassium excretion. Sodium and potassium excretion in urine were significantly higher ($P<0.05$) for control group than those of seaweed group, meantime the premix group was intermediate between them with insignificant differences.

There were significant differences ($P<0.05$) in the apparent absorption and retention of different minerals expressed as g or mg per day, which the seaweed group showed significantly ($P<0.05$) the highest apparent absorption and retention of different minerals followed by premix group, while the control group had the lowest values. The improvement in minerals absorption and retention with seaweed might be attributed to that minerals were found in the organic forms (seaweed) which enhance their absorption and even improve their metabolic utilization **(Leeson, 2005),** while bioavailability of inorganic minerals of common feeds is not well characterized, and is affected by: intake level, feed type, variations of the same feed, and interactions between mineral, soil fertilization, method of analysis, etc. **(NRC, 2001, 2005).** The use of organic mineral sources can improve intestinal absorption of trace elements as they reduce interference from agents that form insoluble complexes with the ionic trace elements **(Van Der Klis and Kemme, 2002).**

Minerals in hair:

Hair analyses may help to detect severe deficiencies of some required minerals or exposure to some heavy metals. However, if hair analyses are to be conducted, care must be taken to compare values from test animals with those from animals of similar breed, sex, season, sire and color. **(Combs, *et al* 1982).**

Minerals contents in hair of dairy cows as affected by premix and seaweed additives are shown in Table (4). Seaweed group showed significantly ($P<0.05$) the highest minerals contents in hair followed by premix group, while the control group had the lowest contents. Moreover, the contents of calcium, phosphorus, copper, zinc and manganese in hair of cows in the control group were lower than the critical levels in black hair, being 2100, 200, 7, 115 and 12 ppm, respectively **(Anke, 1967).** These results may be due to the deficiency of these minerals in the control group than the recommended requirements as shown in Table (2). Furthermore, the increase minerals contents in hair of seaweed group than premix group may be attributed to increase the apparent minerals absorption and net retention in seaweed group than premix group as shown in Table (3). These results agreed with those obtained by **Gaafar (2009)** who found that minerals contents in hair increased with increasing dietary minerals intake and reflect the minerals deficiency in ration.

Table 2: Minerals contents of feedstuffs and basal ration.

Item	Concentrate feed mixture	Corn silage	Rice straw	Basal ration
Macro-minerals (%)				
Calcium (Ca)	0.96	0.27	0.21	0.53
Phosphorus (P)	0.63	0.21	0.12	0.36
Magnesium (Mg)	0.46	0.10	0.11	0.25
Sodium (Na)	0.76	0.13	0.24	0.40
Potassium (K)	1.32	1.15	0.69	1.13
Micro-minerals (ppm)				
Copper	12	6	4	8
Zinc	42	27	22	32
Manganese	49	15	52	36
Iron	461	247	343	352

Table 3: Effect of premix and seaweed additives on tested macro and micro-minerals balance by dairy cows.

Item	Macro-minerals (g/day)					Micro-minerals (mg/day)			
	Ca	**P**	**Mg**	**Na**	**K**	**Cu**	**Zn**	**Mn**	**Fe**
Intake									
Control	90.26	61.31	42.58	68.12	192.44^{b}	136.24	544.96	613.08^{b}	5994.60
Premix	91.16	61.95	43.08	68.52	193.57^{ab}	137.29	549.16	617.68^{ab}	6031.00
Seaweed	91.16	61.95	43.04	69.09	194.50^{a}	137.46	561.39	634.87^{a}	6080.20
SEM	0.43	0.29	0.20	0.33	0.90	0.63	3.45	4.28	29.27
Feces									
Control	51.17^{a}	33.93^{a}	22.75^{a}	9.41^{a}	29.08^{a}	76.42^{a}	296.53^{a}	350.27^{a}	3775.90^{a}
Premix	48.30^{ab}	32.05^{ab}	21.51^{ab}	8.20^{ab}	27.28^{ab}	71.99^{b}	279.30^{b}	329.86^{b}	3550.90^{b}
Seaweed	46.28^{b}	30.70^{b}	20.59^{b}	7.11^{b}	25.19^{b}	69.05^{b}	273.54^{b}	324.81^{b}	3429.60^{b}
SEM	0.83	0.55	0.36	0.34	0.65	1.24	4.24	4.86	59.60
Urine									
Control	18.98	11.30	8.16	38.47^{a}	111.83^{a}	27.43	107.52	127.01	1353.70
Premix	18.58	11.07	8.01	37.21^{ab}	108.50^{ab}	26.79	105.03	124.04	1320.20
Seaweed	18.05	10.75	7.77	36.55^{b}	106.68^{b}	26.06	104.31	123.86	1293.10
SEM	0.23	0.14	0.10	0.43	1.16	0.33	1.15	1.34	15.80
Absorption									
Control	39.09^{c}	27.38^{c}	19.83^{c}	58.70^{c}	163.36^{b}	59.82^{c}	248.43^{c}	262.81^{c}	2218.70^{c}
Premix	42.85^{b}	29.90^{b}	21.57^{b}	60.32^{b}	166.29^{ab}	65.30^{b}	269.86^{b}	287.52^{b}	2480.10^{b}
Seaweed	44.88^{a}	31.25^{a}	22.45^{a}	61.98^{a}	169.31^{a}	68.41^{a}	287.85^{a}	310.05^{a}	2650.60^{a}
SEM	0.85	0.57	0.38	0.52	1.01	1.26	5.70	6.83	63.01
Retention									
Control	20.12^{c}	16.08^{c}	11.67^{c}	20.23^{c}	51.53^{c}	32.39^{c}	140.91^{c}	135.80^{c}	865.00^{c}
Premix	24.28^{b}	18.83^{b}	13.56^{b}	23.11^{b}	57.79^{b}	38.51^{b}	164.82^{b}	163.78^{b}	1159.90^{b}
Seaweed	26.83^{a}	20.49^{a}	14.68^{a}	25.43^{a}	62.63^{a}	42.34^{a}	183.53^{a}	186.19^{a}	1357.50^{a}
SEM	1.00	0.66	0.45	0.76	1.65	1.48	6.27	7.43	73.81

a, b, c: values and means in the same row with different superscripts differ significantly (P<0.05).

Table 4: Effect of premix and seaweed additives on minerals contents in hair of dairy cows (ppm on DM basis).

Element	Treatments			SEM
	Control	**Premix**	**Seaweed**	
Macro-minerals				
Calcium (Ca)	1985.40^{c}	2150.65^{b}	2275.80^{a}	16.42
Phosphorus	187.20^{c}	218.35^{b}	241.60^{a}	5.45
Magnesium	1172.65^{c}	1254.30^{b}	1346.48^{a}	12.35
Sodium	1030.40^{b}	1205.20^{a}	1265.10^{a}	29.74
Potassium	3091.30^{b}	3615.50^{a}	3795.40^{a}	89.22
Micro-minerals				
Copper	6.67^{c}	7.55^{b}	8.16^{a}	0.82
Zinc	103.84^{c}	120.56^{b}	128.42^{a}	1.63
Manganese	10.78^{c}	13.16^{b}	14.76^{a}	0.41
Iron	34.62^{c}	38.94^{b}	41.37^{a}	0.67

a, b, c: values and means in the same row with different superscripts differ significantly (P<0.05).

Table 5: Effect of premix and seaweed additives on minerals concentrations in blood plasma of dairy cows.

Element	Treatments			SEM
	Control	Premix	Seaweed	
Macro-minerals (mg/100 ml)				
Calcium (Ca)	8.24^{c}	10.16^{b}	12.38^{a}	0.46
Phosphorus	6.65^{c}	8.20^{b}	9.62^{a}	0.27
Magnesium	2.89^{b}	3.27^{ab}	3.81^{a}	0.16
Sodium	342.04^{b}	378.42^{a}	395.47^{a}	7.30
Potassium	34.20^{c}	38.54^{b}	41.26^{a}	0.89
Micro-minerals (ug/100 ml)				
Copper	87.25^{c}	96.43^{b}	104.72^{a}	0.61
Zinc	91.56^{c}	98.65^{b}	105.84^{a}	0.74
Manganese	2.81^{c}	3.15^{b}	3.38^{a}	0.11
Iron	124.58^{c}	132.16^{b}	141.71^{a}	0.96

a, b, c: values and means in the same row with different superscripts differ significantly (P<0.05).

Table 6: Effect of premix and seaweed additives on minerals concentrations in milk of dairy cows.

Element	Treatments			SEM
	Control	Premix	Seaweed	
Macro-minerals (g/kg)				
Calcium (Ca)	1.09^{c}	1.25^{b}	1.37^{a}	0.17
Phosphorus	0.86^{c}	1.02^{b}	1.16^{a}	0.10
Magnesium	0.15^{b}	0.19^{ab}	0.22^{a}	0.03
Sodium	0.65^{c}	0.76^{b}	0.82^{a}	0.08
Potassium	1.54^{c}	1.76^{b}	1.89^{a}	0.14
Micro-minerals				
Copper	0.13^{b}	0.18^{ab}	0.21^{a}	0.02
Zinc	3.75^{c}	4.12^{b}	4.28^{a}	0.17
Manganese	0.026^{b}	0.032^{ab}	0.037^{a}	0.003
Iron	0.54^{b}	0.59^{ab}	0.63^{a}	0.02

a, b, c: values and means in the same row with different superscripts differ significantly (P<0.05).

Minerals in blood plasma:

The effect of premix and seaweed additives on minerals concentrations in blood plasma of dairy cows are shown in Table (5). Blood is sometime used to determine the adequacy or deficiency of mineral compound in the ration. There were significant differences (P<0.05) in minerals concentrations among the different groups, which seaweed group showed significantly (P<0.05) the highest minerals concentrations in blood plasma followed by premix group, while the control group had the lowest contents. Moreover, the concentrations of calcium, phosphorus, copper, zinc and manganese in plasma of cows in the control group were lower than the normal levels in plasma, being 9, 7.5 mg/100 ml, 90, 95 and 3 ug/100 ml, respectively **(Herdt *et al.*, 2000 and NRC, 2001).** These results revealed the deficiency of these minerals in the control group than the recommended requirements as shown in Table (2).

Furthermore, the increase minerals concentrations in plasma of seaweed group than premix group may be attributed to increase the apparent minerals absorption and retention in seaweed group than premix group as shown in Table (3). These results agreed with those obtained by **Khan (1995)** who reported that blood mineral status in cattle depend upon the daily mineral intake through feed, a part from nonnutritional factor such as season, age, weight, pregnancy and lactation. **Knowlton and Herbein (2002)** found that minerals concentrations in blood plasma of cattle increased with increasing dietary minerals intake.

Minerals in milk:

The effect of premix and seaweed additives on minerals contents in milk of dairy cows are shown in Table (6). Seaweed group showed significantly (P<0.05) increases of minerals contents in milk followed by premix group, while the control group had the lowest contents. Moreover, the contents of calcium, phosphorus, copper, zinc and manganese in milk of cows in the control group were lower than the normal levels in milk, being 1.2, 0.95 g, 0.13, 3.90 and 0.022 mg/ kg milk, respectively (. These results revealed the deficiency of these minerals in the control group than the recommended requirements as shown in Table (2). Furthermore, the increase minerals contents in milk of seaweed group than premix group may be attributed to increase the apparent minerals absorption and retention in seaweed group than premix group as shown in Table (3). 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.

From these results it could be concluded that feeding dairy cows on ration containing 40% concentrate feed mixture + 40% corn silage + 20% rice straw need to minerals additives, specially 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.

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