Assay of Blood Mineral Profiles of Dairy Cows at Various Physiological Status, Seasons and Production Systems in Two Districts of East Shoa Zone, Oromia Region, Ethiopia

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ABSTRACT

This study was conducted in East Shoa Zone, Oromia Region, Ethiopia, to determine serum minerals of dairy cows at different season. The mineral assessed were Calcium (Ca), Magnesium (Mg), Phosphorus (P), Iron (Fe), Copper (Cu), Cobalt (Co) and Zinc (Zn). The district and the production systems were selected purposively. A total of two hundred forty blood samples were collected. Blood serum was collected, digested and analyzed for minerals, using Atomic Absorption Spectrophotometer and Photoelectric colorimeter. The mean serum calcium level was 0.080 vs 0.082g/L for lactating and 0.090, vs 0.081gm/L for dry cows in both seasons, in Ada’a and Adama district, which was mean serum calcium level was very close to critical level (CL) or said to borderline. The mean serum phosphorus was 0.037vs 0.039 g/L for lactating and 0.038 vs 0.037 gm/L for dry cows in both season in study districts. In general, in addition to Ca limited number of dairy cows were deficient for P, Cu and Co. The difference in mean serum magnesium was significant (P<0.05) by production system, physiological state of the animals with seasons. Similarly, the difference in serum copper level was statistically significant (p<0.05) based on physiology of cows, production system and season. Iron serum concentration showed a significant difference (P< 0.05) by season, physiology and production system. In case of Zinc and cobalt serum concentration showed a significant difference (p<0.05) between production system, physiological state and season. It could be concluded that in the study area most serum minerals of dairy cows were either below the critical level or very near to the critical level. The variation in serum level of measured mineral was also significant in many cases. Therefore, it is necessary to supplement these deficient minerals to the ration of dairy cows to improve production, productivity, health and reproduction efficiency.

Key words: Dairy cows, Districts, East Shoa Zone, Ethiopia, Photoelectric colorimeter, Serum mineral

INTRODUCTION

Dairy farming is a livelihood rehearsal that people contribute in for home consumption and proceeds generation in Ethiopia. Nevertheless, in both urban and rural dairy production systems, cost and availability of animal feed and health are often challenging. One of the major problems often associated with cattle nutrition in Ethiopia and elsewhere in the tropics is a mineral shortage (McDowell and Arthington, 2005). Every single living cell in the body depends upon minerals for the suitable structure and functions of the organism. Minerals, unlike other nutrients, cannot be synthesized in living things. Minerals act as structural components of body organs and tissues, constituents of blood fluids and tissues as electrolytes and catalysts in enzyme and hormone systems (Underwood, 1981).

In order to maintain efficient production and normal health of animals, it is necessary to deliver essential minerals, protein and energy. Minerals play a vital role in the production and health of the animals. It is also essential to have a proper ratio of these minerals in the feeds and animal body because an improper ratio between these minerals interferes with the absorption of another one thereby resulting in a deficiency. Moreover, dairy animals commonly suffer from nutritional deficiencies due to high production and deficient feeding ultimately leading to poor reproductive performance.

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In the tropics, it was found that mineral deficiency or imbalances lead to poor production, decreased immunity and reproduction problems among grazing ruminants (Sharma et al., 2002a; Kumar et al., 2005b). Complex inter-relationships exist between certain micronutrients, immune function and disease resistance in cattle (Prasad and Gowda, 2005). Mineral supplementations are known to improve feed intake and digestibility of feeds resulting in increased dairy animal performance. Animal mineral feed mixture supplementation is essential where the dietary
concentrations are highly inconsistent due to seasonal variation, location and forage species and in increased demands such as lactation, pregnancy and rapid growth (Tashi et al., 2005).

In Ethiopia in general and in study area in particular, there is a gap between the total number of dairy animals and per head production and productivity of dairy animals. One of the main reasons for this low productivity might be mineral nutrient deficiency and unbalanced feeding. There was also no previous study on dairy feed mineral contents and mineral status of blood in dairy cattle in the study area. The present investigation was undertaken to assess serum level of some selected minerals in crossbred dairy cows and to evaluate the effect of season and location on serum level of these minerals in urban and peri-urban production systems of Ad’a and Adama districts of Oromia region, Ethiopia.

**MATERIALS AND METHODS**

**Description of the study area**

The study was conducted in urban and peri-urban production systems of Ad’a and Adama districts in East Shoa Zone. The study zone extends between 7°33’50”N-9°08’56” N and 38°24’10”E-40° 05’34”E with a total area of approximately 10241 km². Ad’a district is located at 08°442 E latitude and 38°582 N longitude with an altitudinal range of 1540-3100 m a. s. l. (AWAO 2009). The largest portion (95%) of the district has mid highland agro-climate and the remaining portion (5%) has highland agro-climate. Mean annual temperatures range from about 8°C to 28°C (Alemayehu et al., 2012). Adama district is located at 8°33’35”N-8°36’46” N latitude and 39°11’57” E - 39°21’15” E longitude about 99 km Southeast of Addis Ababa (CSA 2005). It is situated at an altitude ranging from 1400 to 2700 m. a. s. l. The area receives an average annual rainfall ranging from about 600 to 1150 mm, which is erratic in nature. There is a significant seasonal variation for rainfall. More than 67% of the mean annual rainfall occurs in the four rainy (Wet) months: June, July, August and September (ADARDO 2013). Some additional rains (about 23%) occur in the remaining dry months with mean monthly values of rainfall as low as zero millimetres. The minimum and maximum daily temperatures of the area are 12 and 33°C, respectively (NMSA, 2013).

**Study animals and sample size determination**

The multistage sampling method was employed to select the study sample units, which were expected to be representative of the whole population, found in the study area. The sampling frame comprises those farmers keeping crossbred dairy cows and willing to participate in the study. A total of 240 households were included in the study according to the formula given by (Arsham (2002). Among those representative households a total of (60) farm households were purposively selected in each season (dry and wet) to attain each farm households consisted of two dairy cows each (one lactating and the other dry cow) which have a total of 240 (120 each season) cows that were one dry pregnant (8-9 months of pregnancy) and one lactating cow (30-105 days after birth/early lactation period). Sampling dairy cows were Holstein dairy cows (4-6 years old) both lactating and dry dairy cows from urban and peri-urban areas of Ad’a and Adama districts. Therefore, districts and kebeles in each urban and peri-urban study area were selected purposively based on the concentration of dairy farms and the willingness of farmers. Blood was collected once in a dry season and the other in the wet season. In general, 120 blood samples were collected in the dry season (from January to February/2017) and the other 120 blood samples were collected in the wet season (from July to August/2017). Data collection was held from January to August/2017.

**Blood collection, serum separation and mineral analysis**

About 10 ml of blood was collected from the jugular vein in a sterile vacutainer test tube without anti-coagulant (Charles and Fredeen, 1999). The test tubes containing blood samples were transported to the laboratory and kept for 2 to 3 hrs (Herdt et al., 2000) in a slanting position at room temperature without disturbing the tubes and were centrifuged (at 3000 rpm for 10 min). Then 2 ml serum was collected into cryovials and stored in a deep freezer (-20°C) until processed. The blood samples were collected from urban and peri-urban farms of respective districts.

**Digestion of serum**

The serum samples were digested as per the procedure described by Kolmer et al. (1951). Briefly, 3 ml of serum was mixed with 3ml of concentrated HNO₃ in the tube. The mixtures were kept overnight at room temperature and digested by heat at a temperature of 70-80°C until the volume of samples was reduced to about 1 ml. Then, 3 ml of the double acid mixture (3 part concentrated HNO₃ and 1 part 70% HClO₄) was added and low heat digestion continued until the digested samples became clear and emitted white fumes. The addition of 3 ml double acid mixture followed by low heat digestion was repeated a couple of times. Further heating was continued to reduce the volume to approximately 0.5 ml. The final volume of the filtrate was made up to 10 ml with triple distilled deionized water after luke warming the solution (Kolmer et al., 1951).

While digesting of the serum samples, simultaneous digestion of reagent blank was undertaken and the final volume was similarly made up to 10 ml to have blank. All glassware and microwave vessels were pre-rinsed with diluted HNO₃. Quality control programs were used throughout mineral analyses. All the samples were analyzed for calcium (Ca), phosphorus (P), magnesium (Mg), copper (Cu), zinc (Zn), iron (Fe), cobalt (Co), using Inductively Coupled Plasma-Optical Emission Spectroscopy, Agilent Technologies 200 series AA. Phosphorus concentration in serum samples (Fiske and Subbarow, 1925) was determined with photoelectric colorimeter, based on UV-end point method using phosphorus reagent and standard, which
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Table 1: Serum Macro minerals (g/l) level in lactating and dry cow in Ada’a and Adama zuria districts.

| Macro minerals | Season | Phys. status | Location | Overall mean | P-value | Phy.status |
|----------------|--------|--------------|----------|--------------|---------|------------|
|                |        |              | Ada’a    | Urban        | Peri-urban | Mean       | Adama       | Urban        | Peri-urban | Mean       | P-value | Phy. status |
| Ca             | dry    | Lactating    | 0.073±0.002 | 0.084±0.002 | 0.079±0.002 | 0.078±0.002 | 0.083±0.002 | 0.081±0.002 | 0.080±0.002 | 0.084±0.002 | 0.4282   |
|                |        | Dry cow      | 0.087±0.002 | 0.083±0.002 | 0.085±0.002 | 0.103±0.002 | 0.085±0.002 | 0.094±0.002 | 0.090±0.002 | 0.090±0.002 |          |
|                |        | Mean         | 0.080±0.002 | 0.084±0.002 | 0.082±0.002 | 0.091±0.002 | 0.084±0.002 | 0.088±0.002 | 0.085±0.002 | 0.085±0.002 |          |
| Wet            |        | Lactating    | 0.080±0.002 | 0.078±0.002 | 0.079±0.002 | 0.085±0.002 | 0.082±0.002 | 0.084±0.002 | 0.082±0.002 | 0.085±0.002 | 0.5375   |
|                |        | Dry cow      | 0.085±0.002 | 0.081±0.002 | 0.083±0.002 | 0.078±0.002 | 0.077±0.002 | 0.078±0.002 | 0.078±0.002 | 0.078±0.002 |          |
|                |        | Mean         | 0.083±0.002 | 0.080±0.002 | 0.081±0.002 | 0.082±0.002 | 0.080±0.002 | 0.081±0.002 | 0.081±0.002 | 0.081±0.002 |          |
| Seasonal p-value |      |              | 0.1468 | 0.1711 | 0.1468 | 0.1711 |          |          |          |          |          |
| Production system p-value | |              | 0.1771 |          | 0.1771 |          |          |          |          |          |          |
| P              | dry    | Lactating    | 0.038±0.001 | 0.037±0.001 | 0.038±0.001 | 0.033±0.001 | 0.037±0.001 | 0.035±0.001 | 0.037±0.001 | 0.037±0.001 | <0.001   |
|                |        | Dry cow      | 0.035±0.001 | 0.030±0.001 | 0.033±0.001 | 0.038±0.001 | 0.042±0.001 | 0.040±0.001 | 0.038±0.001 | 0.038±0.001 |          |
|                |        | Mean         | 0.037±0.001 | 0.034±0.001 | 0.036±0.001 | 0.036±0.001 | 0.041±0.001 | 0.038±0.001 | 0.037±0.001 | 0.037±0.001 |          |
| Wet            |        | Lactating    | 0.041±0.001 | 0.041±0.001 | 0.041±0.001 | 0.039±0.001 | 0.034±0.001 | 0.037±0.001 | 0.039±0.001 | 0.039±0.001 | <0.001   |
|                |        | Dry cow      | 0.039±0.001 | 0.043±0.001 | 0.041±0.001 | 0.031±0.001 | 0.034±0.001 | 0.033±0.001 | 0.037±0.001 | 0.037±0.001 |          |
|                |        | Mean         | 0.040±0.001 | 0.042±0.001 | 0.041±0.001 | 0.035±0.001 | 0.034±0.001 | 0.035±0.001 | 0.038±0.001 | 0.038±0.001 |          |
| Seasonal p-value |      |              | 0.1771 |          | 0.1771 |          |          |          |          |          |          |
| Production system p-value | |              | 0.1633 |          | 0.1633 |          |          |          |          |          |          |
| Mg             | dry    | Lactating    | 0.150±0.001 | 0.140±0.001 | 0.145±0.001 | 0.110±0.001 | 0.081±0.001 | 0.095±0.001 | 0.121±0.001 | 0.12±0.001 | <0.001   |
|                |        | Dry cow      | 0.161±0.001 | 0.141±0.001 | 0.150±0.001 | 0.110±0.001 | 0.110±0.001 | 0.110±0.001 | 0.130±0.001 | 0.130±0.001 |          |
|                |        | Mean         | 0.155±0.001 | 0.141±0.001 | 0.148±0.001 | 0.110±0.001 | 0.095±0.001 | 0.103±0.001 | 0.126±0.001 | 0.126±0.001 |          |
| Wet            |        | Lactating    | 0.160±0.001 | 0.161±0.001 | 0.160±0.001 | 0.120±0.001 | 0.090±0.001 | 0.105±0.001 | 0.133±0.001 | 0.133±0.001 | <0.001   |
|                |        | Dry cow      | 0.180±0.001 | 0.160±0.001 | 0.170±0.001 | 0.120±0.001 | 0.120±0.001 | 0.120±0.001 | 0.12±0.001 | 0.145±0.001 |          |
|                |        | Mean         | 0.170±0.001 | 0.160±0.001 | 0.165±0.001 | 0.120±0.001 | 0.105±0.001 | 0.113±0.001 | 0.139±0.001 | 0.139±0.001 |          |
| Seasonal p-value |      |              | <0.001 |          | <0.001 |          |          |          |          |          |          |
| Production system p-value | |              | <0.001<0.001 |          | <0.001<0.001 |          |          |          |          |          |          |

Critical level = is concentrations below which animals are deficient. (Ca<0.08g/l=8mg/dl, P<0.04g/l=4mg/dl, Mg<0.012g/l=1.2mg/dl), adapted from (Miles and McDowell, 1983). Ca=calcium; P=phosphorus; Mg=magnesium; value without superscript =indicated not significantly different; Means with the same superscript in the same column (a, b) and row(xy) are not significantly different; phys.state= physiological state.
zinc in Ada’a urban was higher than the peri-urban, on the contrary in Adama districts the mean value in urban was lower than the peri-urban. In the study area the mean value between districts, physiological status of dairy cows and seasons were significantly different (P< 0.05), whereas, between production systems have not significantly different (P>0.05) as indicated in Table 2. However, based on their critical level (<0.6 ppm) in all cases the value was below the critical level of all variables as shown in Table 2.

The overall mean serum copper level was 0.52±0.01 and 0.60±0.01 respectively for lactating and dry cow in dry season. In wet season the overall mean serum copper level was 0.56±0.01 and 0.55±0.01 respectively for lactating and dry cows. The details of serum copper level in each district, management type and cow physiology were indicated in Table 2. Overall percentage of Ca deficiency based on the critical level of Cu (79.54, 54.62%); (79.23, 49.35%) for lactating cows and (57.62, 67.87%); (67.62, 59.39%) for dry cow were deficient in Cu.

The mean values for Co concentration in serum of dairy cows is given in (Table 2). Overall serum Co concentration throughout the study area, was not detected from serum samples Moreover, it was indicated that based on their critical level (< 0.1 ppm) in all cases, the value was below the critical level of all variables.

The deficiency/imbalance of minerals have a significant effect on health and productivity of livestock (Aregheore et al., 2007; Gonul et al., 2009). Dairy cows age can affect mineral requirement through changes in efficiency of absorption. Animals that are most susceptible to trace element deficiencies are young growing animals and animals during their first pregnancy and lactation (Khan et al., 2003). Mineral insufficiencies in livestock are frequently based on season, in dry season feeds are deficient in most minerals. Moreover, mineral demands significant increased as the result of pregnancy, lactation or prompt growth of animals which is predisposed for deficiency of minerals, when animals accessed only in grazing pasture (Tashi et al., 2005). Moreover, during wet season, high content of energy and protein in forage results in more weight gain in cattle thereby increasing the need for mineral supplementation (McDowell et al., 1983).

In the present study, overall mean serum calcium concentrations in animals at different physiological status in Ada’a and Adama district of the study area were very near to borderline serum calcium concentrations or critical level <0.08 g/l (Miles and McDonald, 1983). However, when individual dairy cows of mean serum Ca level in the study area were compared to critical value some dairy animals said to be deficient.

The mean serum Ca level was higher for Peri-urban dairy animals than Urban in Ada’a district during dry season. However, for Adama districts, serum Ca level was higher for urban than Peri-urban dairy animals in dry season. Similarly, in wet season mean serum Ca level was higher for Peri-urban animals than urban dairy animals in Ada’a district. These differences in plasma Ca values could be due to variations in feed sources (McDowell, 2003). Most of the animals in the peri-urban were free grazing compared to zero grazing animals in urban. Similarly, the present study revealed that serum Ca concentrations were slightly lower in lactating cows compared to their counterpart dry/ non-lactating cows. The lower serum levels of Ca in lactating cattle might be due to high demand of absorbed Ca per liter of milk produced. As per NRC (2001), lactating cattle needs 1.37 g of Ca/kg of milk produced in addition to maintenance requirement. If the Ca plasma/serum levels decline may occur severe enough to produce specific deficiency syndrome i.e. milk fever characterized by circulatory collapse and depressed consciousness (Radostitis et al., 2007). Moreover, this study revealed that the mean serum Ca was lower in dry season than wet/rainy season, which disagree with the report of Khan (2003). This might be due to feed shortage in dry season and higher passage of Ca into milk aggravate the condition. In other case the current study in line with the study of (Chhabra, 2006) who indicated that higher plasma Ca levels had been reported in dairy animals in wet season (8.25 mgdl-1= 0.0825gm/l) than in dry season (7.99 mgdl-1=0.0799gm/l).

Phosphorus (P) is a very essential mineral for the dairy animals. Apart from an important component of skeleton, P is involved in every metabolic reaction in the body including muscle, energy, carbohydrate, amino acid, fat, nerve tissue and nucleic acid metabolism (Rosol and Capen 1997; Peterson and Beede, 2002).

The mean serum P in all physiological groups of cows was below the critical value in this study. The current results were in agreement with various studies reported from East African (Khailii et al., 1993a; Abdelrahman et al., 1998; Tsegahun et al., 2006; McDonald et al., 2011). Those authors reported that East African forages were known to be low in Na and P and it causes the most common nutritional problems in livestock. In the rainy season, cows and calves of both local breeds and crossbreeds were found to suffer mainly from P deficiency. Moreover, Khailii et al. (1993a) suggested that P absorption might also be reduced due to higher Ca or Fe intake. Over Ca intake reduces the efficiency of absorption of P in the digestive tract by decreasing the solubility of P (NRC, 2001). Moreover, molybdenum reduces P absorption at the intestinal level and increases urinary P excretion leading to lowering of P contents in dairy animals (Radostitis et al., 2007). Therefore, deficiency of P is the most prevalent mineral deficiency of livestock throughout the world (McDowell 2003).

The P deficiency results in reduced growth, decreased appetite, impaired reproduction and weak fragile bone (NRC, 2001). Therefore, considerable attention should be given to P when supplementation of feeds is used.

The serum magnesium concentrations in the different physiological status of both districts were found to be above its critical level (<0.012 g/l). The current study was in agreement with Tiwary et al. (2007), who reported that serum
Table 2: Blood serum micro minerals (ppm) level of different categories of cow in Ada'a and Adama Zuria.

| Location          | Season | Phys. state | Cu dry  | Cu lactating | Mean | Cu dry  | Cu lactating | mean |
|-------------------|--------|-------------|---------|--------------|------|---------|--------------|------|
| Ada’a             | Urban  | Lactating   | 0.64±0.010 | 0.49±0.010 | 0.59±0.010 | 0.61±0.010 | 0.59±0.010 | 0.60±0.010 |<0.001|
|                   | Peri-urban | Lactating | 0.64±0.010 | 0.49±0.010 | 0.59±0.010 | 0.61±0.010 | 0.59±0.010 | 0.60±0.010 |<0.001|
| Adama Zuria       | Urban  | Lactating   | 0.64±0.010 | 0.49±0.010 | 0.59±0.010 | 0.61±0.010 | 0.59±0.010 | 0.60±0.010 |<0.001|
|                   | Peri-urban | Lactating | 0.64±0.010 | 0.49±0.010 | 0.59±0.010 | 0.61±0.010 | 0.59±0.010 | 0.60±0.010 |<0.001|
| Overall Mean      |        |             | 0.64±0.010 | 0.49±0.010 | 0.59±0.010 | 0.61±0.010 | 0.59±0.010 | 0.60±0.010 |<0.001|

| Location          | Season | Phys. state | Fe dry  | Fe lactating | Mean | Fe dry  | Fe lactating | Mean |
|-------------------|--------|-------------|---------|--------------|------|---------|--------------|------|
| Ada’a             | Urban  | Lactating   | 2.28±0.05 | 2.31±0.05 | 2.30±0.05 | 2.32±0.05 | 2.31±0.05 | 2.31±0.05 |<0.001|
|                   | Peri-urban | Lactating | 2.28±0.05 | 2.31±0.05 | 2.30±0.05 | 2.32±0.05 | 2.31±0.05 | 2.31±0.05 |<0.001|
| Adama Zuria       | Urban  | Lactating   | 2.28±0.05 | 2.31±0.05 | 2.30±0.05 | 2.32±0.05 | 2.31±0.05 | 2.31±0.05 |<0.001|
|                   | Peri-urban | Lactating | 2.28±0.05 | 2.31±0.05 | 2.30±0.05 | 2.32±0.05 | 2.31±0.05 | 2.31±0.05 |<0.001|
| Overall Mean      |        |             | 2.28±0.05 | 2.31±0.05 | 2.30±0.05 | 2.32±0.05 | 2.31±0.05 | 2.31±0.05 |<0.001|

| Location          | Season | Phys. state | Zn dry  | Zn lactating | Mean | Zn dry  | Zn lactating | Mean |
|-------------------|--------|-------------|---------|--------------|------|---------|--------------|------|
| Ada’a             | Urban  | Lactating   | 2.04±0.03 | 2.15±0.03 | 2.09±0.03 | 2.15±0.03 | 2.13±0.03 | 2.14±0.03 |<0.001|
|                   | Peri-urban | Lactating | 2.04±0.03 | 2.15±0.03 | 2.09±0.03 | 2.15±0.03 | 2.13±0.03 | 2.14±0.03 |<0.001|
| Adama Zuria       | Urban  | Lactating   | 2.04±0.03 | 2.15±0.03 | 2.09±0.03 | 2.15±0.03 | 2.13±0.03 | 2.14±0.03 |<0.001|
|                   | Peri-urban | Lactating | 2.04±0.03 | 2.15±0.03 | 2.09±0.03 | 2.15±0.03 | 2.13±0.03 | 2.14±0.03 |<0.001|
| Overall Mean      |        |             | 2.04±0.03 | 2.15±0.03 | 2.09±0.03 | 2.15±0.03 | 2.13±0.03 | 2.14±0.03 |<0.001|

| Location          | Season | Phys. state | Co dry  | Co lactating | Mean | Co dry  | Co lactating | Mean |
|-------------------|--------|-------------|---------|--------------|------|---------|--------------|------|
| Ada’a             | Urban  | Lactating   | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 |<0.001|
|                   | Peri-urban | Lactating | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 |<0.001|
| Adama Zuria       | Urban  | Lactating   | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 |<0.001|
|                   | Peri-urban | Lactating | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 |<0.001|
| Overall Mean      |        |             | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 | 0.11±0.02 | 0.06±0.02 |<0.001|

Critical level (Cu<0.65ppm, Fe<1.0ppm, Zn<0.6ppm), Co<0.1ppm; adapted from (Miles and McDowell, 1983). Cu=copper; Fe=iron; Zn=zinc; cobalt; ND= not detected; value without superscript =indicated not significantly different; Means with the same superscript in the same column (a, b) and row (x,y) are not significantly different; physiology-state.
Critical level based some of deficient macro and micro mineral status of dairy cow in the study area.

Table 4: Critical level based of some deficient macro and micro mineral status of dairy cow in the study area.

| Mineral | Phys. state | Adama Urban % | Adama Peri-urban % | Critical Level |
|---------|-------------|----------------|-------------------|---------------|
| Ca      | Lactating   | 76.66          | 23.34             | <0.08g/l      |
| P       | Lactating   | 50.77          | 49.23             | <0.04g/l      |
| cu      | Lactating   | 20.46          | 79.54             | <0.65ppm      |
| Co      | Lactating   | -              | 100               | <0.1ppm       |

Critical level (Ca<0.08g/l=8mg/dl, P<0.04g/l=4mg/dl, P<Cu<0.65ppm, Fe<1.0ppm, Zn<0.6ppm), Co<0.1ppm; adapte from (Miles and McDowell, 2003a); cu=copper; Fe=Iron; Zn=zinc; co= cobalt; phys, state=physiological state.

magnesium concentration in animals was above the critical level. The current research result disagrees with the report of Radostits et al. (2007), who indicated that lower plasma Mg status of animals during winter season could be due to forage quality and intake of this forage by the animals can lead to the development of hypomagnesemia. Moreover, according to Dua and Care (1995), the dietary Mg availability to livestock is markedly affected by other minerals in the diet, especially potassium and nitrogen will inhibit Mg absorption from the rumen.

The overall mean serum copper concentration was below the critical value in in the majority of dry and lactating dairy cows in study area. This findings was in agreement with the report of Sharma et al. (2003a) and Tiwary et al. (2007) who indicated that animals are deficient in Cu, this might be due to several factors such as less availability of copper in feeds and fodder and decreased gut absorption as well as increased excretion of copper (Mc Dowell, 1985; Sharma and Joshi, 2004). Moreover, copper deficiency may also due to high intake of soluble protein from fresh pasture, which increase the amount of sulfide production in the rumen, which resulting in unavailable copper sulfide (McDowell and Conrad, 1990). Likewise, the current result in agreement with the report of Tapiwa (2012) who reported that the concentration of Cu was higher in the dry season than in wet season. This might be due to the high leaching and/or absorption of Cu by plants during wet season. Furthermore, Campbell et al. (1974), also suggested that a high level of iron over an extended periods has an influence on copper availability.

In present study, the overall mean Fe serum concentration was higher than the critical level given by Miles and McDonald (1983), in dry and lactating dairy cows, in both seasons in the study area. The current result in line with the report of Lemma et al. (2002); McDowell (2003) indicated that deficiency of Fe in ruminants is uncommon under normal feeding conditions, but may occur in the animals fed on poor quality roughages like straw for extended periods of time might be due to the abundance of iron in soil as well as in animal feeds. Generally, adequate Fe levels in pasture, forage contamination from soil or direct soil intake provide excess dietary Fe to the animals.

The mean serum zinc concentration was found above its critical level (<0.6 ppm), suggested by Miles and McDonald (1983) in present study. The results of the present study were in agreement with the findings of Tiwary et al. (2007) and Shukla et al. (2006) indicated that dairy feed contained adequate zinc level to meet dairy cows’
requirements. Plasma zinc concentrations normally decrease in dairy cows at calving, but usually return to normal within 3 days (Sharma and Joshi, 2004).

The overall mean serum cobalt was below the critical value (<0.1ppm) suggested by Miles and McDonald (1983) in both lactating and dry dairy cows as well as in both districts. The deficiency in serum cobalt was even severe in Adama zuria compared to Ad’a district. Cobalt deficiency is the most severe mineral limitation to grazing livestock in tropical countries (McDowell and Conrad, 1990) and also deficiency of cobalt due to dairy cows feed and/or in the soils.

CONCLUSION AND RECOMMENDATION

The present study was carried out with the objective to know the status of selected macro and micro-minerals in the serum/blood/ profile of dairy cows. Assessment of serum minerals profile of dry and lactating cows in two production systems (urban and peri-urban) of Ad’a and Adama districts depends on dry and wet was performed. Subsequently, collected serum samples were subjected to laboratory analyses to determine selected major macro and micro mineral concentration levels. Milk production is very low due to nutrition deficiencies together with mineral imbalances. The concept of supplementation of the mineral mixture was not a common practice, though done occasionally in semi-organized dairy farms in the different production systems. The results obtained in this study clearly indicated that there were some minerals below the critical level or borderline in the area particularly Ca, P, Cu and Co while the level of Fe and Mg seemed to be above the critical level (adequate) in their blood serum.

Therefore, attention should be given to correct the deficient minerals especially Ca, P, Cu and Co as these minerals are either below the critical level (categorized into deficient) or borderline minerals from blood serum in the study area. In general, the effect of minerals deficiency should be evaluated upon the productivity of dairy animals to come up with an applicable recommendation. Any feeding system based on mineral supplementation for dairy animals by formulating area specific mineral mixture, having highly bio-available mineral salts. Deficient trace minerals, except Co, may be supplemented in the form of chelates, for better production, reproductive efficiency and productive life of dairy cows.

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Conflict of Interest

The authors affirm that there is no conflict of interest in the work described.

REFERENCES

Abdelrahman, M.M, Kincaid, R.L. and Elzubeir, E.A. (1998). Mineral deficiencies in grazing dairy cattle in Kordofan and Darfur regions in Western Sudan. Tropical Animal Health and Production, 30:123-135.

Alemayehu N, Hoekstra D and Tegegne A (2012). Smallholder Dairy Value Chain Development: The Case of Ada’a Woreda, Oromia Region, Ethiopia. Nairobi: ILRI.

ADARDO (Ada District Agricultural and Rural Development Office) (2013). Ada’a District Agricultural and Rural Development Office Annual Activity Report. Unpublished Document, Bishoftu.

Arsham H (2002), Descriptive sampling data analysis. Statistical thinking for managerial decision making.

Areghore, E.M., Hunter, D., Perera, D., Mautoataisi, M.T. (2007). The soil-plant- animal phenomena: Serum mineral status of Fuji fantastic sheep grazing Bali grass (Lechameum aristatum Var. indicum) and Pangola grass (Digitaria decumbens) in Samoa. J. Anim. Vet. Adv. 6: 349-357.

AWAO (Ada’a Woreda Agricultural Organization) (2009). Ada’a Woreda Agricultural Organization: Unpublished Annual Report on Socio-economy of Ada’a District, Ada’a.

Campbell, D.A., Ikuegbu, O.A., Owen, E. and Little, D.A. (1974). The response of supplementation of cobalt, copper, manganese and zinc in white Fulani cattle under agro-pastoral management in northern Nigeria. Tropical Animal Health and Production. 28(2): 183-190.

Charles, B.B. and Fredeen, K.J. (1999). Concepts, instrumentation and techniques in Inductively Coupled Plasma Optical Emission Spectrometry. 2nd Edition, The Perkin Elmer Corporation, Norwalk, U.S.A.

Chhabra S. (2006). Studies on mineral imbalances in dairy animals with special references to copper, manganese and iodine status in Punjab. Ph.D.

CSA (Central Statistics Authority) (2007). Summary and Statistical Report of the 2007 Population and Housing Census. Addis Ababa.

CSA (Central Statistical Authority) (2005). Federal Democratic Republic of Ethiopia Agricultural sample survey. Livestock and livestock characteristics bulletin, Volume II. Addis Ababa, Ethiopia.

Dua, K. and Care, A.D. (1995). Impaired absorption of magnesium in the etiology of grass tetany. British Veterinary Journal. 151: 413-26.

Fiske, C. H. and Sub borr ow, T. (1925). Determination of phosphorus. Journal of Biology and Chemistry. 66: 375.

Gonul R, Kayar A, Bilal T, Erman ORM, Parkan DVM, Dodurka HT, Gulyasar T, Barutcu B (2009). Comparison of mineral levels in bone and blood serum of cattle in Northwestern Turkey. Journal of Animal and Veterinary Advance. 8: 1263-1267.

Herdt, T.H., Rumbelhe W, and Brasilton, W.E. (2000). The use of blood analyses to evaluate mineral status in livestock. Vet. Clin. North Am. Journal Food Animal Practice. 16: 423-444.
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Khalili M, Lindgren E, Varvikko T. (1993a). A survey of mineral status of soils, feeds and cattle in the Selale Ethiopian highlands. Swedish University of Agricultural Sciences, Uppsala, Sweden.

Khan ZL. (2003). Effect of seasonal variation on the availability of macro and micronutrients to animals (sheep and goats) through forage from soil. Ph.D. thesis submitted to University of Agriculture, Faisalabad. p. 286.

Kolmer, J.A., Spaulding, E.H and Robinson, H.W. (1951). Approved laboratory technique. Appleton Century Crofts, New York., pp 1090-1091.

Kumar, P., Sharma, M.C., Joshi, C. and Saxena, N (2005b). Micro-minerals deficiency in buffaloes in two districts of Lucknow region and its effect on serum vitamin A and E. Ind. Vet. J. 82: 964-966.

Lemma, G., Adane, H., Fikadu, J. and G.N. Smit (2002). Mineral element status of soils, native pastures and cattle blood serum in the mid-altitude of western Ethiopia. African Journal of Range and Forage Science. 19(3): 147-155.

McDonald P., Edwards R.A., Greenhalgh J.F.D., Morgan C.A., Sinclair I.A., Wilkinson R.G. (2011). Animal Nutrition 7th ed. Pearson Education Limited.

McDowell, L.R. and Arthington, J.D. (2005). Minerals for Grazing Ruminants in Tropical Regions. Extension Bulletin. Animal Science Department, University of Florida, USA.

McDowell, L.R. (2003). Minerals in animals and human nutrition. 2nd Ed. Elsevier Science BV. Amsterdam, The Netherlands.

McDowell, L.R., Conrad, J.H., Ellis, G.L. and Loosli, L.K. (1983). Minerals for Grazing Ruminants in Tropical Regions. Extension Bulletin 1149 (Animal Science Department, University of Florida: Gainesville).

Miles, W.H. and McDowell, L.R. (1983). Mineral deficiency in the llanos ranges. World Animal Review. 46: 2-10.

NMSA (2010). National Meteorological Services Agency of Adama Station; unpublished data.

NRC (Nutrient Requirements of Dairy Cattle), (2001). Seventh Revised Edition. National Academy Press. Washington, D.C, USA.

Peterson, A.B., Beede, D.K. (2002). Periparturient responses of multiparous Holstein cows to varying prepartum dietary phosphorus. J. Dairy Sci. 85 (Suppl. 1), 187.

Prasad, C.S. and Gowda, N.K.S. (2005). Dietary level and plasma concentration of micro-nutrients in crossbred dairy cows fed finger millet and rice straw as a dry roughage source. Indian Journal of Dairy Science. 58: 109-12.

Radostits, O. M Gay, C.G Hinecliff, K. Wand Constable, P.P. (2007). Veterinary medicine. A 148 Text book of the disease of, Cattle, Horses, Sheep, Pig and Goats 10th edition, W.B. Saunders, 149 Elsevier publication.

Rosol, T.J. and Capen. C.C. (1997). Calcium regulating hormones and diseases of abnormal mineral metabolism. In: Clinical Biochemistry of Domestic Animals. [Kaneko, J.J, Harvey, J.W. and Bruss, M.C. (ed)]. Harcourt Brace and Co. Asia Pvt. Ltd., Singapore. pp 819-87.

Sharma, M.C. and Joshi, C. (2002a). Serum mineral and haematocrit biochemical profile of microfilarial infected cattle and its effects on production andtherpy. Asian Australasian J. Anim. Sci. 15: 357-365.

Sharma, M.C., Joshi, C. and Gupta, S. (2003a). Prevalence of mineral deficiency in soil, plants and cattle in certain districts of Uttar Pradesh. Indian Journal of Veterinary Medicine. 23 (1): 4-8.

Sharma, M.C. and Joshi, C., (2004). Soil, fodder and serum micro-mineral status and haematocrit biochemical profile in cattle of Garhwal region of Uttaranchal. Indian Journal of Animal Sciences. 74(7): 775-779.

Shukla, S. (2006). Studies on mineral profile in feeds, soil and animals in Pithoragarh district of Uttaranchal. M.V.Sc. Thesis (Animal Nutrition) G. B. Pant University of Agriculture and Technology, Pantanagar, India.

Standing Committee on Agriculture (SCA), (1990). Feeding Standards for Australian Livestock. Ruminants. CSIRO: East Melbourne.

Tapiwa, L. (2012). The effect of soil and plant seasonal mineral Variations on goat plasma mineral status in siavonga District of southern province of Zambia. MSc. thesis Lusaka, Zambia.

Tashi, N., Xugang, L., Shunxiang, Y. and Judson, G. (2005). A survey of the mineral status of livestock in the Tibet Autonomous Region of China. ACIAR working Paper No. 59.

Tiwary, M.K., Tiwari, D.P., Kumar Anil and Mondal, B.C. (2007). Macro and micro mineral profile in soil feeds and animals in Haridwar district of Uttarakhand. Animal Nutrition and Feed Technology. 7(2): 187-196.

Tsegahun A., Chairatanayuth P., Vijchulata P., Tudsri S. (2006). Macro mineral status of feds in the central and western parts of Ethiopia. Kasetsart Journal Natural Science. 40 (2): 410-419.

Underwood, E.J. (1981). The Mineral Nutrition of Livestock. Common wealth Agriculture Bureux, London, England.