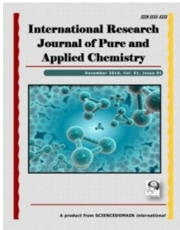

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Manganese and Magnesium Status of Forage Grasses, and It's Implications for Grazing Animals, Dareta Village, Zamfara, Nigeria

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Authors' contributions

This work was done in collaboration between all authors. Author UUU designed the work. Authors UUU, MA, AHJ and BG handled sample collection. All authors took part in sample preparation and analysis. Authors AMS, HAM and OS managed the literature searches. The statistical analysis was performed by author UUU. Authors MOO, UUU, BG and AHJ wrote the protocol, and wrote the first draft. All authors read and approved the final manuscript.

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ABSTRACT

Forage mineral concentration is of considerable importance to livestock production. High concentrations of lead in the soil environment causes imbalance of mineral nutrients in growing plants. In most cases lead blocks the entry of cations (potassium, Calcium, Magnesium, Manganese, Zinc, Copper, and iron) and anions (NO_3^-) in the root system. The elevated levels of lead in soil and pastures reported in Zamfara, following mass acute lead poisoning crisis in the Northern Nigerian state informed this study. The forage concentrations of Manganese and Magnesium were investigated with respect to the nutrient requirement of the grazing ruminants in Dareta village. The analysis was carried out using Atomic Absorption Spectrophotometer (AAS) while method validation was achieved using reference material, Lichen (IAEA-336). Based on the data recorded, it was concluded that the concentration of these two minerals varied among different

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pastures. The difference was statistically significant at 95% confidence level. Manganese concentration in the forage ranged from 2.89mg/kg to 137.00mg/kg dry weight in different pastures and Magnesium from 22.84mg/kg to 62.59mg /kg dry weight. The concentration of Manganese and Magnesium determined in this study are significantly lower than their recommended minimum concentrations (critical levels) in pasture for grazing animals. The implications of these findings for grazing animals are fully discussed.

Keywords: Forage; mineral concentration; grazing ruminants; nutrient requirement; Dareta village.

1. INTRODUCTION

The nutrition of grazing animals is a complicated interaction of soil, plant, and animal. Plants are the main source of food for the animals. Forage plants absorb most of the minerals and heavy metals from the soil and polluted air [1]. These substances are most often transferred to grazing animals and subsequently to man along the food chain. All soils contain varying concentrations of metals depending on the type of parent material from which the soil was formed, presence of metals in the environment, and soil chemical characteristics [2,3]. Heavy metals may be added to pasture soils through agricultural, industrial and mining activities. The availability of metals to plants is high in acidic soils; Uptake of metals in plants is regulated by pH, particle size and cation exchange capacity of the soils and, other physico-chemical parameters [1].

Plants require essential nutrients for normal functioning and growth. A plant's sufficiency range is defined as the range of nutrient necessary to meet the plant's nutritional needs and maximize growth. Nutrient levels outside of a plant's sufficiency range will cause overall crop growth and health to decline due to either a deficiency or toxicity [4]. Nutrient deficiency occurs when an essential nutrient is not available in sufficient quantity to meet the requirements of a growing plant. Scarcity of these elements may cause metabolic disorders and/or deficiency diseases. The severity of such deficiency diseases depends greatly on the degree and duration of the deficiency and on the maturity of the plant [5,1]. Toxicity occurs when a nutrient is in excess of plant needs and decreases plant growth or quality [4]. Animals also require trace elements for good health and many of these can become toxic if ingested in excess. The supply of most metals slightly exceeding the optimal level causes considerable toxicity to animals. Heavy metal pollution is posing a serious problem world over, threatening the animal and human health, and quality of environment. It is potentially dangerous because of bio-accumulation along the food chain. The toxicity level varies widely depending largely on specie, breed, elements, and interactions with other elements. Forage grasses are an important source of feed stuff for ruminants. Grazing livestock are expected to acquire the majority of required nutrients from forage. Their growth and health are considerably affected due to malnutrition or toxic sis depending on the concentration of trace minerals in feed. There are many diseases and abnormalities that are associated with mineral deficiencies and heavy metal toxicity [1]. The Concentration of a metal may affect the level of other metals in plant or animal tissues; elevated levels of lead for instance, interfered with normal copper and Zinc absorption [6,7].

High concentrations of lead in the soil environment causes imbalance of mineral nutrients in growing plants. In most cases lead blocks the entry of cations (potassium, Calcium, Magnesium, Manganese, Zinc, Copper, and iron) and anions (NO_3^-) in the root system [1]. Elevated levels of lead in pastures also interfere with normal magnesium and manganese absorption by grazing animals [8]. Mass acute lead poisoning crisis was reported in zamfara, Nigeria in 2010 [9,10,11,12]. The source was traced to environmental exposure to lead resulting from artisanal gold mining and associated processing of the lead-rich ore. Grinding of the rocks into find particles in the grinding mills scattered round the villages resulted in the dispersal of Lead dust [11,13]. Dareta village is one of such mining fields and perhaps the most troubling of all the villages with lead levels sometimes exceeding 60,000mg/kg, whereas the US EPA guideline for lead in soil is 400mg/kg [11,13]. This study was undertaken to assess manganese and magnesium content of forage grasses and its implications for grazing animals in Dareta Village, considering the importance of manganese in livestock fertility and in development of young ruminants, and the danger associated with gross tetany occasioned by magnesium deficiency.

2. MATERIALS AND METHODS

2.1 Sampling

Five feeding sites or pastures where cattle, goats and sheep are grazed freely around Dareta village in Anka Local Government Area of Zamfara state, Nigeria were selected for the study. The pastures or feeding sites were designated as sampling stations; 1, 2, 3, 4, and 5 respectively. Grazing animals were followed and forage samples corresponding to those consumed by the ruminants were harvested 5cm from the ground. Forage grasses were harvested from three different points per sampling station. A total of fifteen samples were collected, stored in polyethylene bags and transported to the environmental technology division, National Research Institute for Chemical Technology, Zaria-Nigeria for preparation and analysis.

2.2 Sample Preparation

Samples from each point in the sampling stations were cut into small pieces, air dried for 5 days in the laboratory and thoroughly mixed together. The samples were pulverized and passed through 1 mm sieve. Digestion of these samples (1g each) was carried out using 5 ml of concentrated nitric acid, according to Awofolu [14].

2.3 Metal Analysis

Metal analysis was carried out using flame atomic absorption spectrophotometer AA-6800 (Shimadzu, Japan) at National Research Institute for Chemical Technology (NARICT), Zaria-Nigeria. The calibration curves were prepared separately for each of the metals by running different concentrations of standard solutions. The instrument was set to zero by running the respective reagent blanks. Average values of three replicates were taken for each determination and were subjected to statistical analysis. The metals determined includes, manganese and magnesium.

2.4 Data Analysis

Data collected were subjected to statistical tests of significance using the analysis of variance (ANOVA) to assess significant variation in the concentration levels of the heavy metals in forage grasses across the five sampling stations. Probabilities less than 0.05 ($p < 0.05$) were considered statistically significant. Correlation coefficient was used to determine the association between the two heavy metals in the samples at $\alpha = 0.05$. All statistical analyses were done by SPSS software 17.0 for windows.

2.5 Analytical Quality Assurance

In order to check the reliability of the analytical methods employed for heavy metals determination, Lichens coded IAEA-336 was also digested and then analyzed following the same procedure.

3. RESULTS AND DISCUSSION

To evaluate the accuracy and precision of our analytical procedure, a standard reference material of lichen coded IAEA-336 was analyzed in like manner to our samples. The values determined and the certified values of the elements determined were very close suggesting the reliability of the method employed (Table 1).

Table 1. Shows the results of analysis of reference material (Lichen IAEA -336) compare to the reference value

Element (Mg/l)	Pb	Cd	Cu	Mn	Zn
A Value	5.25	0.140	4.00	55.78	29.18
R value	4.2-5.5	0.1-2.34	3.1- 4.1	56-70	37-33.80

The mean levels, range and standard deviation of manganese and magnesium in forage grasses across the five sampling stations are presented in table 2. The distributions of each metal across the five sampling stations are presented in figure 1 and figure 2. In the study magnesium content in forage was found to be higher than manganese. Statistical analysis revealed a negative correlation between the two elements. The correlation was statistically significant at 99% confidence level indicting that different sources are responsible for their presence at the concentrations determined.

Table 2. Mean ± S.D, and Range of magnesium and manganese in forage grasses across the sampling stations, Dareta village, Nigeria

Element	Sampling stations	Mean ± S.D	Range
Magnesium	1	26.95±4.16	22.84-31.16
	2	43.03±2.17	40.86-45.20
	3	33.86±8.19	25.67-42.05
	4	27.18±2.42	24.76-29.60
	5	55.78±6.81	48.97-62.59
Manganese	1	135.36±1.84	133.36-137.00
	2	12.18±3.92	8.28-16.12
	3	23.88±7.54	16.38-31.46
	4	46.23±7.59	38.64-53.82
	5	3.31±0.43	2.89-3.74

Manganese concentration in forage grasses ranged from 2.89mg/kg dry weight in sampling station 5 to 137.00mg/kg dry weight in sampling station 1. The mean manganese level across the sampling station showed the trend: station 1 > station 4 > station 3 > station 2 > station 5 (Table 2, Fig. 1). The highest concentration of 137.00mg/kg was recorded in station 1, the lowest concentration of 2.89mg/kg at station 5. The mean values were as follows: 135.36±1.84mg/kg, 12.18±3.92mg/kg, 23.88±7.54mg/kg, 46.23±7.59mg/kg, 3.13±0.43mg/kg for station 1, station 3, station 4, station 2 and station 5 respectively (table 2, figure 1). The difference in forage manganese concentration across the sampling stations was statistically significant (ANOVA $P < 0.05$). Station 1 was significantly higher than stations 2, 3, 4 and 5. Station 2 was significantly lower than stations 1, 3, and 4. The difference between station 2 and station 5 was not statistically significant at 95% confidence level. Station 3 was significantly lower than stations 1 and 4 but higher than stations 2 and 5. Station 4 was significantly higher than stations 2, 3 and 5 while station 5 was significantly lower than stations 1, 2, 3, and 4. The differences were significant at 95% confidence level. The results of statistical analysis also revealed positive correlations between all the stations. The correlation between station 2 and station 3, station 2 and station 4, station 2 and station 5, station 3 and station 4 and that between station 3 and station 5 were statistically significant at 99% confidence level while the correlation between station 4 and station 5 was significant at 95% confidence level. The result thus suggests that, same source is responsible for the presence of manganese at the concentration determined at the stations mentioned. The correlation between station 1 and station 2, station 1 and station 3, station 1 and station 4 and that between station 1 and station 5 were not statistically significant.

Manganese is an essential trace nutrient required for a normal plant and animal growth. Trace minerals are those that are required only in extremely small amounts, required concentrations are generally expressed in parts per million (ppm), rather than percent [15,16]. In plants, manganese is involved in chlorophyll synthesis and the activity of oxidase enzymes. Concentrations of manganese required for optimal growth of pasture species are in general higher than the dietary requirements of animals. Manganese deficiency in grazing animals is therefore a rare occurrence [17]. Manganese concentrations in forage are generally adequate but are variable, depending on the availability of manganese because of soil pH and soil drainage. The manganese concentration in the diet provides the most useful means of detecting deficiency in animals. The manganese concentration in blood declines in animals fed low manganese diets [17]. Manganese is required for normal estrus and ovulation in cows and for normal libido and spermatogenesis in bulls. Manganese is essential for bone formation and growth. Manganese is important to the functions of the immune system. It is needed for normal brain and muscle function as well as building bones, blood clotting, cholesterol synthesis, fat synthesis and DNA and RNA synthesis [1,18]. Manganese is a component of many enzymes and also activates a number of other enzymes [19].

Forage Manganese levels above 40 mg/kg (the critical level) are considered adequate to meet the requirements of grazing livestock. All the samples analyzed from the three sampling points in sampling station 1 and two out of three sampling points in sampling station 4 indicated manganese level within the acceptable range (above 40mg/kg which is the critical level and less than 1000mg/kg dry matter). The maximum tolerable concentration of manganese in the diets for various livestock forms is set at 1,000 mg Mn/kg (ppm) diet dry matter. Manganese toxicity is a significant problem for both plants and animals [20,1,18]. Sampling stations 2, 3 and 5 recorded manganese concentration below the critical level. This implies that animals grazed at these pastures without manganese supplement in diet will be exposed to manganese deficiency. Signs of manganese deficiency are skeletal abnormalities in young animals and, in older animals, low reproductive performance resulting from depressed or irregular estrus, low conception rate, abortion, stillbirths, and low birth weights [20]. Manganese sulphate top-dressing at 15 kg/ha has been used effectively to overcome a manganese deficiency in plants. Supplementation of the feed with manganese sulphate will prevent manganese deficiency in animals [1]. Higher mean values of 215±29mg/kg, 193.80±18.68mg/kg, 157.60±17.51 and 153.43±18.13mg/kg were reported for November, December, January and February respectively at a rural livestock farm in Sargodha, Pakistan [21]. A mean value of 75.5ppm was reported in New Mexico forage mineral survey [22]. A range of 5.136mg/kg to 12.442mg/kg and 23.26 to 24.18 were reported for Sargodha Pakistan [1,23].

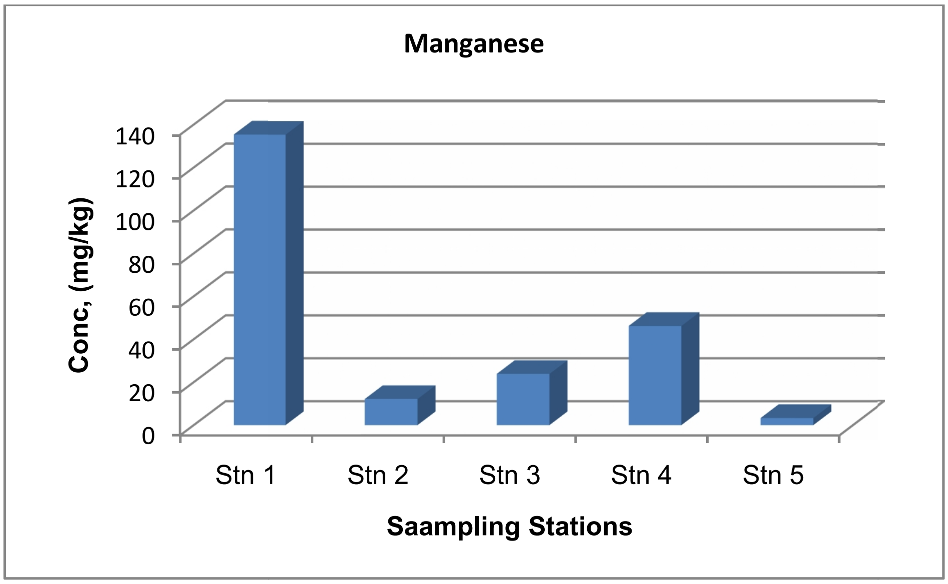

Fig. 1. Distribution of Manganese concentration in forage grasses across five sampling stations, Dareta village, Anka, Nigeria

Magnesium was detected in the following order across the sampling stations: station 5 > station 2 > station 3 > station 4 > station 1. The concentration ranged between 22.84mg/kg and 62.59mg/kg. The highest concentration of 62.59mg/Kg was recorded in station 5, the lowest concentration of 22.84mg/kg at station 1. The mean forage magnesium levels were as follows: 26.95±4.16mg/kg, 43.03±2.17mg/kg, 33.86±8.19mg/kg, 27.18±2.42mg/kg, 55.78±6.81mg/kg for station 1, station 2, station 3, station 4 and station 5 respectively (table 2, figure 2). The difference in magnesium concentration in forage grasses across the sampling stations was statistically significant (ANOVA $P < 0.05$). Station 5 was significantly higher than station 1, station 2, station 3, and station 4. Station 2 was significantly higher than station 1 and station 4. The results of statistical analysis also reveal a positive correlation between station 1 and station 2, station1 and station 5, station 2 and station 5, and between station 3 and station 4 suggesting same source is responsible for its presence at the concentration determined in the study. The correlation between station 1 and station 2, and that between station 1 and station 5 were statistically significant at 95% confidence level while the correlations between station 2 and station 5, and between stations 3 and station 4 were significant at 99% confidence level. The correlations between station 2 and station 4, and between station 2 and station 5 were statistically significant at 99% confidence level. A negative correlation was observed between station 1 and station 3, station 1 and station 4, station 2 and station 3, station 2 and station 4, station 3 and station 5 and between station 4 and station 5 suggesting different sources. The correlations were statistically significant at 99% confidence level, except the correlation between station 1 and station 3 and between station 1 and station 4 that were statistically significant at 95% confidence level.

Magnesium is a macro element essentially required for a normal plant and animal growth. Magnesium is essential for many plant functions. It is the central element of the chlorophyll molecule, therefore play significant role in photosynthesis. It is both an enzyme activator and a constituent of many enzymes, Magnesium is involve in Sugar synthesis, Starch translocation, Plant oil and fat formation, Nutrient uptake control, Increase Iron utilization and nitrogen fixation in legume nodules [24]. Ingested forage is the main source of magnesium for grazing livestock. Magnesium enables livestock nervous and skeletal system to function properly. It is essential in energy metabolism, transmission of the genetic code, membrane transport, and nerve impulse transmissions [15,24]. Failure of forage to transfer enough magnesium to the animal results in grass tetany. The type of soil is important to the level of magnesium in forages. Uptake of magnesium in grasses differs from place to place depending on soil type and is affected by the level of exchangeable Magnesium present in the root zone and the amount of other cations [1]. The more basic the soil, the higher the magnesium absorption by the plant will be [1]. The dietary magnesium requirements of livestock vary with the species and breed of animals, age and rate of growth or production and with biological availability in the diet.

Grass tetany (hypomagnesemia or low blood magnesium) is a metabolic disorder of ruminants associated with low blood serum Mg levels. Grass tetany is a major health problem of cattle and sheep in temperate climates [24]. Low blood magnesium can be due to low levels of magnesium in forage grasses, but it also is caused by mineral imbalances. High concentrations of lead in the soil environment causes imbalance of mineral nutrients in growing plants. Nutrient imbalances can also be as a result of high potassium and nitrogen or low calcium, sodium, and phosphorous [1]. These nutrients are able to interact and tie up Magnesium in the soil, lowering their availability in the forage [25]. Magnesium concentration in blood plasma does not fall until there is a severe deficiency. An excess or a lack of Magnesium is immediately reflected in a higher or lower daily excretion of Magnesium in urine. Hence, daily urinary excretion is considered a good criterion for the assessment of Magnesium supply. Magnesium in urine more than 10.0 mg/100 ml is considered adequate, 2.0 - 10.0 mg/100 ml is considered inadequate and less than 2.0 mg/100 ml is considered severe deficiency- danger of tetany. A rough assessment of supply can be obtained from the content of Magnesium in pasture. Minimum needs of sheep and cattle for growth can generally be met by pastures or rations containing 0.10% [1,18, 24]. Magnesium deficiencies that affect forage dry matter production are not common since critical Mg concentrations are low (0.10%) for most plants.

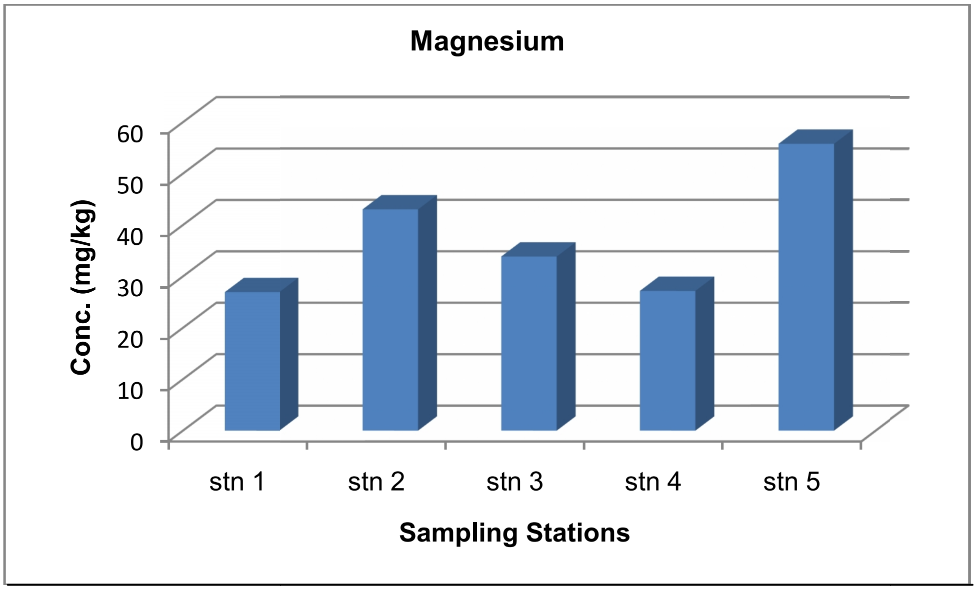

Fig. 2. Distribution of Magnesium concentration in forage grasses across five sampling stations, Dareta village, Anka, Nigeria

The recommended minimum magnesium concentrations in pasture dry matter for grazing cattle and sheep is 1.5g/kg and 1.0g/kg respectively [17]. These amounts represent the average requirements for growth, pregnancy or lactation, in grazing livestock. The forage magnesium concentrations recorded in this study across the five natural pastures (table 2) were lower than the recommended minimum magnesium concentrations for grazing livestock. This implies that animals grazed at these pasture without magnesium supplement in diet will be exposed to magnesium deficiency. Symptoms of magnesium deficiency include; nervousness, reduced feed intake, muscular twitching, uncoordination, salivation and excitability. In advanced stages of magnesium deficiency, convulsions occur, the animal cannot stand, and death soon follows [15,20,26]. The maximum tolerable concentration of magnesium has been estimated at 0.40% diet dry matter. Forage Magnesium values recorded in this study were lower than the average concentration and range (0.09%; 0.03-0.36%)) reported by Mathis and Sawyer [22] in New Mexico forage mineral survey.

4. CONCLUSION

The results of the present investigation clearly depict that forage manganese and magnesium levels varied greatly across the natural grazing pastures studied in Dareta village. The difference for each metal across the grazing pastures was statistically significant at 95% confidence level. The concentration of Manganese and Magnesium determined were significantly lower than their recommended minimum concentrations (critical levels) in pasture for grazing animals. So, the grazing animals at this location need continued mineral supplementation of manganese and magnesium to prevent diseases caused by manganese and magnesium deficiency, and to support optimum animal productivity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kafeel A, Zafar IK, Yousuf R, Muhammad S, Muhammad KM, Rab N, Muneeba S, Nickel FM. Lead and manganese content of forages irrigated with different sewage water treatments: A case study of a semiarid region (Sargodha) in Pakistan, Agricultural Sciences. 2013;4:(4):180-184.
2. De Matos AT, Fontes MPF, Da Costa LM, Martinez MA, Mobility of Heavy Metals As Related to Soil Chemical and Mineralogical Characteristics of Brazilian Soils. Environm. Pollution. 2001;111:429.
3. Ajorlo M, Ramdzani BA, Ahmad HM, Ridzwan AH, Mohd KY, How Cattle Grazing Influences Heavy Metal Concentrations in Tropical Pasture Soils, Polish J. of Environ. Stud. 2010;19:(6):1369-1375.
4. McCauley A. Plant Nutrient Functions and Deficiency and Toxicity Symptoms, Nutrient management module 9, Montana state university; 2009.
5. Hays VW, Swenson MJ. Minerals and bones. 10th Edition, Dukes' Physiology of Domestic Animals. 1985;449-466.
6. Ogundiran MB, Ogundele DT, Afolayan PG, Osibanjo O. Heavy Metals Levels in Forage Grasses, Leachate and Lactating Cows Reared around Lead Slag Dumpsites in Nigeria, Int. J. Environ. Res. 2012;6(3):695-702,
7. Nwude DO, Okoye PC, Babayemi JO. Assessment of accumulation of heavy metals in the kidney of cattle as a function of seasonal variation. Africa Journal of Animal and Biomedical Sciences. 2010;5(3)1-8.ISSN:1819-4214.
8. Udiba Udiba U., Hassan Diya'uddeen B , Odey Michael O, Bashir Inuwa, Lasisi Aisha, Ade-Ajayi, Ade-Bola F, Ezike Nkechi N, Umar Shittu M, Toxicological implications of grazing on forage grasses in Dareta Village, Zamfara, Nigeria, Archives of Applied Science Research. 2013;5(3):220-228.
9. Gale Encyclopedia of Children's Health. , Heavy metal poisoning, The Gale Group, Inc.; 2006.
10. Udiba UU, Ogabiela EE, Hammuel C. Magomya AM, Yebpella GG, Ade-Ajayi AF, Odey MO, Gauje B. Post Remediation Assessment of Contaminants levels in soil, Dareta Village, Zamfara, Nigeria. Journal of Trends in Advanced Science and Engineering, TASE. 2012;4(1):70-79.
11. UNICEF Programme Cooperation Agreement, Environmental Remediation – Lead Poisoning in Zamfara FINAL REPORT September 2010 – March 2011.
12. Telmer Kevin, Assessment of the Artisanal and Small Scale Gold Mining in Anka and Bukkuyum LGAs, Zamfara State, Nigeria, Artisanal Gold Council; 2011.
13. Joint UNEP/OCHA Environment Unit, Lead Pollution and Poisoning Crisis, Environmental Emergency Response Mission, Zamfara State, Nigeria; 2010.

14. Awofolu OR. A survey of Trace metals in vegetation, soil and lower animals along some selected major and Roads in metropolitan city of Lagos. Environmental monitoring and Assessment. 2005;105:431-447.
15. Lalman D, Casey McMurphy. Vitamins and mineral Nutrition of Grazing Cattle, Oklahoma Cooperative Extension Service, Oklahoma State University. 2009.E-861.
16. Sauchelli V. Trace Elements in Agriculture. Van No strand, New York. (All Trace Els); 1969.
17. Underwood EJ. The Mineral Nutrition of Livestock, 2nd edn. Commonwealth Agricultural Bureaux, Farnham Royal, Slough, England; 1981.
18. Manske LL, Mineral Requirements for Beef Cows Grazing Native Rangeland, North Dakota State University Dickinson Research Extension Center, 2002. Annual Report.
19. Arizmendi-Maldonado D, McDowell LR, Sinclair TR, Mislevy P, Martin FG, Wilkinson NS Mineral concentrations in four tropical forages as affected by increasing daylength. II. Micro minerals. Communica- tions in Soil Science and Plant Analysis. 2001-2009:33. Doi:10.1081/CSS-120004838. 2001.
20. NRC. Nutrient requirements of beef cattle. 7th Edition, National Academy Press, Washington DC. 1996.
21. Fardous A, Kafeel A, Sumaira G, Zafar IK, Abid E, Ehsan EV, Assesment Of Iron, Cobalt And Manganese In Soil And Forage: A Case Study At A Rural Livestock Farm In Sargodha, Pakistan, Pak. J. Bot. 2011;43(3):1463-1465.
22. Mathis CP, JE Sawyer, New Mexico Forage Mineral Survey, Proceedings, Western Section, American Society of Animal Science. 2004;(55).
23. Kafeel AA, Ejaz ZI. Khan S, Gondal A, Fardous A, Hussain M, Sher EE. Valeem S. Ullah, Evaluation of Dynamics of Iron And Manganese from Pasture to Buffaloes: A Case Study at Rural Livestock Farms, Pak. J. Bot. 2010;42(5):3415-3421.
24. Sigel H, Astrid Sigel. Metal Ions in Biological Systems, Marcel Dekker, INC New York and Basel. 1990;(26).
25. Lemus R, Daniel Rivera. Spring Grazing and Grass Tetany in Beef Cattle Production Forage News Feb., Missisipi state university; 2009.
26. Church DC, Pond WG. Basic animal nutrition and feeding. O & B Books, Corvallis; 1975.

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