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https://dx.doi.org/10.4314/nvj.v38i4.1 **ORIGINAL ARTICLE**

Survey of Trace Elements and Some Heavy Metals in Goats in Zaria and its Environs, Kaduna State

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SUMMARY

The aim of this study was to determine the trace minerals in the serum of goats in Zaria and its environs, and to find out the levels of lead and cadmium in the serum of these goats, so as to see if they can serve as biomonitors of pollution. A total of 120 goats were sampled from eight different locations randomly and their serum assayed for trace elements, lead and cadmium using the atomic absorption spectrometry (AAS). The values obtained were: lead 0.259 ± 0.470mg/L, cadmium 0.006 ± 0.004 mg/L, chromium 0.072 ± 0.064 mg/L, copper 0.089 ± 0.060 mg/L, iron 0.229 ± 0.180 mg/L, zinc 0.256 ± 0.266 mg/L, nickel 0.127 ± 0.086 mg/L, cobalt 0.135 ± 0.095 mg/L, manganese 0.042 ± 0.031 mg/L. Lead was above acceptable levels, cadmium was at acceptable levels, zinc, copper, iron and nickel were deficient, chromium was marginally deficient, while cobalt and manganese were normal. The effects of breed, sex, age and locations were generally not significant. The values obtained from lead is of public health significance, since these goats are sources of food to people in the immediate environment, and also this implies that people in the immediate environment are also exposed to the same sources of lead. There should be regular seromonitoring of blood lead levels in man and animals, and farmers should be enlightened on the need to augment the feeding of their animal with mineral supplements.

Key words: Heavy metal; trace element; goat; lead; seromonitoring.

INTRODUCTION

There is a growing interest in the role played by micronutrients (essential trace elements and vitamins) in optimizing health and in prevention or treatment of diseases. Trace elements such as manganese (Mn), copper (Cu), iron (Fe), selenium (Se) and zinc (Zn) are essential in animal nutrition and are needed in very small amounts for essential metabolic reactions in the body (Tajik *et al*., 2010). Numerous factors affect mineral requirements for ruminants including sex, mineral level, age, status and chemical form of elements, interrelationship with other nutrients, level of mineral intake, breed, adaptation and productivity. While the deficiency or excess of one or a few elements damages normal bodily functions, imbalance among elements impairs the regular function of organism (Çamaş *et al*., 1994). It has been reported that trace elements are of equal importance as hormone and vitamins and have an impact in all climatic zones (Or *et al*., 2005). It is also been pointed out that losses caused by the effects of trace elements are as important as the losses incurred as a result of infectious and parasitic diseases (Çamaş *et al*., 1994), because trace elements have a significant impact on resistance against diseases in living organisms.

There is an increasing trend in livestock farming in the tropics towards intensive and semi-intensive production systems (Devendra and Mcleroy, 1982). Hence for this to be achieved by farmers, a greater attention must be given to the nutritional status of the animals. Deficiency of these trace elements causes severe economic loss due to increased susceptibility to oxidative stress, growth retardation in young animals, anemia (Bureau *et al*., 2008), decrease in feed efficiency and fertility (Grenier *et al*., 2003), enhance the virulence of the infectious agent (Failla, 2008) and decrease immune system function (Rink and Ibs, 2003 and Knutson and Wessling-Resnick, 2003). These deficiencies affect animal performance (McDowell, 2003).

Animals being biomonitors of the environment, values of lead and cadmium detected from such animals would indicate possibilities of pollution of the environment by these metals. Although lead and cadmium are metals with no apparent biological function, they have been reported to inhibit the absorption of other minerals and may indirectly be the cause of some mineral deficiencies (Erdogan *et al*., 2005). In addition they also have deleterious effects on animals and humans living within that same environment where exposure to the same levels may occur and that these animals also serve as food to man thus complicating the human risk of poisoning.

The assessment of trace element is therefore, done to determine the presence or prevalence of nutrient deficiencies (or toxicities) within a population. There is paucity of information on the concentration of trace elements in ruminants especially goats in Zaria and other northern parts of Nigeria. The study aims to investigate the concentrations of some trace elements in goats kept in households in Zaria, Kaduna State, Nigeria and to use the goats as biomonitors of the environment for lead and cadmium toxicity.

MATERIALS AND METHODS

Study area

The investigative study was carried out in Zaria (11°10'N, 07° 38'E) located in Kaduna State, Nigeria. Zaria is a medium sized city with an estimated population of 1,500,000. It has a tropical climate with a mean total annual rainfall of approximately 1100mm and lies in the natural vegetation zone known as the Northern Guinea Savannah that is primarily wood land (Aliyu and Muazu, 2009). Soils in Zaria mostly belong to the class of leached ferruginous tropical soils whose material consists of several feet deposited silt and sand overlying sedimentary decomposed rock (Chuo, 2008).

Sampling

A total of 120 apparently healthy goats were randomly sampled in Zaria and her environs. Fifteen goats were sampled from 8 locations, namely: Shika, Samaru, Kongo, Bassawa village, Kwangila, Sabon-gari, Zaria city and Wusasa.

Five (5) ml of blood was collected from each goat through the jugular vein into test tubes and allowed to clot. After which it was centrifuged at 1242 x g for 5minutes and the serum decanted into plain plastic test tube and labeled. The sex, age and breed of the goats were also recorded.

Wet Digestion of the Serum Sample

Wet digestion was carried out on the serum sample according to the method described by Bhatti *et al*. (2006). Briefly, add to 0.5 ml of serum in a 50 ml conical flask, 5 mls of nitric acid and heat for 20 minutes until yellow fumes disappeared. After cooling for 30 minutes 2.5 mls of perchloric acid was added and the mixture heated until it becomes colourless. The heated sample was diluted by adding 20 mls of distilled water and filtered into 100 ml plain plastic bottle. The sample was now ready for analysis and was then analysed using an Atomic Absorption Spectrophotometer (AAS) Unicam 969.

Data Analysis

The data obtained were expressed as mean ± SD and was further subjected to Student's T-test, One Way Analysis of Variance (ANOVA) by Tukey's post-hoc test. Values of $P < 0.05$ were considered significant.

RESULTS

Kano Brown had a higher value of lead than the Sokoto Red goats but this difference was found to be not statistically significant. The males had a higher value for lead than the females and this difference was also not statistically significant ($P > 0.05$). Of the different age group the 2 year olds had the highest values for lead followed by the 4 year old group, then the one year old and the lowest values were obtained in the 3 year old groups. The values did not show any regular pattern with age (Table I, II, III & IV).

The cadmium values obtained from the Sokoto Red goats were higher than the values obtained from the Kano Brown goats but these value were not statistically significant ($P > 0.05$). The values obtained from the female goats were higher than the male goats but also was not statistically significant ($P > 0.05$).

For the values of cadmium by age, the two year olds had the highest values while the one year olds had the lowest values. The value for the 2 years olds was not statistically different ($P > 0.05$) from the other values. This showed that the effect of age was not significant.

The Sokoto Red goats had a higher value for chromium than the Kano Brown goats but this difference was not statistically significant ($P > 0.05$). The female goats also had a higher value for chromium that males but this also was not significant ($P > 0.05$). One year olds had the highest values followed by the three year olds, four year olds with the 2 year old having the lowest values these findings were not statistically significant ($P > 0.05$).

Kano brown goats had a higher value for copper than the Sokoto Red goats and this was not statistically significant ($P > 0.05$). The females had a higher value than the males and this finding was not statistically significant. One year olds had the highest values for copper followed by 3 year olds, 2 year old with the 4 year olds having the lowest, but these values were not significant ($P > 0.05$).

Sokoto Red goats had a higher value for iron than Kano Brown goats but this difference was not statistically significant ($P > 0.05$). Males had higher values than females and also this was not significant statistically. One year olds had the higher values for iron, followed by the 4 years old, 2 years old and lastly 3 years old. This finding was not significant statistically ($P > 0.05$) (Table I, II, III & IV).

The Sokoto Red goats had marginally higher values for Zinc than the Kano brown goats and this difference did not result in any statistical significance ($P > 0.05$). Males had higher values for Zinc than females also this was not statistically significant. There were not much differences across the ages with the 2 year olds having the highest values followed by the 1 year olds, 3 years olds and lastly the 4 years old. This variation did not lead to any statistical significance. There was a wide range in the difference across location.

TABLE 1: Mean (SD) values and standard errors of all elements obtained

Element	Mean (mg/L)	SD (±)
Lead	0.259	0.470
Cadmium	0.006	0.004
Chromium	0.072	0.064
Copper	0.089	0.060
Iron	0.229	0.180
Zinc	0.256	0.266
Nickel	0.127	0.086
Cobalt	0.135	0.095
Manganese	0.042	0.031

TABLE II: Mean (SD) of the various elements in mg/L in relation to breed of goats sampled in Zaria

Element	Kano Brown (mg/L)	Sokoto Red (mg/L)
Lead	0.256 ± 0.534	0.219 ± 0.628
Cadmium	0.005 ± 0.004	0.006 ± 0.006
Chromium	0.064 ± 0.054	0.077 ± 0.068
Copper	0.094 ± 0.063	0.077 ± 0.049
Iron	0.225 ± 0.181	0.344 ± 0.351
Zinc	0.256 ± 0.272	0.484 ± 0.388
Nickel	0.134 ± 0.091	0.095 ± 0.123
Cobalt	0.140 ± 0.010	0.097 ± 0.142
Manganese	0.045 ± 0.036	0.029 ± 0.0308

TABLE III: Mean (SD) of the various elements in mg/L in relation to sex of goats sampled in Zaria

Element	Male (mg/L)	Female (mg/L)
Lead	0.338±0.684	0.253±0.547
Cadmium	0.005±0.003	0.006±0.004
Chromium	0.058±0.039	0.075±0.069
Copper	0.085±0.058	0.091±0.062
Iron	0.248±0.221	0.224±0.168
Zinc	0.287±0.273	0.248±0.264
Nickel	0.111±0.074	0.131±0.089
Cobalt	0.151±0.103	0.131±0.093
Manganese	0.036±0.028	0.043±0.032

The Kano Brown goats had a higher value for nickel than the Sokoto red but this value was not significant ($P > 0.05$). The females had a higher value for nickel than the males and this too was not statistically significant ($P > 0.05$). Kano brown goats had higher values for cobalt than Sokoto Red goats but this was not statistically significant ($P > 0.05$). The effect

2 year olds had the lowest values, followed by the 1-year bold, than 3 year olds and four year olds having the highest values. The effect of age was not statistically significant.

of breed was also not statistically significant despite the fact that the males had higher values of cobalt than females.

TABLE IV: Mean (SD) of the various elements in mg/L in relation to age of goats sampled in Zaria

Element	1year (mg/L)	2year (mg/L)	3year (mg/L)	4year(mg/L)
Lead	0.183±0.151	0.401±0.770	0.174±0.433	0.316±0.660
Cadmium	0.004±0.004	0.006±0.004	0.006±0.004	0.006±0.004
Chromium	0.091±0.064	0.061±0.053	0.074±0.081	0.068±0.038
Copper	0.106±0.071	0.085±0.050	0.089±0.065	0.084±0.058
Iron	0.279±0.286	0.226±0.143	0.194±0.120	0.255±0.204
Zinc	0.200±0.242	0.286±0.274	0.258±0.269	0.253±0.275
Nickel	0.127±0.070	0.102±0.069	0.141±0.105	0.142±0.079
Cobalt	0.154±0.110	0.164±0.091	0.121±0.089	0.095±0.082
Manganese	0.043±0.029	0.035±0.026	0.044±0.033	0.047±0.0350

Two year old goats had the highest cobalt values followed by one year olds, then three year olds and lastly four year olds. The effect of age was not statistically significant ($P > 0.05$).

Females had a higher value for manganese than males and it did not make a statistical significance ($P > 0.05$). Kano brown goats had a higher value than Sokoto Red goats and this result was statistically significant ($P < 0.05$). The 4 year old group had the highest values for manganese followed by the 3 year old group then the 1 year old group with the 2 year old group having the lowest values. The effect of age was not statistically significant ($P > 0.05$) Table I, II, III & IV).

DISCUSSION

The value obtained for lead in goats during the study was 0.259± 0.470 mg/L and this differed statistically (P >.0.01) from the value of 0.1mg/L suggested by Lidsky and Schnieder (2003) as the acceptable limit. The value obtained was more than two times the acceptable limit, which shows that the environment these goats are living in was contaminated with lead. It is an accepted fact that the common pollutant of the lead in the environment is from the use of leaded fuel (Needleman, 2000; Mathee *et al.,* 2006). Nigeria still uses leaded fuel and in Zaria like in most parts of the country there is an increase in the number of petrol stations over the years and this may have led to increase lead pollution in the environment. However the value obtained was much lower than the 0.56mg/L obtained by Oluokun *et al*. (2007) in Shagamu, Nigeria in a nearby cement industry. Similarly the value obtained in this study was much different from the 0.068± 0.0227mg/L obtained by Yazar *et al.* (2006) in Turkey. There were no statistical differences between breeds which agreed with the report of Yazar *et al.* (2006). The males had a higher lead value than the females which was not significant statically but agreed with Vahter *et al.* (2007) who stated that males generally have a higher lead value than females because of a naturally higher Packed Cell Volume (PCV) value and also because they consume more feed than females and hence have a higher probability of picking up more lead than females.

The value obtained for Cadmium was 0.006 ± 0.004mg/L which was similar to the value of 0.007mg/L obtained in control animals by Oluokun *et al*. (2007) but was far lower than that of the test group which was 0.012mg/L. This value was however just at about the acceptable limit of 0.005mg/L described by Schoeters *et al*. (2006). The findings of this study also differed from the value of 0.002 mg/L recorded by Or *et al.* (2005). Elsewhere though it was not significant the finding that females had a higher cadmium value than males agreed with Vahter *et al.* (2007) who stated that women are more susceptible to cadmium toxicity because it has been found to have estrogenic effects on them. Cadmium was found to act like estrogen in breast cancer cells as a result of its ability to form high affinity complex with the hormone binding domain of the estrogen receptor.

Chromium, values obtained was 0.072± 0.064 mg/L and was within the value of 0.009- 0.092mg/L reported by Pechova and Pavlata (2007) as being normal for cattle.

For zinc, the value of 0.256 ± 0.266 mg/L was obtained which was a far below the held belief that the normal values for zinc are within 0.8-1.2mg/L (Kargin *et al.*, 2004). Kaya *et al.* (1998) had values of 0.406 mg/L and 0.387 mg/L for the Morkaraman and Tuj breeds, respectively, which were not too distant from the values obtained here in Zaria. These values varied largely from the value of 1.065 mg/L reported by Gurdogan *et al.* (2006) in pregnant sheep.

A value of 0.229± 0.180 mg/L was obtained for iron and this is far below the accepted range of 1.02-3.04 mg/L stated by Underwood (1997). Nazki and Ratyan (1990) suggested a level of 1.15-2.3mg/L in sheep.

For copper 0.089 ± 0.060 mg/L was the value obtained. This is well off the range of 0.6-1mg/L reported by Sharma *et al*. (2005) in heifer. Matrone (1946) stated that there was an increase in copper concentration with advancing age, which differed from the general findings of a decrease in copper value with advancing age in this study which was not statistically significant. Matrone (1946) did state that there was a daily fluctuation in copper values with copper values being highest in the morning and lowest at evening times.

In this study 0.135± 0.095 mg/L was the value obtained for cobalt and this differs from the 0.023 mg/L by Yazar *et al*. (2006) in Angora goats. The values obtained were much higher than the values they obtained implying that the goats in this study were apparently well supplied with cobalt hence the low chance of a Vitamin B12 deficiency cases. The lack of statistical difference between breeds and age also agreed the report of the latter.

The value of 0.127 ± 0.086 mg/L was obtained for nickel which was lower than the value of 0.25 mg/L obtained by Yazar *et al.* (2006). Females had a higher nickel value than males which was not statistically significant but agreed with higher values of Vahter *et al*. (2006) who stated that females have a higher nickel values than males. There was no statistical significant of age on nickel value which agreed with the one from Yazar *et al.* (2006).

Rojas *et al* (1965) reported a value of 0.021mg/L for manganese which was lower than the values obtained for manganese which was 0.042 ± 0.031 mg/L. implying that the animals sampled had adequate manganese intake. Webb *et al*. (2001) who measured manganese values in liver samples found that there was no statistical difference in the effect of age and sex on the values they obtained, which is in agreement with what was obtained in this work.

In conclusion, this study it has been established that lead and other trace elements abound in the soil in Zaria and its environs but animals within the study area are generally deficient in some essential micro nutrients. The high lead content implies a contamination of the animal's immediate environment, and that grazing and pasture are not enough to meet an animal's mineral requirement. It is therefore imperative to begin to advocate the use of mineral supplement into farm management protocols. The increased lead levels in the blood of goats which are known biomonitors is of serious public health importance as it implies that the human lead burden in the study area will presumably be higher than normal.

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