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MINERAL COMPOSITION OF LOCAL SALT LICKS (TOKA) IN ADAMAWA STATE, NIGERIA

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ABSTRACT: *The objective of the study was to determine some mineral composition of local salt licks (Toka) produced from crop residues in Adamawa State, Nigeria. Five (5) local salt blocks made from Maize cobs, Beni-seed straws, Sorghum stover, Cowpea husk and Maize stover were analyzed. The mineral contents were analyzed using Triple Acid Digestion Methods (TADM). The results showed that, local salt licks produced from crop residues majorly contained seven (7) macro-minerals namely: sodium (Na), potassium (K), calcium (Ca), chlorine (Cl), magnesium (Mg), phosphorus (P) and sulfur (S) and ten (10) micro minerals or trace elements namely: iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), iodine (I), molybdenum (Mo), cobalt (Co), selenium (Se), fluorine (Fl) and chromium (Cr). The results further showed that, the local salt licks produced from crop residues had little or no heavy metals. All livestock require some percentage of mineral elements for cellular respiration, nervous system development, protein synthesis, metabolism and reproductive purposes. Macro and micro elements are important components of livestock ration which aid in the prevention of mineral deficiencies. Therefore, the local salt licks produced from crop residues could be used as mineral supplements to improve palatability and acceptability in animal feeds thereby, increasing livestock performance and productivity in the region. This could also conveniently substitute the usually imported, highly expensive mineral licks used for livestock production in the state and Nigeria as a whole.*

KEYWORDS: mineral composition, salt licks, livestock, Adamawa State, Nigeria

INTRODUCTION

Many plant and animal parts are being evaluated and tested for new products such as low cost feeds which are nutritious, attractive and acceptable to livestock just like conventional feeds. Research attention has now been shifted toward increasing utilization of cheaper animal feed sources. Feed resources that contain minerals include; range or pasture plants, harvested forages, concentrates and mineral supplements (Babayemi *et al*., 2014). Forage intake by pastoral grazing ruminants depends on the level of mineral consumption (Babayemi *et al*., 2014). The levels of minerals in plants is a function of interaction between several factors which include soil type, plant species, stage of maturity, dry matter yield, grazing management, topography of the land,

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interaction between animals and humans, time and period of sampling, climate, season and application of inorganic fertilizer (Khan *et al*., 2005; Gulilat & Chekol, 2020).

Mineral licks generally provide nutritional benefits and bio-metals required for the development of bones, muscles, growth and functioning of other body systems in livestock and wildlife (Ayotte, Parker, Arocena, & Gillingham, 2006; Mills, & Milewski, 2007; Hogan, 2010; Black, Mosquera, Guerra, Loiselle, Romo, & Swing, 2011). Urea mineral block is an excellent supplementary feed that are formulated and used to increase digestion of roughages, provide protein and energy to ruminant animals (Geleta, 2013). Similarly, urea mineral block provides crude protein (N) that is usually deficient in dry feeds (Adugna, Roger, Arthur, Tilahun, & Tegene, 2000; FAO, 2007) and supply enough microbial protein needed for the maintenance and growth of animals (Upadhyay *et al*., 2018).

Conventional salt licks used by farmers for years in many developing and developed countries, which provides fermentable nitrogen and are good sources of minerals, are highly expensive and beyond the reach of a common farmer. Local salt licks, also known as toka in Hausa, are locally produced from ashes of crop residues and animal dung indigenous to North-Eastern Nigeria. The mineral composition of these local salt licks is not known. There is little or no literature on the mineral composition of these local salt licks produced from crop residues in Adamawa State, Nigeria. This study, therefore, generates the information that could be used to optimize feeding mineral licks during different seasons of the year, especially during the lean feed resource periods. The objective of the study is to determine some mineral composition of local salt licks produced from crop residues in Adamawa State, Nigeria.

MATERIALS AND METHODS

The Study Area

Adamawa State is located at the area where the River Benue enters Nigeria from Cameroon Republic and is one of the six states in the North-East geopolitical zone of Nigeria. It lays between latitudes 7^0 and 11^0 North of the Equator and between longitudes 11^0 and 14^0 East of the Greenwich Meridian (Mohammed, 1999). It shares an international boundary with the Republic of Cameroon to the East and interstate boundaries with Borno to the North, Gombe to the North-West and Taraba to the South-West (Adebayo, 1999; ASMLS, 2010), as shown in Figure 1.

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Figure 1: Map of Nigeria Showing Adamawa State

According to Adebayo and Tukur (1997), Adamawa State covers an area of land mass of about 38,741km². The state is divided into three Senatorial Zones (Northern, Central and Southern) which translates to three agricultural zones as defined by INEC (1996), which are further divided into 21 Local Government Areas (LGAs) for administrative convenience.

The state has minimum and maximum rainfall of 750 and 1050 mm per annum and an average minimum and maximum temperature of 15^0C and 32^0C, respectively. The relative humidity ranges between 20 and 30% with four distinct seasons that include early dry season (EDS, October – December); late dry season (LDS, January – March); early rainy season, (ERS, April – June) and late rainy season (LRS, July – September), according to Adebayo (1999). The vegetation type is best referred to as guinea savannah (Areola, 1983; Adebayo & Tukur, 1997). The vegetation is made up of mainly grasses, aquatic weeds along river valleys and dry land weeds inter-spersed with shrubs and woody plants. Plant heights ranges from few centimeters (Short grasses) to about one meter tall (tall grasses), which form the bulk of animal feeds.

The major occupation of Adamawa people is farming. Cash crops grown in the state include cotton and groundnuts, sugarcane, cowpea, benni-seed, bambara nuts and tiger nuts, while food crops include maize, yam, cassava, sweet potatoes, guinea corn, millet and rice. The communities living on the banks of rivers engage in fishing, while the Fulani and other tribes who are not resident close to rivers are pastoralists who rear livestock such as cattle, sheep, goats, donkeys, few camels, horses and poultry for subsistence (Adebayo & Tukur, 1997; Adebayo, 1999). The mineral resources found in the state include iron, lead, zinc and limestone (Adebayo & Tukur, 1997).

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The Study Site

The study was conducted in Mubi Region, located at the northern part of old Sardauna Province, which now forms Adamawa North Senatorial District as defined by INEC (1996). The region lies between latitude 9^0 30´´ and 11^0 North of the Equator and Longitude 13^0 and 13^0 45´´ East of Green witch Meridian. Mubi region is bordered in the North by Borno State, in the West by Hong and Song LGAs and in the South and East by the Republic of Cameroon. It has a land area of about 4,728.77 km² and human population of about 759,045 going by NPC (1991) census projected figure. It has an international cattle market linking neghbouring countries to southern Nigeria where cattle are consumed as shown in figure 2.

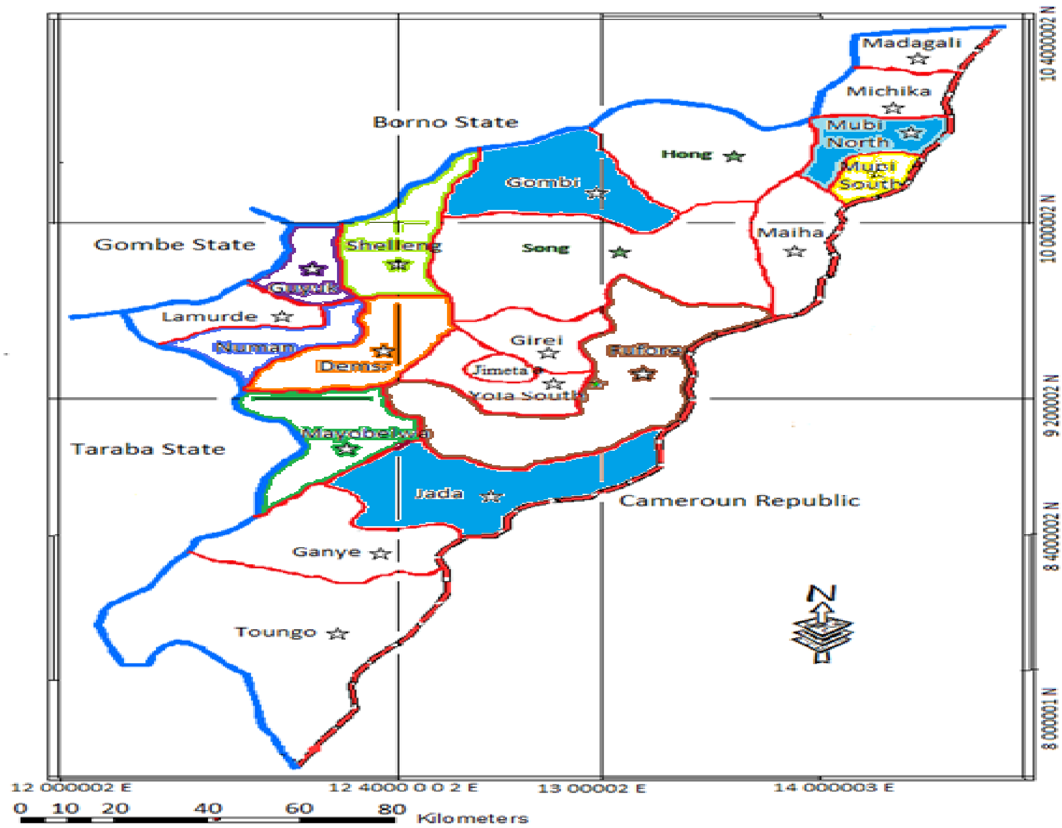

Figure 2: Map of Adamawa State Showing Study Site

Production Techniques

Dry crop residues were carefully collected from the field at about 23% moisture content and packed to an open field at the farm. The materials were then burnt to ashes under cool wind-free atmosphere and allowed to cool to a room or environmental temperature of about 21^{oC} in the morning hours as described by Kubkomawa (2017). The ashes were carefully and gently gathered using a broom and packed into perforated clay pot as can be seen in plate 1. Fine grasses were obtained to serve as sieves which were put into clean clay pot with holes or perforated bottom. The

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ashes were packed into the perforated pot filled to the brim and mounted on another clean container without perforation supported with stones since the perforated was bigger than the intact container. Water was sprinkled on the ashes gently and gradually until it was fully soaked and submerged. More water was then added gradually and continually until the pot was filled. The system was allowed to stay overnight and the concentrated mineral solution filtered or leached down slowly into the clean container serving as collection chamber. The concentrated mineral solution was then boiled while adding more ashes and constantly stirring with a long cooking spoon for six to eight hours. The solution then formed paste like product, as the water evaporated leaving only the solid mineral licks. The product was then molded into blocks using small plastic containers polished with groundnut oil to prevent the mineral blocks sticking in them and to ease removal of blocks after sun-drying for 2 days. The process or production cycle took 2 to 3 days to complete (Kubkomawa, 2017) as shown in plates 1 and 2.

Plate 1: Local Salt Solution

Plate 2: Local Salt Blocks

Preparation of Samples Analysis

Five (5) local salt blocks made from crop residues namely: maize comb, beni-seed straws, sorghum stover, cowpea husk and maize stover were packaged neatly in polythene bags and labeled until used for analysis.

Mineral Determination

Five (5) local salt blocks made from maize comb, beni-seed straws, sorghum stover, cowpea husk and maize stover were purposively analyzed for Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P), Chlorine (Cl), Sulfur (S), Iron (Fe), Zinc (Zn), copper (Cu), Manganese (Mn) Iodine (I), Molybdenum (Mo), Cobalt (Co), Selenium (Se), Fluorine (Fl), Chromium (Cr), Lead (Pb) and Nickel (Ni). The minerals were determined using Triple Acid Digestion Method (TADM) as described by Sahrawat, Kuaar and Rao (2002). Two (2g) of the

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samples were weighed into a micro-Kjeldahl digestion flask to which 24ml of mixture of concentrated HNO3, H2SO4, and 60% HclO4 (9:2:1 v/v) were added. The flask was put on the heating block and digested to a clear solution, cooled and the content was transferred into 50ml volumetric flask and made-up to the volume mark with water.

Phosphorous was determined using Eno and Trenchard (2009) methods. Digested supernatant solution (2ml) was placed into 50cm3 volumetric flask, 2ml of sample and 2cm3 of ammonium molybdate solution were added with distilled water to makeup to 48ml, the content was mixed and 1ml of diluted stannous chloride solution was added and mixed, then 1ml of distilled water was added to make-up to 50ml marked and left to stand for 5minutes. The % absorbance on spectrophotometer at 660nm wavelength was recorded.

Data Analysis

Data generated were subjected to descriptive statistics such as tables, percentages and means to explain the mineral compositions of novel salt licks (Toka) indigenous to the study area.

RESULTS AND DISCUSSION

Macro-Minerals or Elements

Sodium (Na)

The findings showed that, maize cobs had the highest value of 25.21%, followed by maize stover with 22.19%. The least value was from sorghum stover with 19.86%. The results indicated the overall mean value of 27.60% while the range was from 19.86 to 25.21% (Table 1). These observations showed that, crop residues used for this study are good sources of sodium. However, the variations seen may be attributed to the differences in varieties of the crop residues. Some crops are naturally salty and may have tendencies of containing more minerals in their residues. Other likely factors may include the soil conditions and inorganic fertilizers applied to the crops.
The findings corroborated that of Mensah, Okoli, Ohaju-Obodo and Eifediyi (2011) who reported calcium and sodium as the major component of bitter leaf which are the factors sustaining strong bones and reduced the risk of arthritis. Contrary to the results of this study, Yusuf *et al*. (2017), reported low sodium content in crop residues in Nigeria. This may not be unconnected to soil factor, topography of the land, application of inorganic fertilizer and the sampling time and period. Similarly, Gulilat and Chekol (2020) also reported low macro and micro mineral contents of crop residues during the dry season in Ethiopia.

Sodium (Na) is usually combined with chlorine (Cl) to give sodium chloride (NaCl) commonly known as the normal salt (Babayemi *et al*., 2014). They are both critical electrolytes in body fluids. The sodium content obtained in this study is adequate to support in amino acid and glucose transport and muscle contractions which corroborated the report of Njidda (2011); Njidda and Olatunji (2012); Babayemi *et al*. (2014).

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Sodium chloride (common salt) is always mixed with other minerals, because salt improves intake (Babayemi *et al*., 2014). Cattle have almost zero nutritional wisdom, they do not seek out feedstuffs or minerals when they are deficient, with the exception being sodium, so adding salt to other minerals generally improves intake among cattle (Babayemi *et al*., 2014). Although, WHO (2012) reported that, reduced sodium intake has a reduced risk ratio on cardiovascular diseases, coronary diseases and stroke.

Table 1: Macro-mineral Content of Local Salt Licks (toka) in Adamawa State, Nigeria

Macro-minerals	**Maize Cobs (%)**	**Beni -Seed Straw (%)**	**Sorghum Stover (%)**	**Cowpea Husk (%)**	**Maize Stover (%)**	**Overall Mean (%)**
Sodium (Na)	25.21	21.04	19.86	21.05	22.19	27.60
Potassium (K)	1.29	0.36	0.29	0.32	1.17	0.80
Calcium (Ca)	21.05	25.53	30.10	29.86	19.62	25.40
Magnesium (Mg)	2.67	2.08	1.85	0.23	2.84	2.00
Phosphorus (P)	6.64	5.66	6.02	0.53	5.29	5.00
Chlorine (Cl)	29.57	31.16	27.89	32.65	29.95	30.24
Sulfur (S)	0.04	0.06	0.04	0.03	0.04	0.04

Potassium (K)

The results of potassium (K) content also showed that, maize cobs had the highest value of 1.29%, followed by maize stover with 1.17% as shown in Table 1. The least value was from sorghum stover with 0.29%. The results showed that, the overall mean value of potassium was 0.80% while the range was 0.29% to 1.29%.

The results agreed with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents from indigenous forages grown naturally in Nigeria. Similarly, Gulilat and Chekol (2020) also found macro and micro mineral contents of crop residues to be low during the dry season in Ethiopia. On the other hand, Achinewhu (1982) reported higher potassium in plant foods from Nigerian soils. This may also be attributed to soil and climatic factors. Equally, potassium deficiencies are not normally anticipated in most ruminants' diets because most forage is good sources of potassium (Onyeonagu *et al*., 2013; Babayemi *et al*., 2014).

Correspondingly, the low potassium obtained from this study, could still be used as supplementary mineral to support livestock production in addition to other sources. Importantly, K is involved in regulation of osmotic pressure, water or fluid balance, muscle contractions, nerve impulse transmission and several enzymatic reactions (Onyeonagu *et al*., 2013). A marginal to deficient level of potassium in growing and finishing cattle results in decreased feed intake and rate of gain (Onyeonagu *et al*., 2013; Babayemi *et al*., 2014).

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Calcium (Ca)

The results showed that, sorghum stover had the highest value of calcium (Ca) content (30.10%), followed by cowpea husk with 29.86% as shown in Table 1. The least value was from maize stover with 19.62%. The results presented that, the overall mean value of calcium content of local salt licks was 25.40% while the range was from 19.62% to 30.10%.

The results agreed with the findings of Onyeonagu, Obute and Eze (2013) who reported relatively higher calcium content in roughages in Nigeria. Likewise, Yusuf *et al*. (2017) also reported higher sodium content in crop residues in Nigeria. Similarly, the findings again agreed with Onyeonagu *et al*. (2013) who reported that, leguminous roughages are excellent sources of calcium; even non legume roughages may supply adequate calcium for maintenance of cattle. On the other side, research revealed that cereal grains (corn, oats, milo, wheat, barley) are low in Ca (Onyeonagu *et al*., 2013; Babayemi *et al*., 2014).

The calcium content obtained in this study could be used to improve mineral elements in the body with about 98% functioning as a structural component of bones and teeth (Onyeonagu *et al*. (2013). The remaining 2% is distributed in extracellular fluids and soft tissues and is involved in such vital functions as blood clotting, membrane permeability, muscle contraction, transmission of nerve impulses, cardiac regulation, secretion of certain hormones, and activation and stabilization of certain enzymes (Onyeonagu *et al*. (2013). Calcium is responsible for teeth and bone formation in conjunction with phosphorus, magnesium, manganese, vitamin A, C, D, chlorine and protein (Bogert, Briggs & Galloway, 1994). High amount of Ca, K and Mg in diets have been reported to reduce blood pressure (Yusuf, Folarin & Bamiro, 2007; Omosuli, Ibrahim, Oloye, Jude – Ojei & Agbaje, 2009).

Magnesium (Mg)

The results of magnesium (Mg) content indicated that, maize stover had the highest value of 2.84% followed by maize cobs with 2.67% as shown in Table 1. The least value was from cowpea husk with 0.23%. The results showed that, the overall mean value of magnesium content of local salt licks was 2.00% while the range was from 0.23% to 2.84%.

The low magnesium content found in this study is in agreement with Njidda (2011); Njidda and Olatunji (2012) who reported similar findings from indigenous forages in Nigeria. The results also corroborated Babayemi *et al*. (2014) who reported mineral requirements of livestock to be of a few tenths of a gram to one or more grams per day. Contrary to the observations of this study, Yusuf *et al*. (2017) reported higher magnesium content in crop residues in Nigeria.

Magnesium is also found to be involved in maintenance of electrical potentials across nerve endings and activation of some enzyme system (NRC 1996; Babayemi *et al*., 2014). Similarly, 65 to 70% of magnesium is found in the skeleton (NRC 1996; Babayemi *et al*., 2014). It functions in carbohydrate and fat metabolism and serves as a catalyst in over 300 enzyme systems. Like

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phosphorus, Mg is bitter and sometimes used to limit consumption of mineral supplements (NRC 1996; Babayemi *et al*., 2014). A magnesium deficiency in calves, results in excitability, anorexia, hyperemia, convulsions, frothing at the mouth, and salivation (NRC 1996; Babayemi *et al*., 2014).

Phosphorus (P)

The results of phosphorus (P) content showed that, maize cobs had the highest value of 6.64%, followed by sorghum stover with 6.02% as shown in Table 1. The least value was from cowpea husk with 0.53%. The results showed that, the overall mean value of phosphorus content of novel salt licks was 5.00% while the range was from 0.53% to 6.64%.

The low phosphorus found in the present study could be attributed to the crop varieties, soil type and the production location. The results concurred that of Njidda (2011); Njidda and Olatunji (2012) who reported similar findings in Nigeria. In the same way, roughages are often reported to be low in phosphorus that is why some ruminant rations are deficient in it and have to be supplemented (Onyeonagu *et al*., 2013). Furthermore, as forage plants mature, their phosphorus content decline, making mature and weathered forages a poor source (Underwood, 1981). On the contrary, Yusuf *et al*. (2017) reported higher phosphorus content in crop residues in Nigeria. Oilseed meals are also an excellent source of P with low palatability (Underwood, 1981). Most natural protein supplements are fairly good sources of phosphorus (Underwood, 1981). Good sources of supplemental phosphorus include steamed bone meal, mono and di-calcium phosphate, de-fluorinated rock phosphate, and phosphoric acid (Babayemi *et al*., 2014). Corn by-products like corn gluten and distillers grains with soluble are also high in phosphorus. Because most grains are relatively good sources of phosphorus, feedlot cattle rarely suffer a phosphorus deficiency, although phytic acid chelation of phosphorus in grains may render up to one-half of it unavailable, especially for monogastric animals such as swine and poultry (Babayemi *et al*., 2014).

It has been established also that, phosphorus has been the most deficient mineral for grazing cattle worldwide (Onyeonagu *et al*., 2013). However, the phosphorus obtained in the study could be used as supplementary minerals to livestock grazing native forages in order to meet-up with the requirements. Approximately 80% of phosphorus in the body is found in the bones and teeth, with the remainder distributed among the soft tissues (Onyeonagu *et al*., 2013). It functions with Ca in bone formation, essential for cell growth, energy utilization, maintains acid-base balance, a component of DNA and required by rumen microbes for optimal growth and activity (Underwood, 1981). The greatest deal in mineral supplementation is generally associated with provision of P. Because adequate phosphorus is critical for optimal performance of ruminant animals, including growth, reproduction and lactation, a phosphorus supplementation program is recommended using either a free choice mineral mixture or direct supplementation in the diet (Underwood, 1981). Phosphorus deficiency always leads to reduced growth and efficiency of feed conversion, decreased appetite, impaired reproduction, reduced milk production, and weak, fragile bones (Babayemi *et al*., 2014).

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Chlorine (Cl)

The results of chlorine (Cl) content highlighted that, cowpea husk had the highest value of 32.65%, followed by beni-seed straw with 31.16% as shown in Table 1. The least value was from sorghum stover with 27.89%. The results showed that, the overall mean value of chlorine content of local salt licks was 30.24% while the range was from 27.89 to 32.65%.

The results are in agreement with that of Muraina *et al*. (2020) who reported that, legumes are rich in macro-minerals far beyond the requirements of ruminants, but low in trace elements. The findings also demonstrated that, crop residues from the study area are good sources of chlorine. For that reason, it could be in-cooperated into livestock rations to form component of hydrochloric acid formation, activation of amylase and a starch digesting enzyme (Njidda, 2011; Njidda & Olatunji, 2012; Babayemi *et al*., 2014). Sodium and chlorine (salt) found in the study could be provided for the proper function of the nervous and muscular systems in animals. They could help to regulate pH and the amount of water retained in the body. Deficiency of these elements causes loss of appetite and inefficient weight gains or body weight loss (Hale & Olson, 2001). Sodium is commonly deficient, but chlorine levels are usually adequate in diets. Sodium and chlorine (salt) are present in soft tissues and fluids but very little are stored. Therefore, a constant, daily source of sodium and chlorine must be provided (Hale & Olson, 2001). Cattle and other ruminants will voluntarily consume more salt when forage is young and succulent than when its matured and dry (Hale & Olson, 2001). Silage-fed cattle will consume more salt than those fed hay, and consumption is higher in cattle fed high-roughage diets than in those on high-concentrate diets (Hale & Olson, 2001).

Sulfur (S)

The results indicated that, beni-seed straw had the highest value of 0.06%, followed by maize cobs, sorghum stover and maize stover with 0.04% as shown in Table 1. The least value was from cowpea husk with 0.03%. The results also showed that, the overall mean value of sulfur content of local salt licks (toka) was 0.04% while the range was from 0.03 to 0.06%.

The findings agreed with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents from indigenous forages grown naturally in Nigeria. Similarly, Gulilat and Chekol (2020) also reported low macro and micro mineral contents of crop residues during the dry season in Ethiopia. But the results contradicted that of Upadhyay *et al*. (2018) who reported molasses to be a rich source of sulfur, calcium and B complex. In the same way, certain by-products such as distillers' grains and corn gluten feed contain higher concentrations of sulfur, which should be taken into account in ration balancing (Upadhyay *et al*., 2018). In addition, research showed that, sulfur is part of the essential amino acids such as methionine and cystine, which make up protein (Upadhyay *et al*., 2018). The two amino acids (methionine, cysteine) and two B-vitamins (biotin, thiamin) contain sulfur (Upadhyay *et al*., 2018).

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Despite the low concentration of sulfur (S) in this study, it could be adequate enough to function in the maintenance of bone, cartilage, tendon and blood vessel (contained in chondroitin). Because, high sulfur levels in the diet antagonize the use of copper and molybdenum (Upadhyay *et al*., 2018). When sulfur is in excess, it can interfere with the metabolism of copper, resulting in a copper deficiency (Upadhyay *et al*., 2018). Also, excess sulfur can reduce feed intake and cause a brain lesion condition known as polioencephalomalacia (PEM). A sulfur deficiency in beef cattle diets is not likely to occur under normal feeding conditions. Rumen microbes are capable of synthesizing all of the sulfur containing compounds from inorganic S (Upadhyay *et al*., 2018).

Micro-Minerals or Trace Elements

Iron (Fe)

The results of iron (Fe) content showed that, beni-seed straws and maize stover had the highest value of 0.28% each, followed by maize cobs with 0.26% as shown in Table 2. The least value was from cowpea husk with 0.22%. The results indicated that, the overall mean value of iron content of local salt licks (toka) was 0.40% while the range was from 0.22% to 0.28%.

The findings agreed with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. Similarly, the results again corroborated that of Muraina *et al*. (2020) who reported that, legumes are low in trace element concentrations. However, the results contradicted that of Obiajunwa, Adebiyi and Omode (2005); Yusuf *et al*. (2017), who reported higher iron and zinc contents from Sesame seed and crop residues in Nigeria. But the values they obtained for potassium, calcium and phosphorus were lower than the literature values. Nevertheless, since trace elements are required by animals in minute quantity, iron (Fe) obtained from the study could be more than enough for use in cellular respiration and oxygen transport via hemoglobin. Research has shown that, 50% of the body’s iron is involved in hemoglobin and can also antagonize copper and zinc availability (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012).

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Table 2: Micro-mineral Content of Local Salt Licks (toka) in Adamawa State, Nigeria

Micro-minerals	**Maize Cobs (%)**	**Beni Seed Straw (%)**	**Sorghum Stover (%)**	**Cowpea Husk (%)**	**Maize Stover (%)**	**Overall Mean (%)**
Iron (Fe)	0.26	0.28	0.25	0.22	0.28	0.40
Zinc (Zn)	0.53	0.56	0.39	0.27	0.48	0.60
Copper (Cu)	0.18	0.21	0.20	0.23	0.16	0.20
Manganese (Mn)	0.21	0.31	0.27	0.39	0.20	0.40
Iodine (I)	0.01	0.00	0.01	0.00	0.01	0.00
Molybdenum (Mo)	0.00	0.00	0.00	0.00	0.00	0.00
Cobalt (Co)	0.00	0.00	0.00	0.00	0.00	0.00
Selenium (Se)	0.00	0.00	0.00	0.00	0.00	0.00
Fluorine (Fl)	0.10	0.12	0.14	0.11	0.11	0.12
Chromium (Cr)	0.04	0.05	0.04	0.03	0.07	0.05
Heavy Metals						
Lead (Pb)	0.00	0.01	0.01	0.02	0.00	0.00
Nickel (Ni)	0.00	0.00	0.00	0.00	0.00	0.00

Zinc (Zn)

The results of zinc (Zn) content showed that, beni-seed straws had the highest value of 0.56%, followed by maize cobs with 0.53% as shown in Table 2. The least value was from cowpea husk with 0.27%. The results showed that, the overall mean value of zinc content of local salt licks (toka) was 0.60% while the range was from 0.27 to 0.56%.

The findings agreed with Yusuf *et al*. (2017), who reported low zinc content in crop residues in Nigeria. The findings again supported that of Lemma and Smith (2005); Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Ethiopia and Nigeria respectively. Similarly, research has also shown that, zinc is one of the minerals that often seemed deficient in beef cattle diets (Njidda, 2011; Njidda & Olatunji, 2012; Babayemi *et al*., 2014). The results again agreed with that of Muraina *et al*. (2020) who reported legumes to be low in trace elements. But notwithstanding, zinc (Zn) found in the study could be substantial enough when utilized in stress management, immune response, enzyme systems and protein synthesis (L´opez-Alonso, 2012). Livestock producers need to know the micro mineral or trace element contents of the feedstuffs used in ruminant rations. This would prevent deficiencies especially when commercial salt minerals are fed to the herd (Njidda, 2011; Njidda & Olatunji, 2012; Babayemi *et al*., 2014).

Copper (Cu)

The results of copper (Cu) content showed that, cowpea husk had the highest value of 0.23%, followed by beni-seed straws with 0.21% as shown in Table 2. The least value was from maize

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stover with 0.16%. The results showed that, the overall mean value of copper content of local salt licks was 0.20% while the range was from 0.16 to 0.23%. The findings corroborated that of Yusuf *et al*. (2017), who reported low copper content in crop residues in Nigeria. The results again agreed with Lemma and Smith (2005) who reported low mineral contents of crop residues in Ethiopia. Also, Njidda (2011); Njidda and Olatunji (2012) reported low mineral concentrations in indigenous forages in Nigeria.

However, irrespective of the low content of copper in the study, it could still be adequate to utilize to function as an essential component of enzyme systems and production of blood components. Copper is also involved in nervous and immune system function (L´opez-Alonso, 2012). Recommended levels of cobalt and copper should be provided in the diet, either by supplementation of the total mixed ration or as part of the free choice mineral mix or supplemental mix (McDowell, 1992).

Studies have shown that, copper (Cu) is second only to phosphorus in severity of deficiency throughout the world. Copper interacts with iron, zinc, sulfur and molybdenum in antagonistic relationships. Sheep are very susceptible to copper poisoning as dietary Cu levels approach or exceed 20 ppm (Ward, Spears & Gengelbach, 1995).

Manganese (Mn)

The results of manganese (Mn) content revealed that, cowpea husk had the highest value of 0.39% followed by beni-seed straws with 0.31% as shown in Table 2. The least value was from maize stover with 0.20%. The results showed that, the overall mean value of manganese content of local salt licks (toka) was 0.40% while the range was from 0.20 to 0.39%. The findings agreed with Yusuf *et al*. (2017), who reported low manganese content in crop residues in Nigeria. The results again agreed with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. The low manganese content obtained here could be enough to support livestock production in several enzyme systems (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012).

Iodine (I)

The results of iodine (I) content showed that, maize cobs; sorghum stover and maize stover had the highest value of 0.01% each, followed by cowpea husk and beni-seed straws with 0.00% as shown in Table 2. The results showed that, the overall mean value of iodine content of local salt licks (toka) was 0.00% while the range was from 0.00 to 0.01%.

The findings again corroborated that of Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents from indigenous forages in Nigeria. Similarly, the results again are in agreement with Muraina *et al*. (2020) who reported legumes to be low in trace element concentrations. However, micro or trace elements are required in small quantity for the normal functioning of basically all biochemical processes in the body (L´opez-Alonso, 2012). They are

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part of numerous enzymes and coordinate a great number of biological processes, and consequently they are essential to maintain animal health and productivity (L´opez-Alonso, 2012). Optimal nutrition, with adequate trace mineral levels, guarantees proper functions of the organism, among which the most important are structural, physiological, catalytic, and regulatory (Suttle, 2010).

Iodine (I) is primarily involved in the thyroid hormones that regulate the rate of metabolism. It is an integral part of thyroxin which is largely responsible for control of many metabolic functions (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Although, some soils do not have sufficient iodine to meet-up with most of the livestock needs. Iodine requirements in cattle can be met adequately by feeding stabilized iodized salt. Use of iodized salt has helps in eliminating some deficiency problems in ruminants (Njidda, 2011; Njidda & Olatunji, 2012).

Molybdenum (Mo)

The results of molybdenum (Mo) content showed that, maize cobs; beni-seed straws, sorghum stover, cowpea husks and maize stover had little rounded value of 0.00% each as shown in Table 2. The results showed that, the overall mean value of molybdenum content of local salt licks (toka) was 0.00% while the range was from 0.00 to 0.00%.

The results again supported that of Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. Trace minerals are essential livestock requirements (Close, 2006). Molybdenum occurs naturally in the diet, so producers need to ensure that copper is available in enough amounts to overcome the molybdenum (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Molybdenum is rarely deficient (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). It is one of the most notorious antagonists to copper, especially in the presence of sulfates (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Molybdenum and sulfates together will tie up copper in the rumen so that it cannot be absorbed. Molybdenum can tie up copper even once it has entered the bloodstream, making it necessary to increase the amount of copper in the diet (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012).

Cobalt (Co)

The results of cobalt (Co) content showed that, maize cobs; beni-seed straws, sorghum stover, cowpea husks and maize stover had little rounded value of 0.00% each as shown in Table 2. The results showed that, the overall mean value of cobalt content of local salt licks (toka) was 0.00% while the range was from 0.00 to 0.00%.

The results agreed with other authors who reported most forages in tropical Africa to have low micro-minerals or trace elements and are required in small quantities (Ayotte, Parker, Arocena, & Gillingham, 2006; Mills, & Milewski, 2007; Hogan, 2010; Black, Mosquera, Guerra, Loiselle, Romo, & Swing, 2011; Muraina *et al*., 2020).

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Research has also shown that, cobalt functions as a component of vitamin B_{12} (Underwood, 1981; Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Ruminants do not depend on dietary vitamin B_{12}, because ruminal microorganisms can synthesize it from dietary cobalt (Underwood, 1981; Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). In ruminants therefore, a cobalt deficiency is a relative vitamin B_{12} deficiency, and such animals show weight loss, poor immune function, unthriftiness, fatty degeneration of the liver, pale skin and mucosa (Underwood, 1981; Close, 2006; Suttle, 2010; L´opez-Alonso, 2012).

Selenium (Se)
The results of selenium (Se) content indicated that, maize cobs; beni-seed straws, sorghum stover, cowpea husks and maize stover had little rounded value of 0.00% each as shown in Table 2. The results showed that, the overall mean value of selenium content of local salt licks (toka) was 0.00% while the range was from 0.00 to 0.00%.
The results also agreed with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. Studies have shown that, selenium is part of the enzyme glutathione peroxidase, which catalyzes the reduction of hydrogen peroxide and lipid hydroperoxides, thus preventing oxidative damage to the body tissues (Njidda, 2011; L´opez-Alonso, 2012). White muscle disease in calves, characterized by degeneration and necrosis of skeletal and heart muscles, is the result of a selenium deficiency (Njidda, 2011; L´opez-Alonso, 2012). Other signs of a selenium deficiency include unthriftiness, weight loss, reduced immune response, and decreased reproductive performance (Njidda, 2011; L´opez-Alonso, 2012). Selenium (Se) is important in the prevention of white muscle disease (Njidda & Olatunji, 2012).

Fluorine (Fl)
The results of fluorine (Fl) content showed that, sorghum stover had the highest value of 0.14%, followed by beni-seed straws with 0.12% as shown in Table 2. The least value was from maize cobs with 0.10%. The results showed that, the overall mean value of fluorine content of local salt licks (toka) was 0.12% while the range was from 0.10 to 0.14%.

The results again are in agreement with Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. Research showed that, fluorine is a highly toxic element (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). For this reason it is desirable to avoid the feeding of rock phosphate or other minerals high in fluorine (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). While it is true that high fluorine minerals can be fed in limited quantities for limited periods, their use constitutes a hazardous practice (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Minute traces of fluorine appear to be essential for normal tooth formation (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). Larger amounts, such as may be consumed in the feeding of rock phosphate, are distinctly harmful (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012).

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Chromium (Cr)

The results of chromium (Cr) content showed that, maize stover had the highest value of 0.07% followed by beni-seed straws with 0.05% as shown in Table 2. The results showed that, the overall mean value of chromium content of local salt licks (toka) was 0.05% while the range was from 0.03 to 0.07%.

The results again corroborated Njidda (2011); Njidda and Olatunji (2012) who reported low mineral contents of indigenous forages in Nigeria. Other studies showed that, chromium is an essential trace element that can be used to improve insulin sensitivity and enhance protein, carbohydrate, and lipid metabolism (Close, 2006; Suttle, 2010; L´opez-Alonso, 2012). It may also enhance muscle mass, weight loss, and glucose control (L´opez-Alonso, 2012). It is a metallic element that people need in minute quantities (L´opez-Alonso, 2012). Good sources of chromium include broccoli, liver and brewers' yeast (L´opez-Alonso, 2012). Chromium deficiency is rare and there have been no reported cases of chromium poisoning due to food intake (L´opez-Alonso, 2012). However, large intake of chromium in supplement form can cause stomach problems, low blood sugar, and kidney or liver damage (L´opez-Alonso, 2012).

Heavy Metals

Lead (Pb)

The results of lead (Pb) content showed that, maize stover had the highest value of 0.02%, followed by beni-seed straws and sorghum stover with 0.01% as shown in Table 2. The least value was from maize cobs and maize stover with 0.00%. The results showed that, the overall mean value of lead content of local salt licks was 0.00% while the range was from 0.00 to 0.02%. The little or no lead concentration in this study is an indication that, the product is safe for used by the livestock producers to optimize performance. Because lead's toxicity was recognized and its use has since been phased out of many applications (Astrid, Helmut & Sigel, 2017). However, many countries still allow the sale of products that expose animals and humans to lead poisoning, including some types of paints and bullets. Lead is a neurotoxin that accumulates in soft tissues and bones; it damages the nervous system and interferes with the function of biological enzymes, causing neurological disorders, such as brain damage and behavioral problems (Astrid, Helmut & Sigel, 2017).

Nickel (Ni)

The results of nickel (Ni) content showed that, maize cobs; beni-seed straws, sorghum stover, cowpea husks and maize stover had little or no value of 0.00% each as shown in Table 2. The results showed that, the overall mean value of nickel content of local salt licks (toka) was 0.00% while the range was from 0.00 to 0.00%. The low or no concentration of nickel in mineral content produced from crop residues is a proof that, minerals from crop residues are safe to use for livestock production. Research has it that, nickel is a poisonous heavy metal that could affect livestock negatively when consumed in large quantity (Street & Alexander, 1944).

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CONCLUSION AND RECOMMENDATIONS

This study has found that, local salt licks made from crop residues contained seven (7) macro-elements namely: Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Phosphorus (P), Chlorine (Cl) and Sulfur (S) and ten (10) micro-minerals such as Iron (Fe), Zinc (Zn), copper (Cu), Manganese (Mn), Iodine (I), Molybdenum (Mo), Cobalt (Co), Selenium (Se), Fluorine (Fl) and Chromium (Cr). The local salt licks produced from crop residues have little or no heavy metals. Therefore, they could be used as substitute mineral supplements in livestock feeds since all livestock require some percentage of mineral elements for cellular respiration, nervous system development, protein synthesis, metabolism and reproductive purposes.

In order to improve the full utilization of local salt licks (toka) produced from crop residues in Adamawa State, Nigeria, additional or more mineral elements should be studied in the future. Similarly, feeding or biological trials should also be conducted to establish inclusion levels, preference and acceptability of local salt licks (toka). Local and commercial livestock producers are encouraged to try feeding the local salt licks (toka) produced from crop residues to their animals as cheaper and readily available mineral licks.

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