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Laboratory Assessment of Different Kanwa-Based Mineral Lick for Ruminant Nutrition

A. Abdulkarim [a], K. M. Aljameel [b*], S. A. Maigandi [c] and Y. Na-Allah [c]

[a] *Department of Animal Science, Federal University Dutse, Nigeria.*
[b] *Department of Animal Science, Federal University Dutsin-Ma, Nigeria.*
[c] *Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This was conducted to analyse the chemical composition of *Kanwa*-based mineral blocks.Analysis of thechemical composition of all the sources of*Kanwa*-based mineral blocks used in this research was carried out at the Sokoto Energy Research Centre, Usmanu Danfodiyo University, Sokoto. The *Kanwa* used were *Kanwan Bai-Bai, Kanwan Kolo, Hogga, Balma* and conventional mineral lick to represent treatment 1, 2, 3, 4 and 5 respectively. The data obtained from the laboratory report are presented as it is. The result of the survey shows that 94.17% of the respondents offer *Kanwa* to their animals. Majority use *Balma* (32.74%), other types of *Kanwa* used by the respondents include*Burunguzu*(9.73%), Table salt (19.47%), *Hogga*(5.3%) and *Jan gishiri*(0.88%). The result of the analysis of different types of *Kanwa* shows that T1 (*Kanwan Bai-Bai*) had higher amount of Sodium, Potassium, Calcium, Iron, Chromium and Manganese.

Keywords: Kanwa; physical; mineral; mineral lick.

**Corresponding author: E-mail: muhdkjameel@gmail.com;*

1. INTRODUCTION

"Ruminant animals normally obtain most of their minerals from the feeds and forages they consume. Their mineral intake is therefore influenced by factors that determine availability of the mineral in plants" [1]. "The species type and stage of growth of the plant, climatic factors especially type of soil and rainfall, fertility and seasonal conditions are important factors that determined the plants' mineral contents. The importance of any of these factors varies with the mineral element in question and the interactions of the listed factors with the crop or pasture husbandry, including the use of fertilizers, soil amendments, irrigation, crop rotation, intercropping and type of cultivars used" [1].

Up to eighteen (18) mineral elements have been found to play essential functions in the plants and animals' metabolism. They include Calcium (Ca), Phosphorus (P), Sodium (Na), Chlorine(Cl), Potassium (K), Magnesium (Mg), Sulphur (S) (designated as major or Macro-minerals, required by animals at more than 100 ppm). Others areIron (Fe), Zinc (Zn), Copper (Cu), Cobalt (Co), Manganese (Mn), Iodine (I), Selenium (Se), Chromium (Cr), Molybdenum (Mb), Silicon (Si), Nickel (Ne), Arsenic (Ar) (designated as trace elements or Micro-minerals, required by animal at less than 100 ppm). Others elements whose essentiality is inconclusive include Vanadium (Vd), Boron (B), Lithium (Li), Lead (Pb), Fluorine (F), Cadmium (Cd) and Tin (Sn) (ACIAR, 1996). McDonald et al. [2] restricted essentiality to a mineral element that has been proven to have a metabolic role in the animal body. However, Marcy and Grey (2005) asserted that "an element is generally considered essential if it is proven that the purified diets lacking the element cause deficiency symptoms in animal and that those symptoms can be eradicated or prevented by adding the element to the diet". "Although mineral elements make up a small portion of an animal's diet, they play important roles not only in their metabolism of the food substances, but also in their health, growth and reproduction. Numerous mineral deficiencies, imbalances and toxicities have been reported as economically important in livestock production throughout the world" [2].

"Common sources of minerals supplements are Limestone for Calcium, di-Calcium phosphate for Phosphorus, common salt for Sodium, calcined magnesite for Magnesium, Sodium selenite for selenium etc. The commonly used sources of mineral for supplementation in the Sudan and Sahel vegetation zone of Nigeria is Trona (*Kanwa*-Hausa, *Kaun-Yoruba and Igbo)* and is erroneously called 'potash' even though it contains very low amounts of Potassium as compared to Sodium" [3]. *Kanwa* is a dry lake salt which is largely hydrated Sodium carbonate (Na_2CO_2 $NaHCO_3.2H_2O$) [4,5], which occurs as a common deposit of saline lakes. *Kanwa* deposits are usually covered by shallow water of less than two feet deep (Makanjuola and Beetlestone, 1971). Various types of *Kanwa* have been extensively used by Cattle and Sheep farmers,which include *Hogga, Balma, Kanwan Baibai, Kanwan Kolo, Jar Kanwa, Gallu, Kurhua, Budus* etc. This study investigated the use of different types of *Kanwa* as sources of mineral supplements in sheep nutrition through evaluation of their utilisation of some common types by livestock farmers, chemical composition, including the mineralogical contents and their effects on sheep production.

Studies have been conducted on *Kanwa* [6,7,8] but most of the studies reviewed were restricted to only one type of *Kanwa (Ungurnu)*, and were largely carried out on humans. Different types of *Kanwa* (hydrated sodium carbonate) have been extensively used by sheep herders to serve different purposes. They offer them either as free access or incorporated in the diet of animal under the traditional husbandry system in Northern Nigeria. However, there has been no sufficient on the mineralogical and chemical contents of the various types of *Kanwa*.

2. MATERIALS AND METHODS

2.1 Description of the Experimental Site

This study was conducted at the Energy Research, Usmanu Danfodiyo University, Sokoto, Nigeria. Sokoto is located at latitudes 13^o 0' 21.1428'' N and longitudes 5^o 14' 51.1872'' E [9]. Sokoto state is within the Sudan Savannah vegetation zone and on 350m altitude [10]. The climate is characterised by two distinct seasons (wet and dry). The wet season starts in May/June and end in September/October while the dry season covers from October to April/May. Mean annual rainfall varies from 500 to 700mm with a wider inter annual variations. Relative humidity is moderate to high (51— 79%) during the rainy season and very low (10—25%) during the dry season. Mean monthly temperatures vary widely; from 14^oC in December/ January to about 41^oC in April with annual mean of 29^oC.

2.2 Chemical Composition of *Kanwa*-Based Mineral Blocks

Analysis of the chemical composition of the different types of*Kanwa*-based mineral licks was carried out at the Sokoto Energy Research Center, Usmanu Danfodiyo University, Sokoto.

2.3 *Kanwa*-Based Mineral Block Formulations

Varieties of *Kanwa* and binding agents (gum Arabic and Locust bean powder) used in this research were sourced from *Kara* market, Sokoto.A rubber pan (mudu) was used to form the *Kanwa* blocks. Five hundred gram (500 g) of Gum Arabic was dissolved in 2 litres of water and was later mixed with the remaining ingredients as shown in Table 1. The ingredients were homogeneously mixed. The mixture was then poured into the wooden frame lined with Polythene bag and allowed to dry at room temperature to form the block. The chemical composition of conventional mineral block which is used as control in this experiment is presented in Table 2.

2.4 Determination of Chemical and Physical Properties of *Kanwa*

Sample of treatments shown in Table 1 were analysed for metal content at the Sokoto Energy Research Center, Usmanu Danfodiyo University, Sokoto. Calcium and Magnesium were determined using Complex metric method as in (AOAC, 1984). The Corning 421 flame emission photometer was used for the estimation of Sodium and Potassium content [11]. Zinc, Iron, Cadmium, Manganese, Lead and Copper were determined using the Perkin-Elmer model 403 Atomic Absorption Spectrophotometer [12].

2.5 Determination of Solubility

Fifty grams (50 g) of each sample was separately added to 100cm^3 of boiling water and stirred for some timeuntil no more salt can dissolve. The solutions were allowed to cool at room temperature and filtered. Then 20cm^3 of the saturated solution of each sample was evaporated to find the amount of salt that dissolved in it [13].

Table 1. Formulation of the *Kanwa*-based mineral lick

Ingredient (%)	Treatments				
	1	**2**	**3**	**4**	**5**
*Kanwa*nbai bai	75	-	-	-	-
*Kanwa*n kolo	-	75	-	-	-
Balma	-	-	75	-	-
Hogga	-	-	-	75	-
Gum Arabic	10	10	10	10	-
Locust bean powder	15	15	15	15	-
Total	100	100	100	100	-

Note: Treatment 5 (control) represent Conventional mineral lick

Table 2. Composition of a conventional mineral lick (Control)

Contents	Quantity (mg)
Manganese oxide	145
Cobalt	15
Zinc	230
Copper	162
Iron	800
Selenium	5
Iodine	10
Analytic constituents	Percentage (%)
Sodium as Sodium chloride	37.6
Magnesium as Magnesium oxide	0.32
Ash	85

Source: Hebei New Century Pharmaceutical Co. Ltd.

Plate 1. Formulated *Kanwa* blocks

2.6 Determination of Density

Principle of Archimedes was used; five (5 g) of each of the previously dried sample was carefully placed into a 10cm^3 measuring cylinder containing 5cm^3 of kerosene and the differences in volume was recorded [13].

2.7 Determination of pH

One gram (1g) of each of the samples were weighed and dissolved in 10ml distilled water. The solution was properly mixed to allow complete dissolution and pH meter was used to determine the pH after proper calibration of the electrode. The result obtained was the average of duplicate determination [14].

2.8 Determination of Moisture Content

Four (4 g) of each of the samples were placed into a weighed petri dish and dried in an oven at 105^{0}C for 4 hours. The dried samples were placed in a desiccator, allowed to cool and weighed again. The weight loss expressed as a percentage was taken as percent moisturecontent. The result was obtained as the average of two independent determinations [14].

Moisture Content (%) = $(W1-W2)$ / $(W1-W0)$ x 100

W0= weight of Petri dish before

W1=Weight of sample + Petri dish before drying

W2=Weight of sample + Petri dish after drying

2.9 Determination of Degree of Hydro-Absorption

Four grams (4 g) of each of the samples were placed in dried and weighed porcelain crucibles of identical sizes. The crucibles containing the samples were kept above water in a desiccator (to provide saturated atmosphere). The increase in weight of the sample after 24 hours was recorded as degree of Hydrogen absorption [13].

2.10 Determination of Conductivity

From each sample 50 cm^3 of distilled water was taken in a beaker at room temperature. The sample was added to the water in a stepwise manner; 1 g in each step from 0 – 10 g and 2 g in the subsequent steps from 10 – 20 g with continuous stirring after each addition to ensure complete dissolution. The electrodes were kept 4.5 cm apart; the resistance (R) and conductance (C) of the solutions were recorded after every addition [13].

2.11 Mineral and Heavy Metal Determination

One gram (1 g) of each sample was digested using 5ml concentrated HNO_3 and 2 ml of concentrated $HClO_4$. After digestion, the samples were filtered, and the filtrate was diluted to 100 ml with deionized water. The solution was digested in a fume cupboard by heating to a final volume of 3 – 5 ml. Ten to fifteen (10 – 15 ml) of water was added and filtered through an acid washed filter paper into a 50ml volumetric flask. The filter paper was washed with water and diluted to volume with deionized water. Flame photometer was set up according to the instructions in the instrument manual. The instrument was calibrated for each determination using appropriate standard solutions. Distilled water was aspirated in order to set the meter at zero. The highest concentration of the standard solutions was aspirated in order to set the meter to 100% deflection. Percentage deflection reading of all the intermediate standard solutions was recorded. The sample solution was aspirated and the reading (%) was recorded. The concentration of the element in sample solution was noted and K and Na contents in salt samples were measured [15].

2.12 Determination of Copper, Iron and Manganese using Atomic Absorption Spectroscopy

Atomic absorption spectrophotometer was set up according to the instructions in the manual. The digested sample solution was placed in a 100 ml volumetric flask and make up to 100 ml. Three concentrations of standard solution of a particular metal to be analysed were selected; blank solution was aspirated and adjusted to zero. Each standard solution was aspirated into flame, calibration curve for absorbance versus concentration of each standard solution was prepared and the reading of the prepared samples solution was obtained directly from the instrument [15].

2.13 Statistical Analysis

Data generated from the laboratory were reported as obtained.

3. RESULTS

3.1 Physical Properties of Different Formulated *Kanwa* Blocks

The physical properties of different formulated *Kanwa* blocks was presented in Table 3. The result of the analysis of different varieties of *Kanwa* showed T2 to had higher solubility and ash content. Density was higher in T5, but pH and degree of hydro-absorption were lower. Moisture content was higher in T1. Conductivity was higher in T3 and lower in T2.

3.2 Mineral Composition of Different Formulated *Kanwa* Blocks

The mineralogical composition of different formulated *Kanwa* blocks was presented in Table 4. The result of the analysis of different varieties of *Kanwa* showed T2 to had higher amount of Sodium, Potassium, Calcium, Selenium, Chromium and Manganese. Copper and Zinc were higher in T1 while Iron was higher in T5. Magnesium was higher in T3. The result showed that all the forms had no Nickel and Lead.

4. DISCUSSION

4.1 Physical and Chemical Properties of Different *Kanwa* Blocks

Solubility is higher in *Kanwa*n*Kolo* (T2) and lowest in conventional mineral block (T5). The lower solubility of conventional mineral block (T5) might be due to absence of particles with weak intermolecular bonds that can be easily broken by water molecule [16], or due to the compact-ability of the molecules as shown by their density. The results obtained indicated the pH of the samples to be basic. Moisture content was higher for *KanwanBai-bai* and lower in *Kanwa*n-*kolo*, this might be due to the percentage of water content absorbing molecules present within the sample [17]. This is further clarified by degree of hydro-absorption of the samples (treatments). Conductivity of the samples indicated that all the samples can conduct electricity and have equal degree of conductance. The chemical properties show that *Trona* (*Kanwa*) has high amount of Ca, Mg, Na and K. The high amounts of K, Ca and Na of the samples might be due to loss of fine compounds from the surface by wind action, leaving pavement of massive aggregates in the excavation areas. This is caused by high temperature (46°C) experience in areas where evaporation exceed precipitation and moisture may be lost from the *Trona* beds, which leaves other saline related conditions and precipitation of other salts and efflorescence results [18].

Table 3. Physical properties of different *Kanwa* blocks

Parameter	Treatment				
	1	**2**	**3**	**4**	**5**
Solubility (g/100g)	8.76	10.46	8.54	8.67	5.32
Density (g/cm^3)	2.34	2.11	2.92	2.95	3.62
pH	9.43	8.70	9.51	9.33	8.11
Moisture content (%)	4.49	1.17	1.28	3.21	2.04
Ash content (%)	82.11	98.14	97.50	88.13	92.13
Degree of hydro-absorption	5.71	4.12	4.41	4.04	2.33
Conductivity (ohm)	19.78	19.32	19.89	19.39	19.88

1= Kanwan Bai Bai block, 2= KanwanKolo block, 3= Balma block, 4= Hogga block, 5 = Conventional Lick

Table 4. Mineral contents of different types of *Kanwa*-based blocks in mg/kg

Treatment	Na	K	P	Mg	Ca	Cd	Cu	Se	Ni	Pb	Zinc	Cr	Mn	Fe
1	16550	13250	5.11	1992.92	19313.43	0.11	5.88	36.06	Nd	Nd	7.02	0.65	8.83	1771.04
2	21720	16360	3.95	1981.02	21268.66	0.23	1.42	47.90	Nd	Nd	6.62	2.36	13.58	1481.68
3	20460	10210	4.37	2153.20	14522.39	0.03	1.61	38.81	Nd	Nd	6.71	0.11	8.47	1706.49
4	25500	17100	5.60	1981.85	11701.50	0.03	1.97	36.15	Nd	Nd	3.76	1.45	8.14	1965.61
5	22660	15260	4.09	2003.06	18582.09	0.09	3.00	41.75	Nd	Nd	3.65	0.48	8.83	2379.68
R V	90-180	50-80	160-380	120-180	200-820	-	7-10	-	-	-	20-33	-	20-40	30-50

*Nd = Not detected, 1= Kanwan Bai Bai block, 2= Kanwan Kolo block, 3= Balma block, 4= Hogga block, 5 = Conventional Lick. RV = Reference values (Requirement for Sheep), *source = (NRC, 1975)*

Moreover, different secondary minerals of the same metal may form under a variety of chemical conditions thereby leading to a great diversity of minerals species [18,19]. The sample of treatments shows that *Trona* occurs in association with other secondary minerals, such as Iron,Magnesiumand Phosphates. Others such as Kainite, $MgS0_4$ $KCl._{3H20}$, Carnallite, $KMgCh.5H_20$ and Polyhalite $K_2CaMg\ (S0_4)_4{\bullet}2H_20$ as reported by Montimer, [19]; Garrels and Christ; [20]. Generally, in these environments,Phosphates may be derived from FePS or other Phosphorus containing Sulphursalts because wide range of secondary minerals associated with *Trona*.

5. CONCLUSION

Analysis of the chemical composition of the different sources of *Kanwa* revealed high presence of Sodium and other macro minerals. There are remnants of micro-minerals though in small proportion. The laboratory report showed no presence of heavy metals hence *Kanwa* can be used in sheep production without any adverse effect.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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