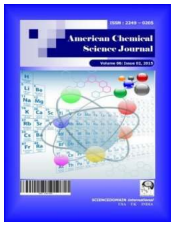

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Studies of Some Essential Elements Composition of Potash Deposits Found in Yusufari Local Government Area of Yobe State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author PDS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors HMM and HB managed the analyses of the study. Authors SMH and AAM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The essencial elemental composition of natural potash deposits obtained in Yusufari Local Government Area of Yobe state has been determined. The samples were obtained in three areas namely; Madukuri, Kotufa and Kirba. The highly concentrated essential elements were potassium followed by sodium. K distribuhtion showed; Madukuri (9625±2.5 to 18035±2.2 mg/kg), Kotufa (855±1.5 to 12493±3.1 mg/kg) and Kirba (11472±2.9 to 25436±3.2 mg/kg). Na distribution showed; Madukuri (3751±1.6 to 5368±1.3 mg/kg), Kotufa (3625±1.9 to 3912±1.8 mg/kg) and Kirba (3535±2.1 to 5535±3.2 mg/kg). The next essential components were Ca followed by Mg. Ca distribution showed; Madukuri (554±0.9 to 885±1.1 mg/kg), Kotufa (448±1.7 to 933±1.5 mg/kg) and Kirba (603±1.4 to 828±1.4 mg/kg). Mg distribution showed; Madukuri (53.4±0.8 to 58.5±0.5 mg/kg), Kotufa (57.4±0.05 to 58.8±0.2 mg/kg) and Kirba (53.4±0.8 to 58.5±0.5 mg/kg). The levels of

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essential component decrease in the order as K >> Na >> Ca> Mg. The level of essential element found in potash may complement of the requirement of these elements in animal nutrition on consumption.

Keywords: Studies; essential; element; potash; Yusufari.

1. INTRODUCTION

The term "potash" originally referred to impure form of potassium salt (mostly potassium carbonate, K_2CO_3) that was obtained from wood ashes [1]. Potash composed of 85.4% K_2CO_3, 5% NaCl, 1.5% $MgCl_2$, 2.5% $CaCl_2$, 0.15% H_2O and 5.45% silicate and others [2]. Potash became the common name for potassium carbonate and all other water – soluble potassium salt. These are almost exclusively retrieved through mining and it is now used as a collective grouping for the commercial product that can be derived from it [1]. Potash denotes a variety of mined and manufactured salts, which contain the element potassium in water soluble form such as potassium chloride, KCl, potassium oxide, K_2O and potassium hydroxide, KOH [3]. The name derives from "Pot – ash", which refers to plant ashes soaked in water in a pot [4]. A number of chemical compounds containing potassium use the word potash in their traditional names this includes potash fertilizer (potassium oxide, K_2O), caustic potash or potash lye (potassium hydroxide, KOH), carbonate of potash, salt of tartar or pearl ash (potassium carbonate, K_2CO_3), chlorate of potash (potassium chlorade, $KClO_3$), nitrate of potash or salt peter (potassium nitrate, K_2NO_3) and sulphate of potash (potassium sulphate, K_2SO_4). When potash is dissolve in water only the carbonate and perhaps chlorides and sulphates of alkali metals go into solution including minute fraction of thus other metals which are not or sparingly soluble [5]. Hydroxide and carbonates of K and Na are soluble in water, applying the explanation of [6] the alkaline character of potash (crude form of potassium carbonate, K_2CO_3) when dissolve in water is

$$H_2O_{(l)} \rightleftharpoons H_{(aq)}^{+} + OH^{-}_{(aq)}$$

$$K_2CO_{3(s)} \longrightarrow 2K^{+}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$H_2O_{(l)} + CO_3^{2-} \rightleftharpoons HCO_3^{-}{}_{(aq)} + OH^{-}_{(aq)}$$

$$H^{+}_{(aq)} + CO_3^{2-} \rightleftharpoons HCO_3^{-}{}_{(aq)}$$

Natural potash deposits are formed as a result of evaporation of ancient lakes and seas over a long period of time. All the major solid potash deposits are of marine origin and were formed due to the evaporation of sea water in almost all geographical systems in the earths's history [7]. In geological past, large inland seas existed for a time, which were separated from the ocean by straits and bars. These bars hindered or completely halted the influx of salt bearing sea water in the Inland seas evaporate. As a result of the salt concentration of the water increased and dissolved salt crystallized, which where them deposited in the order of there solubility, first rock salt and later potassium and magnesium salt [4]. The geology within the drainage basin impacts chemistry of run off and spring waters and the resulting brine and thus controls which constitutuent and the ease with which a given potash can be extracted as reported by [8-13]

Studies have found a positive correlation between potassium, lithium and boron in brines which is probably indicative of their common origin in vocaniclastic terranes that typically are associated with convergent plate boundaries [14,15,10]. Elevated levels of magnesium are also typical of many of the closed – basine brines [15]. Sizes of these deposits are highly variable, both in term of area and the mount of potash contained within the brines [13]. The major objective of this work is to determine the essential elements composition in potash deposits found in yusufari local Government Area of Yobe State, Nigeria.

2. MATERIALS AND METHODS

2.1 Instruments/Apparatus

Analytical weighing balance, Back scientific 210 VGP atomic absorption spectrophotometer, PFP7 flame photometer, laboratory glass wares, whatman No. 42 filter paper, spatula, motar, pistile, and biomega H400 – HS hot plate.

2.2 Chemicals/Reagents

All the reagents and chemicals used were of analytical grade. 60% $HCl0_4$, H_2SO_4 analar SG 1.84, $HN0_3$ Analar SG: 1.42, NaCl, KCl, $MgCl_2$. $6H_20$, $CaCl_2$ and distilled H_20.

2.3 Area of Study

Yobe state lies between latitude 12º00′N and longitude 11º30′E. Yusufari lies between latitude 13º04′06″ N and longitude 11º10′33″ E with altitude of 305 m and area of 3,928 km^2.

2.4 Sampling

There were nine sampling locations where the samples were collected. Area where the samples were collected include Madukuri, Kotufa and Kirba. The potash was sampled using the method described by [16].

2.5 Samples Preparation

The sample preparations were done according to the method described by [17].

2.6 Sample Digestion

The samples were digested according to the requirement for the determination of elements using Atomic Absorption Spectrometry (AAS) and Flame Emission Spectrometry (FES). The digestion method has been described by [18].

2.7 Determination of Essential Elements

K and Na were determined using PFP7 flame photometer and the method by [19] was adopted. Ca and Mg were determined using VPG210 atomic absorption spectrophotometer and the method by [20] was adopted.

3. RESULTS AND DISCUSSION

The results for the concentrations of essential elements K, Na, Ca and Mg in different areas are presented in Tables 1 – 3 below.

The results of the analysis were treated using different statistical tools such as the mean, standard deviation and coefficient of variation to analysed the data. Potassium and sodium were highly concentrated in all the areas (Madukuri, Kotufa and Kirba) compared with Ca and Mg. K however is much higher than Na in all the areas and at all locations this is in accordance with the work reported in [21]. K levels showed these ranged; Madukuri (9625 to 18035 mg/kg), Kotufa showed (10827 to 12493 mg/kg) and Kirba showed (11472 to 25436 mg/kg) with the CV% ranged as follows; Madukuri (0.012 to 0.027%), Kotufa (0.017 to 0.029%) and Kirba (0.013 to 0.029%) for Tables 1, 2, and 3 respectively. These showed that there is no much variations in the mean concentration of K at each location because the deposit shows the same mineralogical characteristic as report by [22]. Na levels at the different areas are; Madukuri (3751 to 5368 mg/kg), Kotufa (3625 to 3912 mg/kg) and Kirba (3535 to 5535 mg/kg)with the CV% ranged; Madukari (0.024 to 0.047%), Kotufa (0.046 to 0.055%) and Kirba (0.052 to 0.059%) for Tables 1, 2, and 3 respectively. This showed that there is no much variation between the mean concentrations of Na at all the locations. The essential element Na showed significant concentration in all the locations because, potash –bearing brine deposits contain components like sodium carbonate and sodium sulfate which may contributes to the higher level of Na in potash as reported by [23,24].

Calcium and magnesium being the next essential components are much lower in concentrations compared to the essential elements K and Na in all the areas and all the locations. Ca however is much higher in concentration than Mg in all the areas and locations studied. Ca levels at different areas showed the concentration ranged as follows; Madukuri (554 to 885 mg/kg), Kotufa (448 to 933 mg/kg) and Kirba (603 to 828 mg/kg) with the CV% which ranged; Madukuri (0.12 to 0.18%), Kotufa (0.16 to 0.38%) and Kirba (0.17 to 0.23%) for Tables 1, 2, and 3 respectively. These shows that there no much variation s between the mean concentration of Ca in all the location. There is a connection between $MgSO_4$, potash and $CaCl_2$ brine in magnetically active rift basins that caused the accumulation of these component as reported by [25]. For Mg the levels are; Madukuri (53.4 to 58.5 mg/kg), Kotufa (57.4 to 58.8 mg/kg) and Kirba (54.4 to 58.3 mg/kg) with the CV% which ranged as follows; Madukuri (0.012 to 1.5%) Kotufa (0.09 to 0.51%) and Kirba (0.35 to 1.54%) for Tables 1, 2, and 3 respectively. Elemental level of Mg are also typical of many closed –basin brine s as reported by [15]. The essential elements content showed the dominance of K in all the locations and areas studied while Mg had the lowest values. The main component in potash was K which may be attributed to the most abundant components in potash like potassium chloride and potassium oxide in Yusufari L.G.A were similar to the deposit of western Canada and Qaidam basin as reported by [26]. The potash deposit in Yusufari L.G.A contain high amount of K the principal element for the production of potash fertilizer as reported by [4]. From the results one can conclude that the levels of the essential components are in the order of decreasing order as K >> Na >> Ca > Mg.

Table 1. Mean concentrations (mg/kg) of essential elements in potash at Madukuri

Area	Locations	K	Na	Ca	Mg
Madukuri	A	18035±2.2 **(0.012)**	5368±1.3 **(0.024)**	544±0.9 **(0.17)**	53.4±0.8 **(1.50)**
	B	10869±2.9 **(0.027)**	800±1.8 **(0.047)**	3885±1.1 **(0.12)**	57.5±0.7 **(0.012)**
	C	9625±2.5 **(0.026)**	3751±1.6 **(0.043)**	660±1.2 **(0.18)**	58.5±0.5 **(0.85)**

Each value is the mean values of three determinations ± S.D, each value in the parentheses is the coefficient of variation CV%, S.D is the standard deviation, A- Northern Madukuri, B- Central Madukuri, C- Southern Madukuri

Table 2. Mean concentrations (mg/kg) of essential elements in potash at Kotufa

Area	Locations	K	Na	Ca	Mg
Kotufa	D	10827±2.8 **(0.029)**	3912±1.8 **(0.046)**	933±1.5 **(0.16)**	58.4±0.3 **(0.51)**
	E	8855±1.5 **(0.017)**	3625±1.9 **(0.052)**	838±1.8 **(0.21)**	58.8±0.2 **(0.21)**
	F	12493±3.1 **(0.025)**	3822±2.1 **(0.055)**	448±1.7 **(0.38)**	57.4±0.05 **(0.09)**

Each value is the mean values of three determinations ± S.D, each value in the parentheses is the coefficient of variation CV%, S.D is the standard deviation, D- Northern Kotufa, E- Central Kotufa, F- Southern Kotufa

Table 3. Mean concentrations (mg/kg) of essential elements in potash at Kirba

Area	Locations	K	Na	Ca	Mg
Kirba	G	25436±3.2 **(0.013)**	5535±3.2 **(0.058)**	828±1.4 **(0.17)**	54.4±0.6 **(1.10)**
	H	11604±3.4 **(0.029)**	3659±1.9 **(0.052)**	603±1.4 **(0.23)**	58.3±0.9 **(1.54)**
	I	11472±2.9 **(0.025)**	3535±2.1 **(0.059)**	765±1.7 **(0.22)**	57.6±0.2 **(0.35)**

Each value is the mean values of three determinations ± S.D, each value in the parentheses is the coefficient of variation CV%, S.D is the standard deviation, G- Northern Kirba, H- Central Kirba, I- Southern Kirba

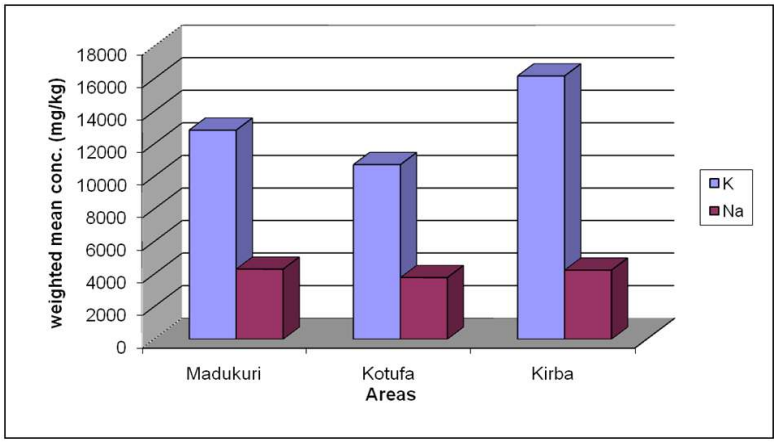

Fig. 1. Comparison of K and Na at different areas

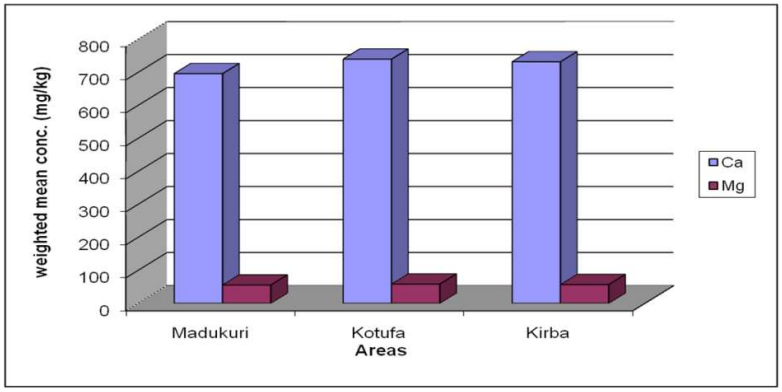

Fig. 2. Comparison of Ca and Mg at different areas

3.1 Comparison of Essential Elements at Different Areas

Above Fig. 1 summarizes the comparison of essential elements K and Na at the different areas. This figure confirms that K levels were very significantly much higher in all the areas (Madukuri, Kotufa and Kirba) as compared with Na. Above Fig. 2 summarizes the comparison of essential elements Ca and Mg at different areas (Madukuri, Kotufa and Kirba). This figure also confirms that Ca levels were significantly much higher compared with Mg in all the areas (Madukuri, Kotufa and Kirba) and in all the locations studied.

4. CONCLUSION

The following conclusions were made:

(i) The essential elements K and Na were found at elevated levels in all the areas and locations. The K levels however were much more higher compared to Na in all areas and locations.
(ii) The Ca and Mg levels were much lower than K and Na, however the Ca level were much higher in concentration compared to Mg at all the areas and locations.
(iii) The order of concentrations of essential element are in the order. K >> Na >> Ca > Mg.

5. RECOMMENDATIONS

- Potash can be used as a source of essential mineral supplement to human and animals.
- Potash deposits in yusufari L.G.A of Yobe contained high amount of potassium, therefore it can be used as a source of potassium in manufacturing potassium fertilizer which can boost agricultural production.
- Potash is used for the production of glass and soap and also potassium silicate which is obtained from potash is used as dehydrating agent and to produce pigment, printing Ink, soft soap and laboratory reagent, I therefore recommend that the abundant potash in Yusufari L.G.A of Yobe state Nigeria can be utilized for various industrial purposes.
- I also recommend that the Raw Material Research and Development Council (RMRDC) and Ministry of Solid Mineral Development should make effort to exploit the potash in Yusufari L.G.A Yobe State, Nigeria.
- Finally, I recommend that further research should be carried out to determine the level of heavy metals in potash.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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