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International Digital Organization for Scientific Research ISSN: 2550-794X
IDOSR JOURNAL OF SCIENTIFIC RESEARCH 4(1) 84-90, 2019.

Alkalis Extract from banana peels ash used as an alternative source for removal/reduction of total and calcium hardness of water.

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ABSTRACT

The purpose of this study is to use the alkalis extract of banana peels ash as an alternative source of total and calcium hardness reduction in water. This was carried out by ashing the peels and the ash was leached in distilled de-ionized water, filtrated and the filtrate applied in five water boreholes each from Abakaliki, Ohaukwu and Onicha respectively between Nov. – Dec 2018, for water hardness reduction. Complexometric method was used to determine the water hardness. The results showed total hardness values before treatment to be 190, 175 and 130 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively, while after treatment with the peels extract the values were 90, 70 and 60 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively between Nov. – Dec 2018. The results of calcium hardness revealed the values before treatment to be 110, 120 and 78 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively, while after treatment with the peels extract the values were 58, 50 and 38 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively between Nov. – Dec 2018. The results from June – July, 2019 was similar and presents the value of total hardness to be 188, 170 and 125 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively before treatment, and after treatment with the peels extract the values were 85, 68 and 60 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively. Calcium hardness results showed the values before treatment to be 98, 120 and 74 mgL^{-1} as $CaCO_3$ for Abakaliki, Ohaukwu and Onicha respectively, while after treatment with the peels extract the values were 56, 50 and 36 mgL^{-1} as $CaCO_3$. This is an indication that alkalis extract from banana peels is effective in removing/reducing both total and calcium hardness of water.

Keywords: Banana peels ash, alkalis, total hardness, calcium hardness, borehole water.

INTRODUCTION

For many decades, Ebonyi state was one of the states in Nigeria invested with guinea worm scourge and other related water borne diseases due to lack of access to safe drinking water [1]. However, there has been drastic reduction in guinea worm disease and other microbial contaminants since 1986 achieved through community based programs. The programs include drilling of borehole, education of local populace to boil and filter their waters before drinking and to cultivate habit of hands washing after defecating. Survey of different water sources used as potable water in Ebonyi State by [2] in 2006 revealed that 42% of the populace depends on borehole. Borehole waters in Ebonyi State are characterized by high levels of hardness, heavy metal content, salty taste, turbidity, odour, and often have brownish thin films on the surface after about 30 mins of sourcing it [3]. These qualities often limit the usage of borehole water in Ebonyi State. The problems may be attributed to the geological strata and hydrogeology of the area due the presence of minerals such as limestone, gupsum and dolomite at Abakaliki which may introduce calcium and magnesium

salts, lead at Ishiagu and Abakaliki. Other mineral deposits present at high levels in aquifers in the state include Zn, As, Mn, Cu, Cr, P and F^- (Ministry of Commerce and Industry, Ebonyi, 2001).
These lead Udedi in 2003 to publish an article titled "From Guinea worm scourge to metal toxicity in waters in Ebonyi state of Nigeria." His publication revealed that contaminant levels of some lethal metals in Ebonyi state water far exceeded the recommended level by the World Health Organization (WHO) and the Standard Organization of Nigeria (SON). Studies have shown that majority of boreholes within Ebonyi state have heavy metals more than the recommended values of WHO and SON. Studies carried out by Obasi and his colleagues in (2015) on heavy metals in Abakaliki boreholes revealed heavy metal levels range as Cd (0.011-$0.036mgh^{-1}$), Hg (0.069-$0.700mgL^{-1}$), Pb (0.4-$0.8mgL^{-1}$), As (0.12 – $0.51mgL^{-1}$) as against Cd ($0.003mgL^{-1}$), Hg ($0.002mgL^{-1}$) and Pb ($001mgL^{-1}$), As ($0.01mgL^{-1}$) for [4]. [5] reported Pb to be 0.05 ± 0.003 and Zn to be 114.40 ± 0.10. [6] showed borehole water total hardness range between 55-$289mgL^{-1}$ and revealed that only three out of the fifteen samples met the [7], guideline for drinking water range of 100-$250mgL^{-1}$ and Nigeria international standard (N1S) of $150mgL^{-1}$, which are indication that borehole water in Ebonyi State are contaminated. However, [8] reported range of 32.16 - $34.89mgL^{-1}$, in which the range is below the WHO's (2011) and N1S (2017) guideline limit. Although the studies vary depending on the interaction of other factors like pH, alkalinity and temperature, total hardness above $200mgL^{-1}$ may cause scale deposition in the treatment works, distribution system, formation of scales in pots and kettles, etc [9].
Magnesium and calcium salts are response for hardness in water. Although calcium is important in blood clotting and is needed to empower the contraction of muscles and regulate heartbeat, [10] revealed that excess of calcium causes increased volume of urine, muscle fatigue, poor mental concentration and formulation of kidney stones [11]. [12] reported that excess calcium contributes to cardiovascular disease. Magnesium ion is essential in the human body and is an important constituent of chlorophyll [13] however, low or excessive level of Mg results in kidney failure and heart attack [14]. The World Health Organization permissible limit for Mg is $50mgL^{-1}$ and calcium is $75mgL^{1-}$ According to [15], water hardness below 60 mg L^{1-} is regarded as being soft, 60–120 mg L^{1-} as moderately hard, 120–180 mg L^{1-} to be hard and more than 180 mg L^{1-} to be very hard. Where there is water hardness, water softening is necessary to reduce the negative effects. Although hard water can soften either by boiling or using water softener like sodium carbonate or removed by ion exchange depending on the nature of hardness, the methods are expensive and sometimes have adverse effects. These resulted in a search for alternative low-cost potash extract from banana peels ash to reduce water hardness. Researchers have shown that banana peels are good sources of potash when ashed, dissolved in water and filtered [16], [17]. The filtrate is the crude potash (potassium) in which the quality depends on temperature, materials used and nature of the soil [18]. Banana peels have been adjudged to content cellulose, hemicelluloses, lignin and pectin in its biomass consisting of functional groups such as carboxyl, hydroxyl and amine. These functional groups are responsible for the removal of metal ions from water either through ion exchange or complex formation.
This study investigated the use of alkalis derived from banana peels ash to reduce water hardness in fifteen highly hard water boreholes, five each from these three locations: Abakaliki, Ohaukwu, and Onicha LGA, Ebonyi State of Nigeria.

MATERIALS AND METHOD

All reagents used were of analaR grade (Merck products) and were supplied by Cobaxy chemicals, Enugu.

Ash from banana peels was processed according to the methods of [3] [4]. Unripe banana bunch bought at Kpirikpiri market at Abakaliki, was washed with distilled water and peeled. The peels were sun dried for a three days and oven dried for 2hrs at 200 ± 5°C. Weighed 200.00g of the peels were ashed using furnace and then allowed to cool for 3hrs and weighed.

Potash: Ash of 20.0g was dissolved in 100 mL beaker and made to mark with de-ionized water and allowed to stand for 24hrs, then filtered and filtrate used for the water hardness reduction.

Purity of the potash: The method of [8] was followed in determining the purity of the ash. Crude potash of 0.2 g was dissolved with de-ionized water in 50 cm^3 volumetric flask and made to the mark. The solution (10 mL) was pipetted into 100 cm^3 conical flask and diluted 25.0 cm^3 with distilled water, then 2 drops of methyl orange added and titrated against 0.1M HCl. Three replicates were obtained and in duplicate analysis. The reaction above is shown in equation 1.

$K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O$ 1

Determination of hydroxide and trioxocarbonate (IV) contents of the ash

The methods of [11] [12] using double indicator acid-base titration. Ten (10) cm^3 of the mixture was pipette into 100cm^3 conical flask and 2 drops of phenolphthalein was added and then titrated against 0.1M HCl to colourless end point and reading taken. Then 2 drop of methyl orange was added to mixture and titrated from yellow to pink. The phenolphthalein indicator neutralized all the hydroxides and converts the carbonates to bicarbonates, while methyl orange indicator converts bicarbonates to carbon (IV) oxide and water. Equation of reactions:

Phenolphthalein Indicator:

$KOH + HCl \rightarrow KCl + H_2O$ 2

$K_2CO_3 + HCl \rightarrow KCl + KHCO$ 3

Methyl orange Indicator:

$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$ 4

Calculation:

0.1 M HCl required to neutralize KOH = V-Vi

0.1 M HCl required to neutralize K_2CO_3 = 2Vi

Molar concentration of KOH 0.1M (V-Vi)/10 = X

Gram concentration Of KOH = molar mass x X = Y

Molar concentration of K_2CO_3 = 0.1M (2Vi)/20 = a

Gram concentration of K_2CO_3 = molar mass x a = b

RESULTS AND DISCUSSIONS

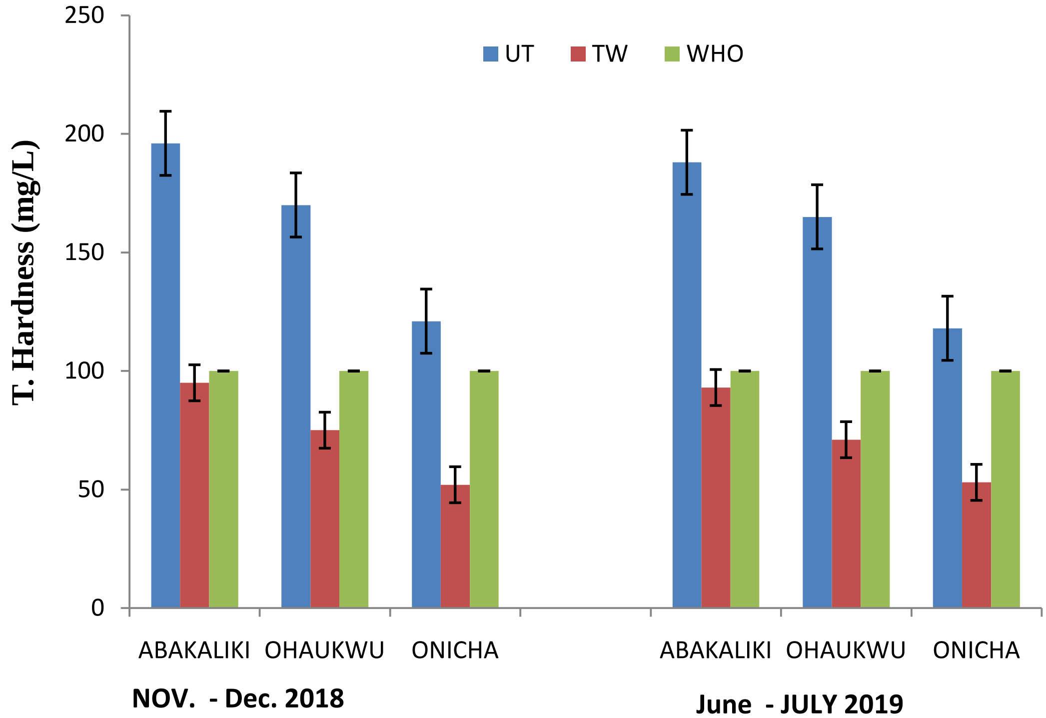

Fig. 1: Total Hardness concentration of the Borehole Samples (UT = untreated, TW = treated)

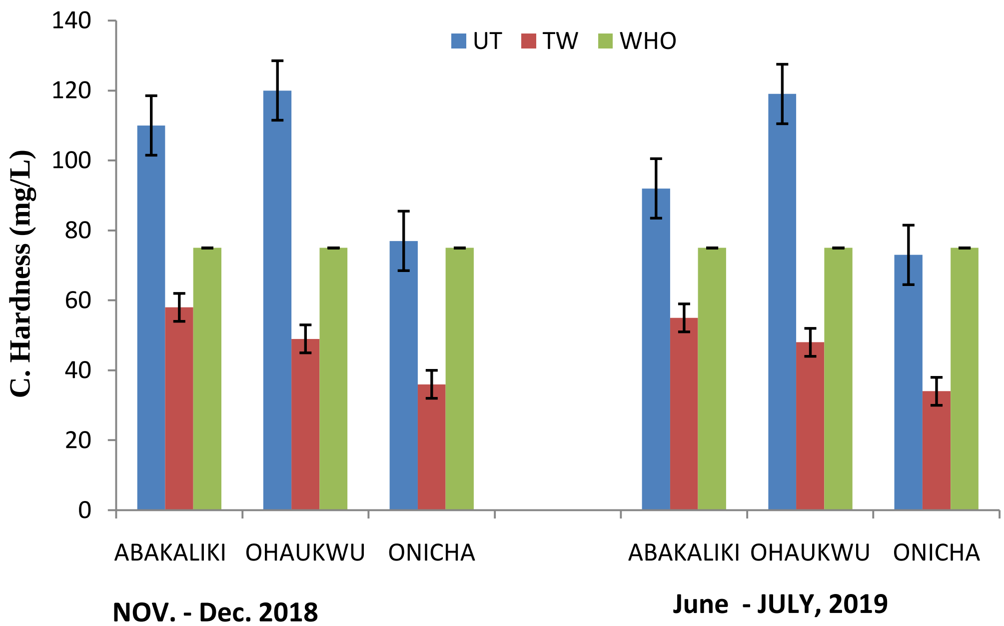

Fig. 2: calcium hardness concentration of the Borehole Samples (UT = untreated, TW = treated)

Figures 1 – 2 is the summary of the findings of the total and calcium hardness of the borehole water samples from Abakaliki, Ohaukwu and Onicha compared with World Health Organization (WHO) standard limits for the two periods –

November to December, 2018 (dry season) and June to July, 2019 (rainy season) in bar chart forms. Figure 1 presented bar chart of total hardness, while Figure 2 presented the bar chart of calcium hardness. The results showed that all the untreated water samples (UT) for both seasons were within WHO's recommended values of 100- 250mgL^{1-} for total hardness (Figure 1), but higher than WHO's guideline limit (75mgL^{1-}) for calcium hardness (Figure 2). After treatment (TW), both calcium and total hardness values were reduced to the recommended values of the WHO. It is an indication that banana peels extract can be used to soften hard water.

Table 1: Potash extract reduction of water hardness (Borehole sample)

Sample (mL)	Potash (mL)	T.H (mL)	T.H (mgL^{-1})	C.H (mL)	C.H(mgL^{1-})
100.0	0.0	22.90	229.0$\pm$0.23	13.20	132.0$\pm$0.12
100.0	2.0	20.80	208.0$\pm$0.24	12.20	122.0$\pm$0.09
100.0	4.0	18.75	187.5$\pm$0.56	10.15	101.5$\pm$0.13
100.0	6.0	16.60	166.0$\pm$0.16	8.30	83.0$\pm$0.23
100.0	8.0	14.50	145.0$\pm$0.36	7.20	72.0$\pm$0.18
100.0	10.0	12.35	123.5$\pm$0.11	6.10	61.0$\pm$0.15
100.0	12.0	10.30	103.0$\pm$0.23	4.70	47.0$\pm$0.04
100.0	14.0	8.25	82.5$\pm$0.21	3.70	37.0$\pm$0.34
100.0	16.0	6.10	61.0$\pm$0.22	3.00	30.0$\pm$.25
100.0	18.0	3.95	39.5$\pm$0.18	2.20	22.0$\pm$0.21
100.0	20.0	1.95	19.5$\pm$0.33	1.20	12.0$\pm$0.06
100mL	22.0	0.25	2.5$\pm$0.12	0.20	2.0$\pm$0.40
100mL	24.0	0.12	1.2$\pm$0.16	0.11	1.1$\pm$0.12

C.H = calcium hardness, T.H = total hardness

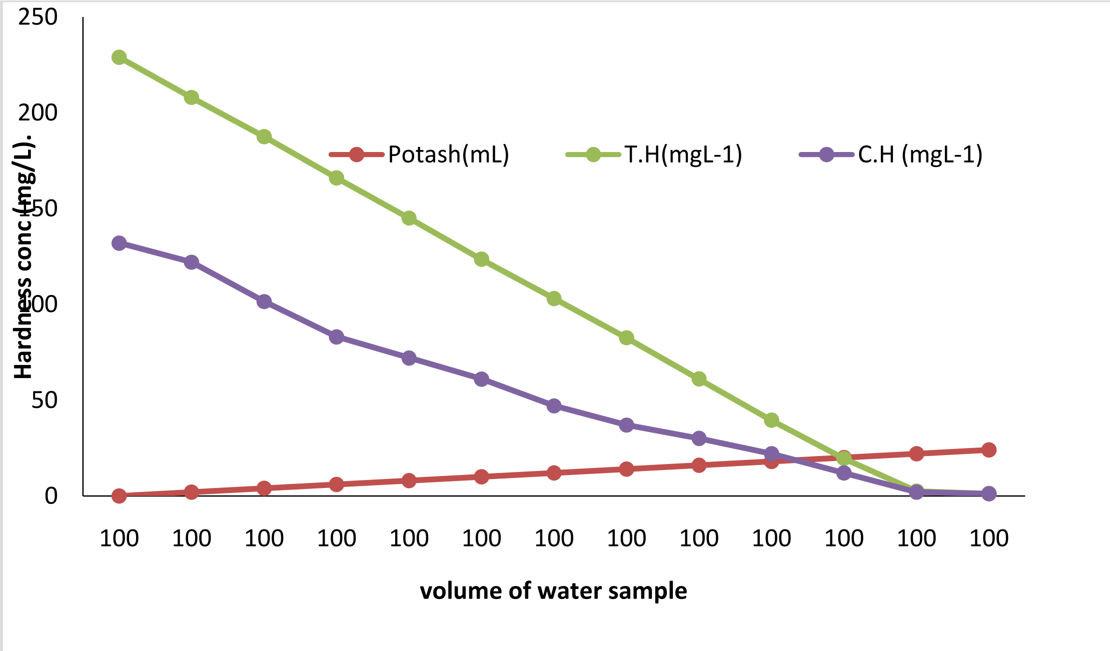

Fig. 3: Calibration of Potash extracts reduction of water hardness.
***T. H = total hardnesss, C.H = calcium hardness, potash = ash**

Figure 3 (Table I) presented the result of the borehole water samples from Abakaliki treated with potash extract in graph form to show the efficacy of the potash ash extract in reducing both total and calcium hardnesses. The result revealed that as the concentration of the potash (ash) is increasing by adding more (mL) of potash extract, the concentrations of both total and calcium hardness were decreasing. For instance, total and calcium hardness (Table1) were 229.0 mgL^{-1} and 132.0 mgL^{-1} respectively when potash extract was not yet added, however, on going down the (Table I) at 24 mL of the potash extract, both total and calcium hardness were reduced to 1.2 mgL^{-1} and 1.1 mgL^{-1} respectively. This is an indication that banana peels ash is effective in reducing water hardness which could be due to ion effect as a result of high potassium content of the ash and the high surface area and pore size of the ash. It may also be as a result of many functional groups present in banana peels ash which may bind main hardness causing ions (Ca^{2+} and Mg^{2+}) and other polyvalent ions and remove them out of water [16]; [17]: [18].

CONCLUSION

Potash extract from banana peels ash was used to reduce water hardness from borehole water samples in Abakaliki, Ohaukwu and Onicha LGAs, of Ebonyi State, Nigeria. The result showed that the extract was effective in reducing both total and calcium hardness.

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