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Quality Assessment of Okposi Salt for Domestic Use in Ohaozara Southeast Nigeria

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ABSTRACT

The study was carried out to assess the quality of Okposi salt for domestic use. Three replicate 500g samples of Okposi salt were bought from the producers in July, August and September, dissolved in 1.5 litres of water and analysed for indicators of salt qualities. Electrical conductivity, pH, Na^+, Mg^{2+}, $K^{+,}$ Cl^-, I^-,SO_4^{2-}, Fe^{2+}, $Pb^{2+}$and Zn^{2+} using the method described by Association of Official Analytical Chemists. Similarly, three replicates 500g samples of the control (uncle palm table salt) were bought dissolved in same volume of water and analysed using the same methods. The data obtained were compared with World Health Organisation (WHO) standards for edible salts. There was non-fixed pattern of increase or decrease in parameters studied, with the exception of magnesium and iodine which increased along the months with control recording the lowest and highest concentration of magnesium and iodine, respectively. Okposi salts recorded higher values of heavy metals - zinc, lead and iron than the control. The recorded values were higher than WHO recommended values for Zn (11.82 – 57.55 mg/l), Pb (0.03 – 0.17 mg/l) and Fe (0.16 – 1.68 mg/l). Similarly, at (P>0.05) significant differences were observed in temperature (27^{0}C 31^{0}C), pH (5.43 – 6.65), electrical conductivity (465.00 – 830.00) and calcium among the salts. Okposi salts and the control recorded lower anions and cations than WHO stipulated standards. The result showed that Na^+ , K^+ , Mg^+ , Ca^+ , Cl^- , I^- , SO_4^{2-} ranged from (155.20 – 191.00), (14.05 – 40.80), (17.00 – 28.00), (2.8 – 12.8), (196.00 – 200.00), (15.00 – 32.00), (196.00 – 210.00) all in mgL^{-1}, respectively. Thus, the ionic concentration and separation of Okposi salt need attention as a result of development of multi-hydration spheres with exceptional counter-forces that lower friccohesity index of the resultant solutions.

Keywords: Domestic; lake; ohaozara; okposi; salt.

INTRODUCTION

Salt is the specific name of the naturally-occurring compound sodium chloride (NaCl). As an edible substance, salt has been known from very early times and is frequently mentioned in the bible and other ancient writings [2]. It is essential for animal life. Naturally occurring common salt (halite) is a cubic mineral with a perfect cubic cleavage and its crystal structure was the first to be analyzed by x – ray diffraction methods. It is colourless and transparent when pure, but apt to be coloured; yellowish or reddish by ferruginous impurities. Occasionally, the mineral has a patchy deep blue coloration. It is highly soluble in water (H_2O) and has a saline taste. Salt, also known as sodium chloride, comprises the elements sodium and chlorine. Sodium is a silver coloured metal that is so unstable that it reacts violently in the presence of water and chlorine, a greenish – coloured gas that is dangerous and may be lethal. Yet the combination of these two elements forms sodium chloride that is a white- coloured compound essential to life itself. Virtually every person in the world has some direct or indirect contact with salt daily. People routinely add salt to their food as a flavour enhancer or apply rock salt to walkways to remove ice in the winter [14]. Salt is used as feedstock for chlorine and caustic soda manufacture. These two inorganic chemicals are used to make many consumer- related end- use products, such as polyvinyl chloride (PVC), a plastic made from chloride and paper- pulping chemicals manufactured from sodium hydroxide (caustic soda). With the heightened domestic awareness regarding terrorism, a PCV suit that shields against nuclear radiation has been developed for military and civilian uses [5]. The crystalline salt from Okposi salt lake is a rich source of common salt and an economic base for most of the inhabitants of the community who are mainly farmers. Indeed, the natives and some salt manufacturing outfits use the lake water for salt making [12] and it is readily available in the open market, the salt water is usually evaporated to dryness to obtain the common crystalline salt [15]. The present study was therefore, undertaken, to assess the quality of Okposi salt for its suitability for domestic use. The crystalline salt produced from Okposi salt lake is said to contain both metallic and non-metallic ions (cations and anions) such as Na^+, $Ca^{2+,}$ Mg^{2+}, Zn^{2+}, Co^{2-} SO_4^{2-}etc [2]. Salt occurs in extensive beds of compact, granular and massive characters and is usually associated with gypsium, and anhydrite, and sometimes with potash salts (Sylvite, Carnaliteetc). Its preservative properties are utilized for curing various food products such as meat, fish and vegetables and for preserving hides and skins before tanning.

Study Area

Okposi is 21km North of Afikpo, about 95km, South of Enugu as the crow flies, and about 135km North- East of Umuahia, Abia state. Okposi is located between latitude 06^0 40^0 N and longitude 07^0 48^0 E. It has an area of 750 square Kilometers. Okposi is bounded to the North East by Oshiri, to the west by Uburu, Mpu and Ishiagu, to the East by Ugwulangwu and to the south by Amasiri and Afikpo. Okposi is primarily bestowed with salt lakes, and other natural minerals such as silicon dioxide (SiO_2), galina (lead sulphate), zinc sulphate and sand stone, [11] and [10].

MATERIALS AND METHODS

Materials

The materials used include:

i. 1 liter capped plastic bottles
ii. Thermometer
iii. Permanent marker and masking tape
iv. Measuring tape
v. A nylon bag
vi. A cooler of ice to maintain the temperature at room temperature

Sample Collection

The salt samples were collected and handled in accordance with the methods described by [4]. Three replicates samples of Okposi salt produced within 2 days were bought from the Okposi salt producers in July, August and September. Similarly, three replicates of control (uncle palm table salt – mostly consumed salt in the study area) were bought from the market. These salt samples were taken to laboratory for analysis immediately after collection.

Laboratory Methods/ Procedure

500 g salt samples were dissolved in 1.5 Litres of distilled water prior to the other analyses. Temperature measurements were taken using mercury in glass thermometer. This was done by dipping the thermometer into the salt solution and allowing sufficient time to stabilize. Readings were taken after 30 minutes. Other indictors of salt qualities (Electrical conductivity, pH, Na^+, Mg^{2+}, $K^{+,}$ Cl^-, I^-,SO_4^{2-}, Fe^{2+}, $Pb^{2+}$and Zn^{2+}) were determined using the method described by [3]; [20].

Data Analysis

Coefficient of Variation and standard deviation were used to analyze the data collected, [13]. Similarly, the results obtained were compared with the WHO standard [18]; [20]

RESULTS

Temperature, electrical conductivity and pH of salts processed at different months of peaks of rainfall were as presented on Table 1. There was non-fixed pattern of increase or decrease in temperature, electrical conductivity and pH of the Okposi salts along the months studied. The highest temperature of 31^0C was recorded in Aug-salts and the least temperature value of 27^0C observed in July-salt. The order of increase was Aug-salt > Control > Sept-salt > July-salt. The recorded temperatures were within the WHO standards. Also, the order of increase in pH was Aug-salt > July-salt > Control > Sept-salt. The pH values fell slightly below the WHO recommended range except Sept-salts that fell within WHO recommended range of 6.5 – 8.5. The highest electrical conductivity value of 4,655.00 µS/cm was recorded in Sept-salt and the lowest value of 12.50 µS/cm was observed in July-salt. The electrical conductivity in Sept-salt was higher than the recommended WHO standard whereas July-salt, Aug-salt and control lied within WHO recommended standard.

Table 2 shows the Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, I^- andSO_4^{2-} concentrations of salts processed at different months of peaks of rainfall. There was non-fixed pattern of increase or decrease with respect to parameters with the exception of iodine in Table 2 along the three months of peaks of rainfall studied. The highest sodium of 10.82 mgL^{-1} was observed in Sept-salt. This highest sodium concentrations observed in Sept-salt was higher than sodium in July-salt, Aug-salt and Control by 58, 6 and 17%, respectively. The observed sodium concentrations in all the salts studied lied within the recommended standard [18]. The order of increase for calcium was July-salt > Sept-salt > Aug-salts > control whereas the order of increase in magnesium was Sept-salt > Aug-salt > July-salt > Control. The calcium and magnesium concentrations for these salts were within the WHO standard with the exception of calcium in July-salt which was above the recommended WHO standard. The order of increase of potassium was Sept-salt > Aug-salt > Control > July-salt. Also, the order of increase in Cl^- was Aug-salt > Control > Sept-salt > July-salt. The concentrations of Cl^- were within recommended standard with the exception of Aug-salt which recorded the higher concentration than standard. There was an increase of I^- along the months of peak rainfall studied with the control recording the highest concentration. There was non-fixed pattern of variation along the months of peak of rainfall with regard to SO_4^{2-}. The highest and lowest SO_4^{2-} concentration of 2.01MgL^{-1} and 0.17 MgL^{-1} were observed in Sept-salt and Aug-salt, respectively.

Selected heavy metals concentrations of the various salts processed in different months of the peak of rainfall were as presented on Table 3. There was non-fixed pattern of increase or decrease in heavy metals among the salts produced along these months. The highest Zn concentration of 57.55 mgL^{-1} was observed in Aug-salt whereas the lowest Zn concentration of 11.82mgL^{-1} was observed in Sept and the Control had Zn concentrations of 17.39 mgL^{-1}. The observed Zn concentrations of the various salts studied were higher than the recommended standard of 5.00mgL^{-1} [17]. The order of increase in Pb concentration was Sept-salt > July-salt > control > Aug-salt. Similarly, these observed Pb concentration in the various salts studied were higher than the recommended standard [16]. Also, the order of concentration of Fe was July-salt > Sept-salt > Aug-salt > control. With the exception of Aug-salt which has iron concentration within the recommended standard. All the other salts recorded high concentration of iron above the recommended standard.

Table 1. Temperature, electrical conductivity and pH of salts processed at different months

Treatment	Temperature (^{0}C) $\pm$SD	Electrical Conductivity (μS/cm) $\pm$ SD	pH$\pm$ SD
July-salt	27.00 $\pm$1.6	830.50 $\pm$230.55	6.20 $\pm$0.41
Aug-salt	31.00 $\pm$1.6	796.10 $\pm$230.55	6.56 $\pm$0.41
Sept-salt	27.33 $\pm$1.6	465.00 $\pm$230.55	5.43 $\pm$0.41
Control	27.97 $\pm$1.6	279.03 $\pm$230.55	6.14 $\pm$0.41
CV (%)	6.45	67.43	7.77
WHO STD	20-23	1200.00	6.5-8.5

Note: July-salt= Salt processed in July; Aug-salt = Salt processed in August; Sept-salt = Salt processed in September; SD = standard deviation, CV = Coefficient of variation, WHO STD = World Health Organization standard

Table 2. Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, I^- andSO_4^{2-} of salts processed at different months (MgL^{-1})

Treatment	$Na^+$$\pm$SD	$Ca^{2+}$$\pm$SD	$Mg^{2+}$$\pm$SD	$K^+$$\pm$SD	$Cl^-$$\pm$SD	$I^-$$\pm$SD	$SO_4^{2}$$\pm$SD	
July-salt	155.20$\pm$12.62	40.80$\pm$15.58	17.00$\pm$7.10	2.75$\pm$4.0	200.04$\pm$8.79	15.02$\pm$13.0	210.00$\pm$5.87	
Aug-salt	172.01$\pm$12.62	14.05$\pm$15.58	25.06$\pm$7.10	11.56$\pm$4.0	197.22$\pm$8.79	31.78$\pm$13.0	196.02$\pm$5.87	
Sept-salt	181.00$\pm$12.62	35.06$\pm$15.58	28.90$\pm$7.10	12.81$\pm$4.0	196.50$\pm$8.79	32.32$\pm$13.0	199.10$\pm$5.87	
Control	189.21$\pm$12.62	2.30$\pm$15.58	36.72$\pm$7.10	11.00$\pm$4.0	218.00$\pm$8.79	50.60$\pm$13.0	195.40$\pm$5.87	
CV%	8.36	78.04	30.47	48.09	5.00	44.31	3.39	
WHO STD	200	75	50	ND	250	45	250	(Mg/L)

Note: July-salt= Salt processed in July; Aug-salt = Salt processed in August; Sept-salt = Salt processed in September; SD = standard deviation, CV = Coefficient of variation, WHO STD = World Health Organization standard; ND = not dictated

Table 3. Heavy metals concentration of salts processed at different months (MgL^{-1})

Treatment	Zn±SD	Pb± SD	Fe ± SD
July-salt	22.00±18.0	0.075±0.05	1.680±0.6
Aug-salt	57.55±18.0	0.030±0.05	0.158±0.6
Sept-salt	11.82±18.0	0.165±0.05	1.513±0.6
Control	17.39±18.0	0.033±0.05	0.774±0.6
CV%	76.00	83.09	68.15
WHO STD	5.00	0.01	0.30 (mg/L)

Note: July-salt= Salt processed in July; Aug-salt = Salt processed in August; Sept-salt = Salt processed in September; SD = standard deviation, CV = Coefficient of variation, WHO STD = World Health Organization standard

DISCUSSION

The results show that the salt was slightly acidic and this could be attributed to acid rain, industrial waste, mining, sewage, waste dumping through leaching into the soil which ultimately increased the soil acidity and consequently the pH is lowered [6] . However, the high conductivity level in the salt may be linked to sewage materials, leaching of inorganic contaminants into the salt lake [7]. The high chlorine content may be as a result of organic matter contents in the lake. Report has shown that people drinking chlorinated water over long periods have a 21% increase in the risk of contracting bladder cancer and a 38% increase in the risk of rectal cancer [8]. The high concentration of Zn in Okposi salt may be as a result of both natural processes such as weathering of salt and shale rocks and erosion and from human activities such as mining and farming. The high Pb concentration of the salt may be attributed to weathering of rock and also sewage and refuse which may include lead battery that could ultimately leach into the ground and contaminate the lake water. Okposi salt and Control are of low quality. The month of salt production does not influence its quality since the quality indicators studied showed non-fixed pattern of increase or decrease along the months of production. Consumption of Okposi salt and control could pose some health challenges. According to [1], ion is essential for living things and serve many functions such as electrical signal translocation such as chemical signaling, transepithelial transport regulation of cytoplasmic or vesicular ion concentration and pH and regulation of cell volume. Similarly, the concentration of Na^{+}, Ca^{+}, Mg^{2+}, K^{+}, Cl^{-} , I^{-} , SO_4^{2-} which ranged from (155.20 – 191.00), (14.05 – 40.80), (17.00 – 28.00), (2.8 – 12.8), (196.00 – 200.00), (15.00 – 32.00), (196.00 – 210.00) all in mgL^{-1}, respectively. This portrayed that the ionic concentration and separation of Okposi salt lake need attention as a result of development of multihydration spheres with exceptional counter-forces that lower friccohesity index of the resultant solutions [19].

CONCLUSION

The quality assessment of Okposi salts and Control revealed that pH of the salt and the control is slightly acidic. Electrical conductivity, temperature, calcium, iodine and chlorine were well above the recommended standards while the rest of other cations and anions were found within WHO safe limit. The concentration of the heavy metals such as Zn, Pb and Fe of Okposi salts and Control occurred above acceptable limit. The prevalent unorganized mining of the Pb and Zn by the rural dwellers exacerbated the input of these heavy metals in Okposi salt lake. However, the consumption of salt of high Zn and Pb concentration for a long period is associated with some health implication such as loss of appetite and cardiovascular system disorder. It is therefore recommended that the level of heavy metals should be reduced by chemical treatment and the low content ions supplemented before use.

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DISCLAIMER

The products used for this research are commonly and predominantly used 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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