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A NOVEL SOURCE FOR SUPPLEMENTING POTASSIUM INTAKE THROUGH MINERAL DRINKING WATER

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ABSTRACT

Potassium is one of the major electrolytes required for human metabolism. Deficiency in the Required Dietary Allowance (RDA) of potassium has been associated with health issues, particularly cardiovascular disease and hypertension. Some research has shown that a high percentage of the population do not consume enough potassium-rich foods due to the relatively high cost of such foods thereby resulting to undesirable high sodium to potassium (Na:K) ratio in the blood. This work investigated a low-cost means of supplementing the intake of potassium through drinking water that has been fortified with potassium. An edible source of potassium, Palm Bunch Ash (PBA) was identified and the appropriate amount to be added to drinking water was investigated. It was found that addition of 1 to 2ml (20-40 drops) of 17.5g/l PBA concentrate to 1 litre of water gave fortified drinking water which contains 17.5 to 35mg/l of potassium representing 0.4% to 0.8% of the RDA for potassium. The increase in serum potassium following consumption of the potassium fortified drinking water was found to be statistically significant even at $p < 0.01$.

KEYWORDS: Potassium, electrolyte, mineral water, hypertension.

INTRODUCTION

Potassium is a major electrolyte required for good functioning of the human body. The minerals/electrolytes essential for human metabolic processes include potassium, sodium, magnesium, calcium, phosphorous, chloride, and sulphur. The other minor or trace elements include chromium, zinc, tin, copper, silicon, manganese, selenium, iron, iodine, etc.[1] The human body obtains these electrolytes through food or water intake. However, while some of these essential elements may be found in drinking water, some others like potassium are rarely present in most natural water sources.

Sodium intake from dietary sources quite often surpasses the recommended limits of this mineral in adults. Numerous studies have shown that a high sodium intake is associated with hypertension. It is therefore recommended that people limit sodium intake and choose foods that contain potassium in order to decrease the risk of hypertension and other cardiovascular diseases. Potassium intake increases urinary excretion of sodium through action on the renal tubule.[2,3] The American Heart Association's (AHA) strategic impact goals included a recommendation of sodium intake of less than 1500mg/d, while the recommended optimal intake of potassium ranges between 3600 to 4700mg/d for adults. The optimal Na:K ratio is 0.49 for adults and 0.32 for adults aged > 50years and those with diabetes, hypertension or chronic kidney disease.[4] However, evidence from reported research showed that the ratio of Na:K was never less than 0.83 in the population studied. The reason for this obvious non-compliance can be attributed to the comparatively high cost of potassium-rich foods. Previous research had characterised potassium as comparatively more expensive nutrient of concern.[5] It therefore becomes necessary that dietary patterns which can achieve more healthful diets at lower costs are investigated to enable a greater percentage of the population avail themselves of this essential electrolyte.

Increasing the consumption of fresh fruits, vegetables, dried fruits and nuts, fish, milk, etc, may help increase dietary potassium. However due to the high cost of these foods they may be less accessible to the lower-income groups.

The present work investigated a low-cost source of potassium derived from palm fruit bunch waste (Elaeis guineensis). The research goals included: production of concentrates containing mineral salts of potassium, determination of dosage for fortifying drinking water with appropriate amounts of potassium and determining the effects of the fortified drinking water on some consumers.

MATERIALS AND METHODS

The main material used in this investigation was potash (Potassium Carbonate) derived from palm bunch ash (PBA). The water used for the production of the fortified drinking water was drawn from tap water and was further disinfected by boiling.

The processes included
(i) Complete combustion of dried empty palm fruit bunch to produce PBA
(ii) Leaching of potassium salt from the PBA to produce potassium concentrate (concentrated potassium carbonate solution of 17.5g/l K_2CO_3).
(iii) Adding a specified quantity of the potassium stock solution to a known quantity of drinking water.

Evaluation of the study was carried out by monitoring the effect of consumption of the fortified drinking water on some volunteers. The outcomes measured to evaluate the health benefits of the fortified drinking water were
(i) Blood pressure
(ii) Blood tests for electrolytes
(iii) Bowel movement.

RESULTS AND DISCUSSION

A novel concentrate (Potassium Carbonate) derived from an organic source, PBA, was developed. The fortified drinking water was produced by adding 1 to 2ml of 17.5g/l of PBA concentrate to 1 litre of water. This gives fortified drinking water that contains potassium in the range of 17.5 to 35mg in one litre of water representing 0.4% to 0.8% of the recommended dietary allowance (RDA) for potassium. This is comparable to drugs that contain about 90mg of potassium per tablet. This drinking water fortified with potassium will be beneficial to people aged > 50years (geriatrics) and those having hypertension or other cardiovascular disease. The developed potassium concentrate can also be used for regulating the pH of drinking water at the point of use. The chemical composition of the PBA can be found in a previous work. [6] and is presented here in table 1.

Determination of the chemical composition of the stock palm potassium carbonate solution was carried out to analyse the concentration of the electrolytes, K^+, Mg+, Ca^{2+}etc, using flame photometric and colorimetric methods.

Table 1: Chemical Analysis of Palm Potassium Carbonate derived from PBA.

Cat ion/Anion (mg/L)	Concentration (mg/L)
Potassium (K^+)	35420
Magnesium (Mg^{2+})	403
Calcium (Ca^{2+})	224
Sodium (Na^+)	101
Manganese (Mn^{2+})	0.06
Iron (Fe^{2+})	2.52
Chromium ($^{3+}$)	BDL
Nitrate (NO^{2-})	42
Nitrite (NO^{3-})	8.40
Phosphate (PO^{4-})	242
Chloride (Cl^-)	15176
Fluoride (F^-)	204
Sulphate (SO^{4-})	2072
Total Alkalinity	28840mg/L as $CaC0_3$
Bicarbonate	4760mg/L as $CaC0_3$
Carbonate	24080mg/L as $CaC0_3$
Total Hardness	2240mg/L as $CaC0_3$
Calcium Hardness	560mg/L as $CaC0_3$
Magnesium Hardness	1680mg/L as $CaC0_3$
Total Dissolved Solids (TDS)	94133

pH =12

A comparison of the mineral contents of the produced potassium fortified drinking water with some branded bottled mineral water is shown in table 2.

Table 2: Comparison of composition of Potassium fortified drinking water and that of other brands of mineral drinking water.

Mineral water source	Nestle bottled water [a]	Swan bottled water [b]	PBA drinking water
Potassium (mg/L)	1.0	2.0	17.5
Magnesium (mg/L)	0.3	2.0	0.5
Calcium (mg/L)	32.0	20.0	5.1
Sodium (mg/L)	6.2	9.0	10.5
Bicarbonate (mg/L)	11.0	52.0	12.5
Chloride (mg/L)	57.2	7.0	7.6
Sulphate (mg/L)	4.0	5.0	10.0
Phosphate (mg/L)	-	-	0.1

Source: Product information Nestle Pure Life Water Nestle Nigeria Plc, Lagos – Nigeria.

Product information Swan Natural Spring Water, Spring Waters Nigeria Ltd.

The dosage requirements for producing potassium fortified drinking water using Palm Potassium Carbonate, derived from PBA, of concentration 17.5g/l are presented in Table 3.

Table 3: Dosage requirements for producing potassium fortified drinking water using PBA concentrate of 17.5g/l potassium and the expected Potassium contents.

Dosage of Stock solution	10 drops	20 drops	30 drops
Volume of water to be treated	1 litre	1litre	1 litre
Potassium content	8.75 mg/L	17.5 mg/L	27 mg/L

Expected pH range: 7.1-9.6

Potassium is essential for transmission of nerve impulses, contraction of cardiac muscles, maintenance of intracellular tonicity, skeletal and smooth muscle contractions and maintenance of normal renal functions. Electrolytes such as potassium, sodium, magnesium etc are essential ions in the body. However, the recommended Na:K ratio is 0.49. The quantity of potassium in the body is 98% intracellular. The ratio of intracellular to extracellular potassium determines the cellular membrane potential. Hence, small changes in the extracellular potassium level can produce profound effects on the functions of the cardiovascular and neuromuscular system.[7] Hypokalemia is one of the clinical conditions that will derail the overall wellness of a patient and will require potassium supplementation or conservation. The present study introduces this supplementation in the form of potassium fortified potable water with potassium derived from PBA concentrate. Table 4 shows the effect of consumption of potassium fortified drinking water on the serum potassium level of some volunteers. The results obtained showed an increase in the serum potassium level ranging from 0.10mEq/L to 0.30mEq/L for the 2-week period of investigation. This increase in serum potassium is statistically significant even at $p < 0.01$.

Table 4: Electrolyte distribution of volunteers before and after PBA fortified potable water administration.

Volunteers	Base line values of electrolytes (mEq/L)			1st week electrolytes (mEq/L)			2nd week electrolytes (mEq/L)		
	Na^+	K^+	Cl^-	Na^+	K^+	Cl^-	Na^+	K^+	Cl^-
OK	143	3.4	104	143	3.5	108	142	3.9	107
NS	141	3.5	104	141	3.7	100	143	3.8	105
NC	143	3.4	106	142	3.5	101	142	3.5	109
AS	143	4.1	99	143	4.2	98	144	4.2	98
ME	144	3.8	95	144	3.9	99	142	3.9	100
EG	143	3.6	105	141	3.8	100	143	3.8	98
NO	142	3.5	105	142	3.6	109	141	3.7	101

Population-wide efforts to increase potassium intakes remain elusive. Substituting potassium chloride for sodium chloride in processed foods is not a feasible option, given the bitter taste of potassium salts.[8] Furthermore, persons with chronic kidney disease, end stage renal disease or those taking angiotensin-

converting enzyme inhibitors and angiotensin receptor blockers that impair potassium excretion may be adversely affected by the use of population-wide fortification or reformation.[9] Hence the present study which advocates a point-of-use administration of potassium supplementation through potassium fortified drinking water provides a means of targeting only the persons who can benefit from the potassium supplementation without adverse effects.

The multisided nature of water and wellness requires that professionals in the related areas be involved in the research and in addition that policies and practices of local governments, states and the country be geared towards supplying good quality potable water to the population. For the purpose of improving drinking water quality, this work highlights the need for establishment of industries for harnessing palm bunch ash as a by-product of palm oil processing. This will apart from providing the water treatment chemical, PBA concentrate, help boost the national economy from the perspective of increasing the nation's palm oil production.

CONCLUSION

The present work has identified an affordable and organic source of potassium for fortifying drinking water with potassium at the point-of-use. With the present global economic down turn due to COVID-19 pandemic which has exerted enormous pressure on limited resources, there is a need to explore local substances that are easily available to help combat health problems of hypokalemia or electrolyte deficiency and improve the wellness of the population. One such local source of electrolytes is palm bunch which when completely combusted will yield the PBA used in potassium fortification of drinking water. This alkaline mineral concentrate from PBA is an affordable source of essential minerals compared to the water pH boosters in the market, most of which are very expensive and not readily available. This is in keeping with the doctrine of Primary Health Care (PHC) of availability, acceptability and affordability, since the palm bunch, the source of PBA is available and can be sourced within most locality. Above all, PBA is innocuous and had long been in use for culinary purposes in some African countries. Future work should be in the direction of exploring the whole range of the health benefits of potassium fortified potable water produced in this work.

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REFERENCES

1. O' shea, T Mineral Tim O'shea Supplements (www.life-enthusiats.com/minerals), 2012.
2. Institute of Medicine Dietary Reference intakes for water, potassium, sodium, chloride, and sulphate, Washington DC: The National Academies Press, 2005. [Google Scholar]
3. Morris RC Jr, Schmidlin O, Freassetto LA, Sebastin A, Relationship and Interaction between sodium and potassium, J. Am CollNutr, 2006; 25: 262-270. [PubMed] [Google Scholar]
4. Cook NR, Obarzanek E, Cutler JA, Burring JE, Rexrode KM, Kumanyika SK, Appel LJ, Whelton PK; Trials of Hypertension Prevention Collaborative Research Group, Joint effects of sodium and potassium intake on subsequent cardiovascular disease, Arch Intern Med, 2009; 169: 32-40.
5. Monsivais P, Aggarwal A, Drewnowski A; Following Federal Guidelines to increase nutrient consumption may lead to higher food costs for consumers. Health Aff (Millwood), 2011; 30(8): 1471-1477.
6. Okoloekwe RC, Igwe SA, Agbata CA; Production of Mineral Water using Palm Bunch Ash (PBA) from Elaeis guineensis, Journal of Health and Visual Sciences, 2015; 17: 38-44.
7. Latronico N, Neuromuscular sequelae of critical illness, CurrOpinCrit Care, 2005; 4381-390.
8. Beauchamp G K, Stein L J, Salt taste .in Basbaum A I, editor, The senses: A comprehensive reference 6 vols.vol.4. New York; Elsevier, 2008; 401-408. [Google Scholar]
9. Dietary guidelines Advisory Committee. Report of the Dietary guidelines for Americans, 210, to the secretary of Agriculture and the secretary of Health and Human Services, Washington, DC: US Department of Agriculture, Agricultural Research service, 2010. [Google Scholar]