MPRI-JMBP | INTERNATIONAL JOURNAL OF MEDICAL, BIOLOGICAL AND PHAR. SCI. VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

DETERMINATION OF THE PHYSICOCHEMICAL PROPERTIES OF ALKALINEWATER PRODUCED VIA ELECTROLYSIS

NDIFE CHIDIEBERE TEMPLE AND MGBECHI CLETUS EKENE

Department of Science Laboratory Technology, Federal Polytechnic Oko, Anambra State.

Abstract

In this work, the physicochemical properties of alkaline water produced through electrolysis were determined. The alkaline water sample was gotten from Kangen alkaline water company in Awka, Anambra State and was taken to the laboratory for analysis. The physicochemical properties of the alkaline water were determined using standard water analysis methods and the results for the analysis showed that the alkaline water is colourless, oourless, has an ash taste, a turbidity of 0.02(NTU), temperature 27°C, pH 8.50, conductivity 158µSiemens/cm, total solid 189.2mg/L, total alkalinity 69.8mg $CaCO_3$/L, total hardness 108.0mg/L $CaCO_3$, aluminium 0.05mg/L, iron 0.03mg/L, calcium [redacted] *131.01mg/L, sodium 77.5mg/L, chloride 0.81mg/L and fluoride 0.003mg/L. All the parameters of this alkaline water falls within the WHO an SON permitted levels. The water was made alkaline through*

KEYWORDS:
Alkaline water, Borehole water, Electrolysis, Physicochemical Properties,

electrolysis from a borehole water whose initial pH was 6.17 which is unfit for consumption. This alkaline water is good for drinking specifically as it helps the body to maintain a good pH to fight off certain illnesses caused by some bacteria.

INTRODUCTION

Water is usually discussed from a physical or a normative perspective and discussions are usually limited only to the terrestrial part of the hydraulic cycle, comprised of blue water, green water and gray water (Bakker, 2007). However, in this modern era water is discussed as a single substance which has multiple uses (Feitelson, 2012). Water is very necessary for all forms of life (Bantin *et al*., 2020) and it is an element for promoting the health of individuals and the socio-economic development of human communities (Amin *et al*., 2008). Without this simple but complex material, life would never have existed on earth. Therefore, it is a noble and crucial element that must be protected for future generations. Water intended for human consumption is drinkable when it is free from chemical and biological elements. The provision of portable water to rural and urban population is necessary to prevent health hazards associated with poor drinking water (Owamah *et al*., 2014). According to the WHO, 1.8 million people a year, 90% of whom are children under five, mostly living in developing countries, die from diarrheal diseases (including cholera); 88% of diarrheal illnesses are caused by poor water quality, poor sanitary condition and poor hygiene.

Alkaline water is any water that has its pH above 7. The consumption of alkaline reduced water produced by domestic electrolysis devices was approved in Japan in 1965 by the Ministry of Health, Labour and Welfare for the cure of gastro-intestinal disorders. Today, these devices are freely available in several countries and can be easily purchased without reserve. The commercial information included with the device recommends the consumption of 1–1.5 L of water per day, not only for gastro-intestinal disorders but also for numerous other illnesses such as diabetes, cancer, inflammation, etc (Henry and Chambron, 2013). These electrolysis machines produce acidic water (Electrolyzed Oxidized Acidic Water, EOAW) and alkaline water (Electrolyzed Reduced Alkaline Water, ERAW). Other names for ERAW include: electrolyzed reduced water (ERW), alkali-ionsui water (AIW) or electrolyzed cathodic water (ECW). Acidic water is however unsuitable for human consumption but is appropriate for personal body care and hygiene (Henry and Chambron, 2013). Municipal drinking water, prefiltered and treated by partial electrolysis, followed by collecting the cathodic water that is alkaline (pH 8.5 to 9.5), shows a high negative oxidative reductive potential (ORP) (-150 to -250mV) compared to untreated tap water (+150 mV) as well as smaller molecular clusters. Recently, electrolyzed reduced alkaline water (ERAW) generated by water electrolysis has received increasing attention because of its known benefits in treatment and prevention of diseases. The Korean and the Japanese governments officially acknowledged the efficacy of ERAW as a novel material for the improvement of abnormal intestinal fermentation, chronic diarrhea, gastric hyperacidity and dyspepsia (Ignacio *et al.*, 2012). A growing body of literature indicates beneficial effects from drinking this water by patients with diabetes and kidney disease, with improved outcomes and fewer medical complications. Additional studies suggest that this water increases the activity of a key detoxifying enzyme in the body, superoxide dismutase, which is central to protecting against free radical damage both in aging and chronic degenerative diseases (Rubik, 2011). Over 70% of the human body is made up of water which takes part in almost all functions of life from blood, lymph, cerebrospinal fluid, saliva and other digestive fluids, joint lubrication, detoxification, and maintaining the blood pressure. Yet it is far more than just a constituent. A new science of water is emerging in which the structure and dynamics of water is much more complex than was previously thought. Water is a complex dynamic liquid sensitive and responsive to its environment (Smith, 2004).

Materials and Methods

Collection of Sample

The alkaline water sample was collected from Kangen Alkaline water company in Awka, Anambra State, Nigeria.

Determination of Physicochemical Properties of AlkalineWater

Physicochemical parameters of the the alkaline water and the borehole water (source) such as temperature, colour, taste, odour, pH, turbidity, electrical conductivity, total solids, total hardness, total alkalinity, aluminium, calcium, iron, sodium, chlorides, fluorides and nitrates were determined using standard methods for the analysis of drinking water.

Results

The results for the physicochemical analysis of alkaline water produced by electrolysis is shown in table 1 below.

Table 1: Results for the Physicochemical Properties of Water Samples

Parameters	*WHO*	*SON*	*Sample A*	*Sample B*
Colour	-	-	*Colourless*	*Colourless*
Odour	*Odourless*	*Oourless*	*Odourless*	*Odourless*
Taste	-	-	*Tasteless*	*Slight ash taste*
Turbidity (NTU)	5	5	0.02	0.02
pH	6.5-8.9	6.5-8.5	6.17	8.50
Conductivity (μSiemens/cm)	1000	1000	116	158
Aluminium (mg/L)	-	0.2	0.03	0.05

EDITOR-IN-CHIEF
Prof. A.S. Hossein [Saskatchewan]

Iron (mg/L)	-	0.3	0.01	0.03
Calcium (mg/L)	300	-	79.20	131.01
Sodium (mg/L)	200	200	52.9	77.5
Chlorides (mg/L)	250	250	1.27	0.81
Fluoride (mg/L)	1.5	1.5	0.008	0.003
Nitrates (mg/L)	5.0	5.0	0.30	0.12
Total dissolved solids (mg/L)	1000	500	130.0	189.2
Total alkalinity (mg $CaCO_3$/L)	150	-	17.8	69.8
Total Hardness (mg/L $CaCO_3$)	500	150	81.0	108.0

Sample A = Borehole water (not electrolyzed)
Sample B = Electrolyzed Alkaline Water

Discussion

Some parameters such as colour, odour, and turbidity are the same for both sample A (borehole water) and sample B (electrolyzed alkaline water). But sample B has a slight ash taste while sample A is tasteless. Sample A has a pH of 6.17 which is acidic and falls outside the permitted pH range for drinkable water as proposed by both WHO (pH: 6.5-8.9) and SON (6.5-8.5), while sample B has a pH of 8.5 which is alkaline and falls within the permitted pH range.

The conductivity of sample A is 116 μS/cm which is less than that for sample B 158 μS/cm but both are within the permitted range.

For the metals, sample A has 0.03mg/L of aluminium, 0.01mg/L of iron, 79.20mg/L of calcium and 52.9mg/L of sodium while sample B has 0.05mg/L of aluminium, 0.03mg/L of iron, 131.01mg/L of calcium and 77.5mg/L of sodium. All the values fall within the WHO and SON permitted limits.

For anions, sample A has 1.27gm/L of chlorides, 0.008mg/L of fluorides and 0.30mg/L of nitrates while sample B has 0.81gm/L of chlorides, 0.003mg/L of fluorides and 0.12mg/L of nitrates. All the values fall within the WHO and SON permitted limits.

The total alkalinity of sample A is 17.8 mg $CaCO_3$/L while that of sample B is 69.8 mg $CaCO_3$/L all of which fall within the WHO and SON permitted limits.

Sample A has a total hardness of 81.0 mg/L of $CaCO_3$ while sample B has a total hardness of 108.0 mg/L of $CaCO_3$. The two values fall within the WHO and SON permitted limits.

The total solids in sample A is 130.0 mg/L while that in sample B is 189.2 mg/L. These values also fall within the WHO and SON permitted limits.

From the results above it is obvious that the pH of sample A makes it unfit as a drinking water even though every other parameters of it fall within the permitted limits.

Sample B on the other hand is fit as a drinking water and its alkaline nature makes a very preferable drinking water due to the fact that alkaline waters have antioxidant properties which help protect the body against the damages caused by free radicals (Dieguez *et al*., 2010).

Early studies on animal models reported that alkaline water supplementation may exert positive effects on body weight improvement and development in offspring (Kojima *et al*., 2017).

Even biochemical markers were analyzed, suggesting that alkaline ionized water intake can cause elevation of metabolic activity. In particular, hyperkalemia was observed in 15-week-old rats and pathological changes of necrosis in myocardial muscle were found (Ulleberg, 2013).

Alkaline and electrolyzed water have been shown to exert a suppressive effect on free radical levels in living organisms, thereby resulting in disease prevention and various biological effects, such as anti-diabetic and antioxidant actions, DNA protecting effects, and growth-stimulation activities (Dieguez *et al*., 2010).

Conclusion

The production of alkaline water through electrolysis has been a very good and effective method and the findings of this study showed that truly water from boreholes or other sources can be made alkaline through electrolysis. The parameters of the produced alkaline water falls within the WHO and SON permitted levels which makes the water fit for consumption. Several studies have shown that alkaline waters can prevent many diseases from gastro-intestinal disorders, diabetes, cancer, inflammation, etc. For more than six decades, the Japanese ministry of health approved the consumption of alkaline reduced water produced by domestic electrolysis devices and this has helped to increase the life expectancy of the citizens of Japan.

Recommendations

Many studies worldwide especially in Asia have shown that alkaline water is not only a good drinkable water to quench thirst but also has potentials to prevent and cure some diseases. Hence we recommend that:

- The federal government of Nigeria just like their Japanese counterpart should approve and encourage the consumption of alkaline reduced water produced by domestic electrolysis devices and also try to make these devices available t the Nigerian citizens.
- Individuals who have the financial capability should engage in the commercial production of alkaline reduced water (using commercial electrolysis devices) so that those that cannot afford the domestic electrolysis devices can easily buy alkine waters from them. This should be done under strict supervision and guidance of government agencies such as SON and NAFDAC.
- There should be more sensitization to enable people get the accurate information about alkaline water and how to consume it for its many health benefits.

References

Amin N.C., Lekadou K.S., Attia A.R., Claon J.S., Agbessi K., Kouadio K. (2008). Physicochemical and Bacteriological Quality of Public Supply Water from Eight Municipalities in Cote d'Ivoire. *J. Sci. Pharm. Biol*. 9: 1.

Bakker K. (2007). The 'Commons' versus the 'Commodity': Alter-globalization Anti-privatization and the Human Right to Water in the Global South. *Antipode* 39, 430–455.

Bantin A.B., Wang H. and Jun X. (2020). Analysis and Control of the Physicochemical Quality of Groundwater in the Chari Baguirmi Region in Chad. *Water* 12: 2826; doi:10.3390/w12102826

Dieguez P.M., Ursua A. and Sanchis, P. (2010). Thermal Performance of a Commercial Alkaline Water Electrolyzer: Experimental Study and

Mathematical Modeling. *International Journal of Hydrogen Energy.* 33:7338–7354.

Feitelson E. (2012). What is water? A normative perspective. *Water Policy*. 14: 52-64.

Henry M. and Chambron J. (2013). Physico-Chemical, Biological and Therapeutic Characteristics of Electrolyzed Reduced Alkaline Water (ERAW). *Water*. 5: 2094-2115; doi:10.3390/w5042094

Ignacio R.M.C., Joo K.B. and Lee K.J. (2012). Clinical Effect and Mechanism of Alkaline Reduced Water. *Journal of Food and Drug Analysis*. 20(1): 394-397.

Kojima H., Matsumoto H. and Tsujimura T. (2017). Development of Large Scale Unified System for Hydrogen Energy Carrier Production and Utilization: Experimental Analysis and Systems Modeling. *International Journal of Hydrogen Energy.* 42:13444–13453.

Owamah H.I., Sojobi A.O. and Dahunsi S.O. (2014). Comparative Study of Household Water Treatment in a Rural Community in Kwara State Nigeria. *Nigerian Journal of Technology (NIJOTECH).* 33(1), pp 134-139.

Runik B. (2011). Studies and Observations on the Health Effects of Drinking Electrolyzed-reduced Alkaline Water. WIT Transactions on Ecology and the Environment. *Water and Society* 153: 317-327.

Smith C.W. (2004). Quanta and Coherence Effects in Water and Living Systems. *Journal of Alternative and Complementary Medicine*. 10(1): Pp. 69-79.

Standards Organisation of Nigeria (2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard Nis 554.

Ulleberg O. (2013). Modeling of Advanced Alkaline Electrolyzers: A System Simulation Approach. *International Journal of Hydrogen Energy.* 28:21–33.

WHO. Water, Sanitation and Hygiene Links to Health. Available online: https://www.who.int/water_sanitation_health/publications/facts2004/en/ (accessed on 15th September, 2020).

WHO. (2011) Guidelines for Drinking-Water Quality, Fourth Edition. Available online: https://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/ (accessed on 15th September, 2020)