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Physico-chemical Parameters and Water Quality of Opa Water Irrigation, Ile-ife, South-west, Nigeria

Samson Ishola Ibironke
Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria

ABSTRACT

Quality of irrigation water is an important ingredient of agriculture products and determinant of human health, the purpose of this study is to determine the mineral composition, physico-chemical parameters and water quality of opa water irrigation. Water samples were collected in 10 sterile capped 250 mL bottles and they were obtained from 10 different points around the opa water irrigation. Physico-chemical parameters such as electro-conductivity, total dissolve solid, pH and total solid, sodium percentage, sodium adsorption ratio, Kelly's index and microbial analysis were also determined. The study revealed that the physico-chemical parameters of water samples, such as the electro-conductivity ranged from 2.3-2.7×100 ohm cm^{-1}, total dissolve solid 47-153.6 mg L^{-1}, pH ranged from 5.3-6.9, density and total solid ranged from 0.8386-1.010, 220-260 mg L^{-1}, respectively. Major mineral elements in the water samples such as calcium, magnesium, sodium and potassium ranged from 12.7-16.2; 9.6-17.5; 28.9-50.1; 30.1- 32.5 mg L^{-1}, respectively. Trace mineral element, such as Fe ranged from 3.5-5.4 mg L^{-1} and others including Zn, Mn, Cu, Pb, Ar, B were not available, respectively. It was concluded that the results of the physico-chemical parameters, major and trace mineral elements, sodium percentage, sodium adsorption ratio, Kelly's index and microbial analysis that were obtained from the water samples were within the permissible limits and in line with World Health Organization guidelines.

Key words: Physico-chemical, electro-conductivity, sodium adsorption ratio, kelly's index

INTRODUCTION

Water quality can be classified into three, which may include chemical, physical and biological contents. The primary purpose of the guidelines for drinking-water quality is the protection, well being and safety concern of public health. The quality of drinking-water is a "powerful environmental determinant of health", (WHO, 2008). Assurance of drinking-water safety is a foundation for the prevention and control of waterborne diseases. Water is essential to sustain human life and must be satisfactory, adequate, safe, accessible and available to all. Improving in access to drinking-water can be of enormous benefits to the public health. Diseases related to contamination of drinking-water constitute a major burden on human health. In northern part of Nigeria over 18,000 and 200 children of the populace were reportedly affected and died as a result of lead poisoning (UNEP, 2011).

Every effort should be made to achieve a contaminated free drinking-water quality as well as practicable safe drinking-water. In developing countries, major inhabitants of rural dwellers among the population were living in an extreme conditions of poverty, under sanitize and unhygienic conditions (WHO, 2008). Intervention such as surveillance, quality control of drinking-water could provide significant benefits to human health (WHO, 2008; UNDP, 2013). According to world

Health organization report and global study, it was revealed that, over 900 million people were lacked access to safe water, 2.7 billion were lacked access to basic sanitation, approximately, 1.1 billion people do not have access to improved water supply sources and also 2.4 billion people do not have access to any type of modern improved sanitation facility (WHO, 2008). Mortality due to diarrheal diseases in children less than 5 years of age was accounted for about two million annually. Factors that could influence water quality are toxicity problems, trace elements, including sodium, chloride, boron and organic compounds which are toxic at very low concentration. Generally, irrigation supplies should contain a very low concentration of the trace elements which is within acceptable level. Some workers had reported that normal pH and alkalinity for water irrigation water could range from 6.5-8.4 (Michael, 1998; WHO, 2008). Most problems were attributed to lack of priority given to the water supply sector, lack of financial resources, lack of sustainability of water supply and sanitation services, poor hygiene behaviors and inadequate sanitation in public places including hospitals, health care centers and schools (Michael, 1998; WHO, 2008). Among the major targets of millennium development goal in 2015 is to have access to water and to be achieved globally but with most regional have national gaps, particularly in sub-Saharan Africa that still have low access to water and sanitation which may be linked to drag on socio-economic development in many countries (UNDP, 2013). However, the panacea to reduce burden of disease among the populace is to providing access to sufficient quantity and quality of safe water. The provision of facilities for a sanitary disposal of excreta and introducing sound hygiene behaviors' should be of priority importance to reduce the burden of disease caused by these risk factors (UNDP, 2013). Hence it is our objective to determine the mineral composition, physicochemical parameters and water quality of Opa water irrigation.

MATERIALS AND METHOD

Collection of water samples: Water samples used for this investigation were obtained from opa water irrigation at Obafemi Awolowo University community, Ile-Ife, Nigeria (Fig. 1).

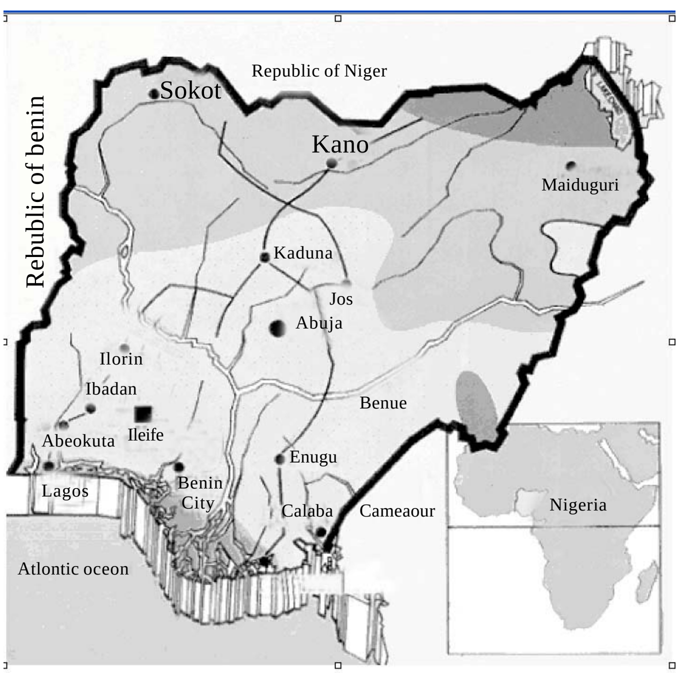

Fig. 1: Map of Nigeria showing Ile-Ife

Water samples were obtained into 10 sterile capped 250 mL bottles containing 372 mg of ethylene diamineteracetate (EDTA) to chelate trace metal, at different points around Opa water irrigation (AOAC, 2000; Arnold, 1990).

Determination of water conductivity of the water samples: Conductivity of water samples was determined by dipping the electrode of the digital conductivity meter into the water samples directly and allowed to stand for 30 sec before taken the reading (AOAC, 2000; Arnold, 1990).

Determination of total dissolved solid of the water samples: Determination of Total Dissolved Solid (TDS) was estimated indirectly with conductivity (EC) and using the empirical relation, TDS (mg L^{-1}) = 0.64EC (ohm/cm) model PT1-18 serial No. 3926 (AOAC, 2000; Arnold, 1990).

Determination of sodium percentage, sodium adsorption ratio: Sodium% and Sodium adsorption ratio was computed using Eq. 1 and 2, respectively:

$$Na\% = \frac{Na + k}{Na + Mg + Na + k} \times 100 \quad (1)$$

$$SAR = \frac{Na}{\sqrt{Ca + Mg / 2}} \quad (2)$$

Determination of water nutrient of the water samples: Water samples were obtained in sterile bottle and read directly for mineral composition with atomic absorption spectrophotometer, model: Perking Elmer 403 (AOAC, 2000; Arnold, 1990).

pH determination of the water samples: The pH of water was determined using a pH meter (HANNA model HI 8314). pH meter was standardized with a buffer solution of pH 4.0 and 9, then water sample was poured into a 100 mL beaker. Electrode was dipped into water sample and allowed to stand for 5-10 min before taking the reading (AOAC, 2000).

Microbial analysis of water samples: One militers of the water samples was diluted with 9 mL of distilled water and this was followed by serial dilutions. The diluted water samples were spread on plate count and violet red agars for total aerobic plate and coliform counts, respectively. For total aerobic plate count, the plates were incubated at 37°C for 24 h while the coliform plates were incubated for 48 h, respectively (WHO/UNICEF, 2006; WHO, 2008; Ibironke *et al.,* 2011).

RESULTS AND DISCUSSION

The results of the study were presented in four categories as follows: physicochemical parameters, sodium percentage, sodium adsorption ratio and Kelly's index, major, trace elements and microbial analysis of water samples as shown in Table 1-4.

Table 1 presents the result of physico-chemical parameters such as electro-conductivity ohm/cm, Total dissolve Solid (mg L^{-1}), pH, density and total solid. They were ranged from 2.3-2.7×100, 147.2-172.2, 5.3-6.7, 0.8386-1.0016 and 220-260, respectively. The findings supported the previous reported for safe water and guidelines for drinking-water quality (WHO/UNICEF, 2006; WHO, 2008; Hartley, 1992; Vetanovetz, 1988; Paparozzi *et al.*, 1994). At points 2 and 3 the

Table 1: Physicochemical parameters of the water samples

Water sample code	Electro conductivity ohm cm^{-1} (×100)	Total dissolve solid (mg L^{-1})	pH	Density (g cm^{-3})	Total solid (mg L^{-1})
W1	2.3	147.2	6.5	1.0100	230
W2	2.7	172.8	5.3	0.8386	240
W3	2.7	140.8	5.7	1.0016	220
W4	2.3	147.8	6.8	0.9935	250
W5	2.3	147.2	6.9	1.0040	240
W6	2.3	147.2	6.6	1.0030	246
W7	2.7	172.2	6.7	1.0030	260
W8	2.4	153.6	6.3	1.0020	250
W9	2.4	153.6	6.5	1.0020	252
W10	2.4	153.6	6.5	1.0020	250

Table 2: Sodium percentage, sodium adsorption ratio and Kelly's index of water samples

Water sample code	Na (%)	SAR	Kelly's index
W1	53(P)	1.32	0.68(S)
W2	75(D)	1.77	1.03(D)
W3	52(P)	1.51	0.73(S)
W4	47(P)	2.53	1.26(D)
W5	67(D)	2.61	1.31(D)
W6	40(P)	1.39	0.55(S)
W7	37(P)	1.15	0.48(S)
W8	60(P)	1.84	0.99(S)
W9	54(P)	1.23	0.59(S)
W10	56(P)	1.32	0.79(S)

G: Good, P: Permissible, S: Suitable, D: Doubtful

Table 3: Major and trace elements of the water samples

Water sample code	Ca	Mg	Na	K	Fe	Zn	Mn	Cu	Pb	Ar	B
	mg L^{-1}										
W1	12.7	12.6	29.3	32.5	4.6	-	-	-	-	-	-
W2	13.8	13.8	35.1	46.1	5.2	-	-	-	-	-	-
W3	14.7	17.2	36.0	38.3	3.5	-	-	-	-	-	-
W4	13.9	12.3	50.1	34.1	4.9	-	-	-	-	-	-
W5	14.2	11.4	38.5	44.5	4.7	-	-	-	-	-	-
W6	13.5	10.5	40.0	45.0	3.5	-	-	-	-	-	-
W7	12.7	9.6	31.3	40.1	5.4	-	-	-	-	-	-
W8	13.5	12.6	39.5	32.2	4.2	-	-	-	-	-	-
W9	12.9	17.5	28.9	33.0	4.5	-	-	-	-	-	-
W10	13.6	11.8	30.2	30.1	3.6	-	-	-	-	-	-

pH fell below recommended for normal irrigation water (6.5-8.4) but pH falls below 5.5-5.7 and this may be associated to the availability of iron (Fe) and manganese of the irrigation water (Biernbaum, 1994; Hartley, 1992).

Table 2 reflects the sodium percentage, sodium adsorption ratio and Kelly's index; they were ranged from 37-75%, 1.15-2.61 and 0.48-1.31, respectively. The values agreed with previous findings and followed the guidelines for drinking-water quality obtained for irrigation water elsewhere (WHO/UNICEF, 2006; WHO, 2008; UOC, 1988; Arnold, 1990).

Table 4: Microbial analysis of the water samples

Sample	Aerobic count (cfu g^{-1})	Coliform count
W1	2×10^{-2}	-
W2	2×10^{-3}	-
W3	2×10^{-3}	-
W4	2×10^{-3}	-
W5	2×10^{-3}	-
W6	2×10^{-3}	-
W7	2×10^{-2}	-
W8	2×10^{-3}	-
W9	2×10^{-3}	-
W10	2×10^{-2}	-

Table 3 shows the major elements such as Ca, Mg, Na, K mg L^{-1} of water samples, they were ranged from 12.7-12.7, 9.6-17.5, 28.9-50.1, 30.1-46.1 mg L^{-1}, respectively. Trace elements such as Fe, Zn, Mn, Cu, Pb, Ar and B, they were ranged from 3.5-5.4 mg L^{-1} for Fe and others were not available, respectively and agreed with guidelines for drinking-water quality, however, the iron content of the water samples were relatively high. They were ranged from 3.5-5.4 mg L^{-1}, this may be linked to inadequate plumbing system that are arising from poor design, incorrect installation, alterations and inadequate maintenance that could have led to iron deposited in the irrigation water (WHO/UNICEF, 2006; WHO, 2008; Biernbaum, 1994; Arnold, 1990).

Table 4 shows the total aerobic plate and coliform counts of the water samples that were obtained at 10 different points the irrigation water, they were ranged from $2\text{-}3\times10^{-3}$ cfu g^{-1} and not available, respectively which indicated safe for public consumption, the findings supported the previous reported for safe water guidelines for drinking-water quality (WHO, 2008; Ibironke *et al.*, 2011; Blom *et al.*, 1987).

CONCLUSION

The results showed that the physico-chemical parameters, major and trace elements, sodium percentage, Kelly's index and sodium adsorption ratio that were obtained from the water samples were within the permissible limits and in line with the World Health Organization guidelines. However, the high iron content was found in the water samples may be attributed to inadequate plumbing system that are arising from poor design, incorrect installation, alterations and inadequate maintenance that could have led to iron deposited in the irrigation water. The microbial loads showed that total aerobic of the water samples obtained at 10 different points of the irrigation were ranged from $2\text{-}3\times10^{-3}$, while the coliform counts were nil, hence the water samples were safe for public consumption and most parameters determined were within the permissible limits. The results obtained revealed that opa water irrigation sited at Ile-Ife is suitable to produce quantity and quality drinking-water to serve Obafemi Awolowo University Community, Ile-Ife, Nigeria.

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