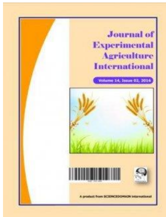

Journal of Experimental Agriculture International

24(2): 1-12, 2018; Article no.JEAI.41558
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Evaluation of Irrigation Water Quality from Major Water Sources in Ondo and Osun States, Nigeria

O. O. Olubanjo[1*] and A. E. Alade[1]

[1]Department of Agricultural and Environmental Engineering, Federal University of Technology, Akure, Ondo State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author OOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OOO and AEA managed the analyses of the study. Author OOO managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/41558
Editor(s):
(1) Dr. Suleyman Korkut, Professor, Duzce University, Department of Forest Industrial Engineeering, Division of Wood Mechanic and Technology, Turkey.
Reviewers:
(1) S. M. Didar-Ul Islam, Tsinghua University, China.
(2) Miguel Aguilar Cortes, Universidad Autónoma del Estado de Morelos, Mexico.
Complete Peer review History: http://www.sciencedomain.org/review-history/25243

Original Research Article

Received 3rd April 2018
Accepted 14th June 2018
Published 23rd June 2018

ABSTRACT

Aims: Irrigated agriculture is dependent on the adequate water supply of usable quality. This study was conducted to determine the quality and suitability of different water sources for irrigation in Ondo and Osun states. The water samples were collected from rivers, dams, streams, bore-holes and hand dug wells within the two states. The physicochemical properties of the sampled water were determined; physicochemical properties including pH, electrical conductivity, temperature, total dissolved solids, major ions (Ca, Mg, K, Na) were analysed in the laboratory and sodium adsorption ratio (SAR), sodium percentage (SP) and kelly's ration (KI) were calculated from the significant cations studied for the criteria of irrigation water quality and suitability for irrigation.
Place and Duration of the Study: The study was performed on main rivers, streams, wells and boreholes in Ondo and Osun states.
Methodology: Samples were collected in Ondo and Osun states, the samples were collected in clean PVC bottles washed and rinsed with distilled water and HNO_3 dilute acid in eight different points across the two states as follows; in the reservoir (Dams), rivers, bore-hole and hand dug wells all channels to farms.

**Corresponding author: E-mail: olubanjoobafemi@gmail.com;*

Results: The study revealed that the values of EC, pH, TDS, TSS, varied from 31 to 1062 mmhos/cm, 5.0 to 7.4, 42.83 to 280.96 mg/L, 28.06 to 203.46 mg/L and turbidity; 0 to 3.5 mg/l, hardness 34 to 160 mg/l and amount of Ca, Mg, K and Na varied from 38.61 to 71.64, 25.3 to 60.17, 17.26 to 35.00 and 21.08 to 33.47 and SAR, SP, KI values varied from 2.98 to 5.74, 30.58 to 49.24, and 0.18 to 0.49 respectively. The total viable count for the microbial present in the surface water sample has the highest value of 5.5×10^{-3} CFU/100ml in the Owena water sample. The presence of faecal indicator bacteria and fungi in the water source suggest pollution raising the possibility of the presence of pathogenic micro-organisms in the water sources, therefore adequate water treatment must be ensured before discharge.

Conclusion: The result shows that there is a higher concentration in groundwater than those in surface water; this implies surface water is good and suitable for irrigation and if groundwater is to be considered as a source for irrigation, proper irrigation management must be required and water analysis for adequate and effective irrigation practice.

Keywords: Irrigation; water quality; physico-chemical properties; sodium adsorption ratio.

1. INTRODUCTION

In determining water availability for irrigation, information is required on both the quantity and quality; however, the quality need has often been neglected. Quality should infer how well a water supply fulfils the needs of the intended user and must be evaluated on the basis of its suitability for the intended use [1,2]. Irrigated agriculture is dependent on the adequate water supply of usable quality. Water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available [3,4]. Irrigation water quality is related to its effects on soils and crops and its management. High-quality crops can be produced only by using high-quality irrigation water keeping other inputs optimal. Characteristics of irrigation water that define its quality vary with the source of the water. Water used for irrigation always contains measurable quantities of dissolved substances which as a general collective term are called salts. These include relatively small but essential amounts of dissolved solids originating from dissolution or weathering of the rocks and soil and dissolving of lime, gypsum and other salt sources as water passes over or percolates through them.

The amount and kind of salts present will determine the suitability of water for irrigation. With poor water quality, various soil and cropping problems can be expected to develop there may also be significant differences in the quality of water available on a local level depending on whether the source is from surface water bodies (rivers and ponds) or groundwater aquifers with varying geology, and whether the water has been chemically treated. The chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency, or indirectly by altering plant availability of nutrients [5]. Water has unique chemical properties due to its polarity and hydrogen bonds. It is able to dissolve, absorb or suspend many different compounds. Thus in nature water is not pure as it acquires contaminants from its surrounding and those arising from humans and animals as well as biological activities [6].

Supplies of good quality water, well-matched to crop irrigation, is highly necessary for irrigation monitoring for maximum crop production to ensure food security in Africa and the whole world at large. Thus, there is a high dependency on untreated water for irrigation purposes [7]. Huge amounts of low-quality water use in irrigation may result in various problems such as toxicity for crops, damage to soil quality, diffusion of parasites, and drawbacks in irrigation systems. Also, poor quality irrigation water will result in low crop production [8,9,10,7]. Irrigation water with good quality is determined based on the characteristics necessary for plant development and growth, acceptable levels of concentrations, water test at reputable laboratory information about the geologic history of the rocks and suitability of the water for agricultural purposes in Ondo and Osun states [4]. This study highlighted the possibility to apply a simple tool to evaluate water quality in Ondo and Osun states for irrigating crops and to guide farmers on the use of high-quality irrigation water using specific recommendations to maximise the yield of crops. The specific objectives are therefore to evaluate the quality of irrigation water in significant sources in Ondo and Osun States, Nigeria and suggest the optimum solution to increase crop production.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was performed on main rivers, streams, wells and boreholes in Ondo and Osun states. Geographically the two-state which are situated in the tropical rainforest zone of the country in which Ondo state lies between latitude 5º45' and 7º52'N and Longitude 4º20' and 6°5'E with a land area of 15,500 square kilometres as shown in Fig. 1 below. Also, Osun state is located 7º30′ 0″ N and longitude 4º30′ 0″ E and a land area of approximately 14,875 square kilometres (Fig. 2). Irrigation practice is part of significant agricultural practice in these two states which get most water use in irrigation practice from water cooperation boards, like the Owena Muti-purpose Dam in Ondo state, Rural and Urban Multi-purpose Dam located in Kajola town Osun state also is the Osun river basin and much more sources of irrigation water including groundwater (i.e. wells and bore-holes). The states have undergone great economic development in recent years pertaining to agricultural practice and in fact they are notably known as agrarians states that contribute to the product of raw materials for the industries in Nigeria. Livestock farming, irrigated vegetables and horticulture are also agrarian activity in the two states.

2.2 Water Sampling

Samples were collected in Ondo and Osun states, the samples were collected in clean PVC bottles washed and rinsed with distilled water and HNO_3 dilute acid in eight different points across the two states as follows; in the reservoir (dams), rivers, bore-holes and hand dug wells all channels to farms and are major sources of irrigation water in the two states. Sample from dams and rivers use for the agricultural purpose were collected as surface water while water samples from wells and bore-holes are collected as groundwater. The samples were taken to the laboratory for chemical analysis according to standard tests [11,12]. Samples were tested for pH, electrical conductivity, total dissolved solids (TDS), and calcium, magnesium and sodium ions and microbial effect. Samples were further tested for the presence of heavy metals like (Fe, Pb, Cd, Cu, Zn, Mn).

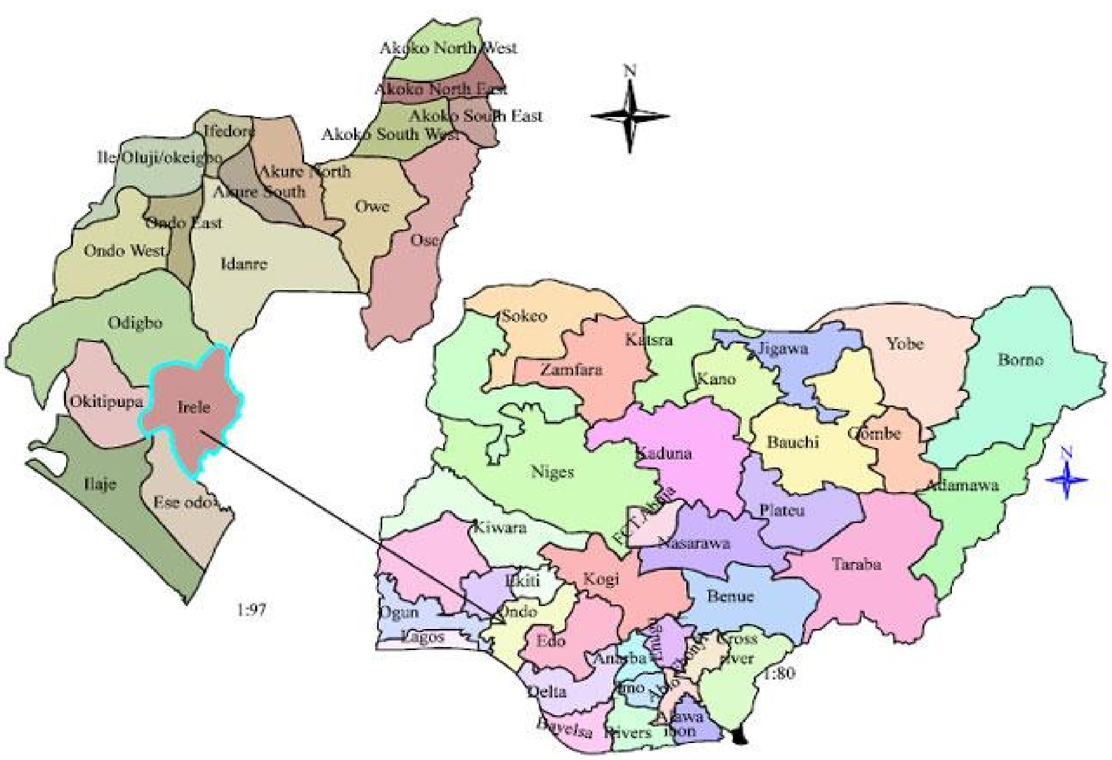

Fig. 1. Map showing location of the study area (Ondo state)

Fig. 2. Map showing location of the study area (Osun state)

2.3 Water Analysis

Parameters such as electrical conductivity (EC), temperature and pH were determined on the site (in situ test) with standard calibrated portable pH/EC/TDS/temperature meter made by Hanna instrument, HI 93703. The analysis for physics-chemical and microbiological parameters were analysed using methods prescribed by APHA, AOAC [11,12]. Water sampling locations were chosen based on the spatial variations in the water stream and irrigation system (irrigation sources, downstream water bodies, rivers, hand dug well and bore-holes). The water samples were to be collected based on the standard method guidelines described in [13]. The content of Fe, Pb, Cd, Cu, Zn and Mn in irrigation water was estimated using the atomic absorption spectrometer (varian model, spectral AA220) [14]. Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO_3, SO^{-2}_4, and Cl^{-} with other parameters were the major ions in ground and surface water of the study area and were determined using titrimetric method in the laboratory and the concentration were analysed, interpreted and calculated with irrigation indexes base on the standard method used by Reddy [15] in the deformation of sodium percentage (SP), sodium absorption ratio (SAR) and Kelly ratio (KR) as follows:

2.3.1 Sodium percentage

This was calculated by employing equation stated by Todd [16] as:

$$Na\% = \frac{(Na^{+} + K^{+}) \div (Ca^{2+} + Mg^{2+} + Na^{+} + K^{+})}{100}$$

(concentrations are in meq/L)

2.3.2 Sodium absorption ration

This was calculated by employing equation stated by Raghunath [15] as:

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+} \div 2}}$$

(Concentrations are in meq/L).

2.3.3 Kelly's ratio

This was calculated by employing equation stated by Kelly [14] as:

$$KR = \frac{Na^{+}}{(Ca^{2+} + Mg^{2+})}$$

(Concentrations are in meq/L).

3. RESULTS AND DISCUSSION

Table 1 represents samples description and location of the study area. The results of physic-chemical properties of irrigation water in Table 2. Table 3 shows the results of hydrogeochemical analysis of the water samples and calculated parameter indexes for irrigation feasibility of the study area. Table 4 to 6 represented

Table 1. Samples description and location

Samples	Location	Symbol	Classification
Ogbese river	Ogbese, Ondo state	A	Surface water
Kajola dam	Kajola, Osun state	B	Surface water
Ilesa river	Ilesa, Osun state	C	Surface water
Owenna dam	Owenna, Ondo state	D	Surface water
Bore-hole	Ilesa, Osun state	E	Ground water
Hand dug well 1	Owenna, Ondo state	F	Ground water
Hand dug well 2	Kajola, Osun state	G	Ground water
Hand dug well 3	Akure, Ondo state	H	Ground water

classification of water based on SAR, SP and KR respectively. The results of water quality parameters and variability for all eight (8) water sources were presented respectively, and the water quality parameters are: Temperature measured in (ºC), pH value, Chloride (mg/L), Hardness, Calcium Hardness (mg/L), Magnesium Hardness (mg/L), Acidity and Alkalinity, Electrical Conductivity and Turbidity.

Table 1 shows different sample locations, samples were collected in eight (8) different points which includes dams, rivers, bore-holes, hand dug wells and were classified under surface and groundwater.

Table 2 shows the pH value ranges from 5.0 to 7.4 for water sources with the mean value of 6.56 which indicating the samples were neutral in nature and slightly alkaline for the surface water which was comparatively higher than that of the groundwater (5.0 to 7.4) which were slightly acidic unless for the sample H which is 7.4. The slightly alkaline nature of the pH value for the surface water might be as a result of or effect of waste disposal and agrochemicals from the upstream [2].

The temperature is the most important physical variable and therefore one of the important water qualities attributes to irrigation system. In Table 2, the temperature value ranges from 20 to 25ºC with the mean value of 23.875ºC which fell within the optimal water temperature. According to WHO the target guidelines is 25-30ºC, within which maximal growth rate of plant, efficient food conversion, best condition for aquatic lives, resistance to disease and tolerance of toxins are enhanced [2,17].

The electrical conductivities for the water sample sources range from 31 to 1062 mmhos/cm with the mean value of 288.5 mmhos/cm in which the value is below the critical water conductivity of 5000 mmhos/cm which is within the permissible limit. An indication of this values shows that the water sources were free from salinity problems as the electrical conductivity gives a good indication of the extent of the dissolved salts (Table 2).

The total dissolved solids (TDS) in water is one of the essential parameters to be determined in relation to irrigation level because many toxic solid materials may be imbedded in the water which may cause harm to the plants [10]. TDS for the water samples range from 42.83 to 208.96 mg/L (Table 2), the values do not exceed the critical level of 4000 mg/L the usage of the raw water will have no salinity problem if applied to plant [9,18].

The chloride analysed ranges between 35.45 to 85.08 mg/L (Table 2) with the mean value of 51.22875 mg/L (Table 2). The water sources can be used since the values were below critical value of 355 mg/l that can result into toxic absorbed by roots and also damage sensitive ornamental plants. Also, the excess value of chloride obtained in the study area prevent the accumulation of chloride on the leaves of the crop to be planted, which can result in leaf burns [19,10].

Another factor to be consider in water quality for irrigation is turbidity, measures the transmission of light through water with respect to matter suspended in water. The turbidity level for surface water ranges from 0 to 3.5 mg/L with the mean value of 1.25 mg/L. The turbidity values obtained were similar to that of Getahun et al. [4].

The value of the total suspended solids for water samples ranges from 28.06 to 203.46 mg/L with the mean value of 97.64 mg/L. It is difficult to formulate general acceptable values for suspended solids in irrigation water therefore total suspended value below 50 mg/L is safe for a drip irrigation system while values above 100 mg/L will cause plugging [14].

Table 2. Physico-chemical properties of irrigation water of the study area

	Surface water				Ground water						
Parameters	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Min**	**Max**	**Mean**
pH Value	7.20	7.10	7.00	7.10	6.30	5.40	5.00	7.40	5.00	7.40	6.56
Temperature	25.00	24.00	24.00	24.00	24.00	25.00	20.00	25.00	20.00	25.00	23.87
Chloride (mg/L)	35.45	39.70	72.32	56.76	41.12	38.28	85.08	41.12	35.45	85.08	51.22
Hardness	34.00	58.00	60.00	160.00	80.00	114.00	58.00	42.00	34.00	160.00	75.75
Calcium hardness (mg/L)	14.00	20.00	28.00	36.00	5.00	20.00	19.40	9.00	5.00	36.00	18.93
Magnessium hardness (mg/L)	20.00	38.00	32.00	124.00	75.00	94.00	38.60	33.00	20.00	124.00	56.83
Electrical conductivity	149.00	99.00	1062.00	120.00	31.00	231.00	234.00	382.00	31.00	1062.0	288.50
Turbidity	0.10	3.50	1.70	2.00	0.00	2.70	0.00	0.00	0.00	3.50	1.25
Dissolved oxygen (mg/l)	11.00	13.00	15.00	10.20	13.00	11.80	11.90	14.00	10.20	15.00	12.49
TDS (mg/l)	114.56	71.04	109.44	74.88	42.83	167.68	280.96	275.84	42.83	280.96	142.15
TSS (mg/l)	132.30	48.86	49.13	52.08	28.06	103.83	163.4	203.46	28.06	203.46	97.64

Table 3. Results of hydrogeochemical analysis and calculated parameters indexes for irrigation quality of the study area

Ca^{2+}	Na^{+}	Mg^{2+}	K^{+}	SAR	KR	Na%
46.28	28.11	34.87	23.43	4.412976	0.346396	38.844241
63.42	23.452	60.17	31	2.983343	0.189756	30.58379
60.26	26.54	32.47	17.264	3.897676	0.286207	32.08285
52.46	21.086	34.76	28.242	3.193016	0.241756	36.12503
57.8	30.01	25.3	21.86	4.655652	0.361131	38.43076
38.61	33.476	29.22	32.332	5.748276	0.493528	49.24348
71.64	31.282	37.4	19.2	4.236591	0.286886	31.64579
60.14	27.612	44.83	35	3.811363	0.263047	37.36201

Sources of irrigation water (surface water and groundwater) were classified and analysed based on sodium adsorption ratio (SAR), Kelly's ratio (KI) and sodium percentage (SP). The Table 3 shows the classification respectively.

The content of Ca in the water samples varies from 38.61 to 71.64 mg/l with mean value of 56.3263 mg/l in which higher percentage of Ca were dominant in groundwater than in surface water. Getahun et al. [18] had similar results. This higher value presence of dissolved calcium in the water samples may be as a result of limestone and carbonate rocks in the study area.

The variation of magnesium concentration ranges from 25.30 to 60.17 mg/l and with the mean value of 37.77 mg/l. Magnesium is one of the constituents in natural water and its salts contribute to water hardness. The value of magnesium does not exceed the critical level of WHO permissible limit of 150 mg/l.

Potassium is one of the natural occurring in the groundwater and surface water [20]. Potassium value ranges from 17.26 to 35.00 mg/l with the mean value of 26.04 mg/l. These values were accepted limit for irrigation and agricultural use according to WHO permissible limit of the value of 200 mg/L.

Sodium content is another important factor in irrigation water quality evaluation. Plant roots absorb sodium and transport it to leaves where it can accumulate and cause injury. Irrigation water with high level of sodium salt can be particularly toxic if applied to plant leaves [19,10]. The sodium value for the sources of water ranges from 21.08 to 33.47 mg/l with the mean value of 27.69 mg/l (Table 3).

3.1 Sodium Adsorption Ratio (SAR)

The sodium adsorption which relates the sodium content with the dicationications calcium and magnesium ranged from 2.98 to5.74 mg/l in the study area (Table 4). It was a significant parameter for determination of suitability of irrigation water. High sodium in water produces the undesirable effects of changing soil properties and reducing soil permeability. In the study area, the SAR values obtained fall within the excellent class and acceptable for irrigation [21,14]. Similar result as observed by Srinivasa, [22] when researching on the assessment of groundwater quality for irrigation of Bhaskar Rao Kunta watershed, Nalgonda District, India.

Table 4. Classification of water based on SAR values

SAR values	Class	% Number of samples and samples number
<10	Excellent	100
10 – 18	Good	Nil
18-26	Fair	Nil
>26	Poor	Nil

3.2 Sodium Percentage (SP)

Sodium is very important cation if too much in soil worsen the structure of the soil and thereby reduces the yield of the crops. The ratio of sodium and potassium in all the cation present is important factor in considering quality of water for irrigation. The concentration of sodium in irrigation water is of importance and play a significant role [18]. The use of high percentage of sodium water for irrigation was stunted, the plant growth and sodium reacts with the soil to reduce its permeability [23]. The values of sodium percentage for the study areas range from 30.58 to 49.24 mg/l (Table 5). According to the classification for SP given by Wilcox [24], Kelly [14] and Eaton [25] classification also gives same assumption [18] that is when SP % is less than 25, it is under excellent and good for irrigation because the sodium percentage were within permissible limit as shown in Table 5.

Table 5. Classification of water based on SP values

SP (%)	Class	% Number of samples and samples number
<20	Excellent	100
20-40	Good	Nil
40-60	Permissible	Nil
60-80	Doubtful	Nil
> 80	Unsuitable	Nil

3.3 Kelly's Ratio

Kelly's ratio is used in evaluate water based on level of sodium measured against calcium and magnesium. Kelly's ratio was more than 1 indicating an excess sodium level in water, therefore the water Kelly's ratio of less than 1 was suitable for irrigation [14,10]. The Kelly's ratio in the study area ranges from 0.189 to 0.493 mg/l therefore indicating the water samples were good for irrigation (Table 6).

Table 6. Classification of water based on KR values

KR meq/L	Class	% number of samples and samples number
<1	safe	100
<1	unsuitable	Nil

3.4 Micronutrients Composition of the Water Samples

Lead is poisonous to human health. The concentration of lead present in the water samples varied between 0.009 and 0.019 mg/L. Samples B and H fell within the WHO permissible limit (0.01 mg/L) which is good for drinking and agricultural activities while A, C, D, E, F and G respectively are above the permissible limit which are detrimental to health and not suitable for irrigation. The concentration of Cadmium present in the water samples were found to be between below detection limit (BDL) and 0.028 mg/L. Samples A, D and G respectively fell within WHO permissible limit of (0.003 mg/L) while samples C, F and H values respectively are above the permissible limit. However, concentration of cadmium in samples B and E were below detection limit. Copper is found mainly as a sulphide, oxide or carbonate in the minerals. Coppers enter into water through mineral dissolution, industrial effluent and corrosion of water alloy distribution pipes. The copper concentration values obtained in this study ranged between 0.380 and 0.912 mg/L. the copper values were found within the permissible limit of (1.0 mg/L). This indicates that the water samples are safe for consumption and irrigation purposes as regards copper concentration.

The concentration of iron in sample C fall below the permissible limit of 0.3 mg/L while A, B, D, E F, G and H were higher than WHO permissible limit of 0.3 mg/L. concentration measured ranged between 0.106 and 2.162 mg/L. The water samples need to be treated before it can be used for irrigation purposes. The concentration of manganese in the water samples ranged between 0.072 and 0.352 mg/L The manganese values were found within the permissible limit of (0.5 mg/L). This indicates that the water samples are good for irrigation purposes.

Zinc is an essential and beneficial element to plant and body growth [26,27]. The values of zinc measured in all the samples were within WHO permissible limit of (3.0 mg/L). The values obtained ranged between 0.003 and 0.045. These make a good quality water for irrigating crops in this region.

Table 7. Micronutrients composition of the water samples

Samples(mg/l)	Pb	Cd	Cu	Fe	Mn	Zn
A	0.011	0.002	0.610	2.028	0.214	0.041
B	0.009	BDL	0.520	0.964	0.286	0.023
C	0.019	0.017	0.650	0.106	0.208	0.003
D	0.011	0.003	0.380	1.603	0.311	0.045
E	0.012	BDL	0.870	1.874	0.238	0.043
F	0.014	0.028	0.540	1.462	0.087	0.025
G	0.014	0.003	0.430	2.162	0.072	0.038
H	0.010	0.006	0.912	0.672	0.352	0.015
Min	0.009	0.002	0.380	0.106	0.072	0.003
Max	0.019	0.028	0.912	2.162	0.352	0.045
Mean	0.0125	0.00983	0.614	1.35888	0.221	0.02913

BLD: Below Detection Limit

Table 8. Total coliform results for Owena water sample, Ilesha water sample, Kajola water sample and Akure water sample

Probable bacteria	Owena water sample				Ilesha water sample			Kajola dam water sample			Akure water sample		
	Escherichia coli	***Bacillus* sp**	***Pseudomonas aeruginosa***	***Micrococcus luteus***	***Aerococcus viridans***	***Escherichia coli***	***Bacillus* sp**	***Escherichia coli***	***Streptococcus* sp**	***Pseudomonas aeruginosa***	***Escherichia coli***	***Bacillus pumillus***	***Micrococcus* sp**
Colour	Yellow	White	Green	Yellow	Cream	Yellow	White	Yellow	Grayish	Green	Yellow	White	Yellow
Surface	Smooth	Smooth	Smooth	Smooth		Smooth	Smooth	Smooth		Smooth	Smooth	Irregular	Smooth
Edge	Rhizoid	Rhizoid	Entire	Entire	Dented	Rhizoid	Rhizoid	Rhizoid	Entire	Entire	Rhizoid	Undulate	Entire
Elevation	Flat	Flat	Flat	Flat	Raised	Flat	Flat	Flat	Raised	Flat	Flat	Flat	Flat
Shape	Rod	Rod	Rod	Cocci	Spherical	Rod	Rod	Rod	chain cocci	Rod	Rod	Rod	Cocci
Gram reaction	-	+	-	+	+	-	+	-	+	-	-	+	+
Motility	+	+	+	-	-	+	+	+	-	+	+	+	-
Spore	+	+	-	-	-	+	+	+	-	-	+	+	-

Table 9. Total viable count

Percentage (%)	Owena	Ilesha	Kajola	Akure
Factor 10^{-4}	$5.5x10^{-3}$	$5.0x10^{-3}$	$4.8x10^{-3}$	$4.7x10^{-3}$
10^{-6}	$4.5x10^{-5}$	$4.0x10^{-5}$	$4.6x10^{-5}$	$4.4x10^{-5}$

Table 10. Fungi present in the samples

Owena	Ilesha	Kajola	Akure
Penicillium chrysogenum	*Fusarium oxysporium*	*Aspergillus flavus*	*Penicillium italicum*
Penicillium digitatum	*Curvularia geniculata*	*Saccharomyces* sp	*Fusarium oxysporium*
Mucor plumbeus	*Penicillium oxalicum*	*Rhizopus oryzae*	*Cladosporium herbarum*
Saccharomyces sp		*Rhizopus stolonifer*	

3.4 Microbial Analysis Result

Water samples were collected from different water sources in clean plastic containers. All these samples are viewed under microscope. Based on the colour, shape, morphology of organisms on the plate, the most dominant bacteria in the samples were *Escherichia coli*, *Streptococcus* sp., *Bacillus* sp., *Pseudomonas aeruginosa*, *Micrococcus luteus* and *Aerococcus viridans* indicate human interactions with the water samples as shown in Table 8. The total coliform result of all the water samples revealed that presence of *Escherichia coli* is present in all the water samples (Table 8). Similar results were obtained by Olaloye and Olaniyan [27] who reported that Escherichia coli at high quantity in the human body causes gastroententis if consume through plants grown by irrigation. Ilesha water was found to contain *Aerococcus* sp. which is an opportunistic pathogen associated with bacteremia, endocarditis and urinary tract infections. It is primary cause of fatal lobster disease called gaffkemia and causes greenish discoloration in pickled and cooked food. *Bacillus* sp. were found in Owena, Ilesha and Akure water samples which are the predominant plant growth promoting bacteria.

The total viable count result obtained as shown in Table 9 indicate that the Owena water sample has the highest microbial load, followed by Ilesha water sample and Kajola water sample. The Akure water sample had the least microbial effect. The consequence is that Akure water sample exhibits less risk when compared to the other water samples even thou health hazards and diseases outbreak depends on more than just microbial load [7].

The following fungi were observed considering the shape and morphology under the microscope for different water samples as shown in Table 10. The fungi present in the water samples show that the Owena water sample contained *Penicillium* sp. which have been found over time to be important in the natural environment for food and drug production. Some members are used in producing antibiotics (penicillin) as it prevents bacteria from affecting the body. *Mucor plumbeus* which studies have shown over time to have the ability to activate the complement system in humans through the alternative pathway. It was also found to contain *Saccharomyces* sp *Fusarium oxysporium* associated with Ilesha and Akure water were found unable to infect humans and endothermic animal because of their inability to grow in warm environments close to 37ºC [27]. Also, *Mucor plumbeus* found in Owena river and. *Rhizopus oryzae* found in Kajola water sample cannot operate at environmental temperature close to 37ºC. *Aspergillus flavus* and *Rhizopus stolonifer* that present in Kajola water have been examined to grow rapidly at temperature between 15 – 30ºC and it also affects the nutrients that present in the crops [7].

4. CONCLUSION

Evaluation of quality of sources of irrigation water was carried out using different index method like SP, SAR and KI among these majority of index results were similar to SP, SAR and KI implying that the 100% of the water samples fall under excellent. The pH values indicated that the water is slightly acidic to slightly alkaline. The increasing EC values of the sample of the different sources in the two states make the impact of agriculture activities. In conclusion, the water in the study areas (i.e. Ondo and Osun states) were suitable for irrigation practices.

Also, the government should enforce strict rules and legislation on adequate evaluation of the quality of irrigation water and ensure a proper acceptable standard for good and effective crop production in Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Affullo AO. Irrigation suitability assessment of effluents from west Kano rice irrigation scheme, Kisumu, Kenya. Ethiopian Journal of Environmental Studies and Management. 2009;2:1-11.
2. Islam MR, Jahiruddin M, Islam S. Assessment of arsenic in the water-soil-plant systems in gangetic floodplains of Bangladesh. Asian Journal of Plant Science. 2004;3:489-493.
3. Ahmed IM. Irrigation water quality evaluation in El-salam canal project. International Journal of Engineering and Applied Sciences. 2013;3:11-28.
4. Getahun K, Heluf G, Tena A, Geremew L. Identification of groundwater level by using geoelectrical resistivity method at Finch'a Sugar Estate, Blue Nile Basin, Western Ethiopia. Science Technology and Arts Research Journals. 2013;2:114-125.
5. Ayers RS, Westcot DW. Water quality for agriculture. Food and Agriculture Organization of the United Nations; 1994.
6. Aiyesanmi AF. Baseline concentration of heavy metals in water samples from rivers within Okitipupa south-east belt of the Nigeria bitumen field, Journal of Chemical Society of Nigeria. 2006;31:30-37.
7. Olubanjo OO. Assessment of groundwater quality for human consumption and agricultural use in Ilara-Mokin, Ondo State, Nigeria. Journal of Engineering and Engineering Technology. 2016;10(2):82-92.
8. Bortolini L, Maucieri C, Borin M. A tool for the evaluation of irrigation water quality in the arid and semi-arid regions. Agronomy. 2018;8:23.
9. Dhirendra M, Alok K, Namita A. Assessment of the irrigation water quality of river Ganga in Haridwar district. Rasayan Journal of Chemistry. 2009;2: 285-292.
10. Masoudi M, Patwardhan AM, Gore SD. A new methodology of producing of risk maps of soil salinity, case study: Payab Basin, Ethiopia. Iran Journal of Applied Sciences and Environmental Management. 2006;10:913.
11. AOAC. Official methods of analysis of the association of analytical chemists. Virgina, USA; 1990.
12. APHA. American Public Health Association. Standard method for the examination of water and waste water. 1998;1-30.
13. Islam MS, Shamsad SZKM. Assessment of irrigation water quality of Bogra District in Bangladesh. Bangladesh Journal of Agric. Res. 2009;34:597–608.
14. Kelly WP. Use of saline irrigation water. Soil Sci. 1963;95:355-391.
15. Raghunath HM, Ground water. Wiley Easten Limited. 1990;563.
16. Todd DK. Groundwater hydrology. John Wiley and Sons Publications, New York; 1995.
17. Sulchdev K. Assessment of surface water quality for drinking and irrigation purposes. A case study of Ghaggar river system surface waters. Bulletin of Environment, Pharmacology and Life Sciences. 2012;1: 1-6.
18. Dider-Ul Islam SM, Bhuiyan MAH, Rume T, Azam G. Hydrogeo chemical investigation of groundwater in shallow coastal aquifer of Khulna district, Bangladesh. Appl Water Sci. 2017;7:4219–4236.
19. Chang Y, Hans MS, Haakon V. The environmental cost of water pollution in Chongqing. China Environ. Def. Econ. 2001;6:313-333.
20. Alfred K, Godfred O, Elikem K. Assessment of surface water quality: The perspective of the Weija dam in Ghana. International Journal of Chemistry. 2011;3: 32-39.
21. Biswas SN, Mohabey H, Malik ML. Assessment of the irrigation water quality of river Ganga in Haridwar district. Asian J. Chem. 2002;16.
22. Sivasubrabramanian P, Balasubramanian N, Soundranayagam JP, Chandrasekar N. Hydrological characteristic of coastal aquiver of Kadaladi Ramanathapuram Distric, Tamil nadu, India. Appl Water Sci. 2013;3:603–612.
23. Getahun K, Heluf G, Tena A. Assessment of irrigation water quality and suitability for irrigation in the Fincha'a Valley Sugar Estate, Nile Basin of Western Ethiopia. Science, Technology and Arts Research Journal. 2014;3:64–73.
24. Wilcox LV. Classification and use of irrigation water. Washington: US

Department of Agriculture. Circular. 1955; 969:19.
25. Eaton EM. Significance of carbonate in irrigation water. Soil Sci. 1950;69:123–133.
26. Gyamfit ET, Ackah M, Anim AK, Hanson JK, Kpattah S, Enti-Brown S, Adjei-Kyereme Y, Nyarko ES. Chemical analysis of potable water samples from selected suburbs of Accra, Ghana, Proceedings of the International Academy of Ecology and Environmental Sciences. 2012;22(1):18-127.
27. Olaoye RA, Olaniyan OS. Quality of rainwater from different roof material. International Journal of Engineering and Technology. 2012;3(8):1413-1421.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/25243