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Biochemical Analysis of Groundwater for Irrigation in Selected Areas of Suru Local Government, Kebbi State for Sustainable Agriculture in Nigeria.

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ABSTRACT

The quality of water remained the most important consideration for agricultural production especially in irrigation system. The used of underground water for irrigation served as the most reliable and stable source of irrigation water in the area. The research work was designed to investigate the biological and chemical compositions of underground water used for irrigation farming in some predominant farming locations in Suru Local Government of Kebbi State Nigeria for Quality production and sustainable food production in the area. Water sample were collected randomly from 2inches tube wells with dept of 10.5m. All samples were collected twice in sterilized containers, and transported for further analysis. Biological parameters determined were bacterial and fungal organisms associated with ground water. Chemical parameters such pH was determined using electronically digital pH meter while Electrical conductivity meter was used in measuring the electrical conductivity EC. Other chemical parameters such as Total Dissolved Solids TDS, Sodium Absorption Ratio SARs, Residual Sodium Content RSC and other ions Ca, Mg, K, and Na were determine using the standard methods. Biological parameters such Total colliform and myco composition of the groundwater were analysed by standard cultures. The result obtained indicated that pH value range from5.2 to 6.0, Ca 50-127, Mg 52-91, K 0.33- 3.1, Na 0.63 -5., Cl 1.33 3.5, SAR 0.10- 0.72, TDs 0.5-2.12 and RSC at 11.34- 42.28. Biological composition includes the bactertia and fungi. It was concluded that most of the parameters investigated are within the acceptable range for world water quality standards. Little amendment is needed for most samples. The biological contaminant bacteria and fungi may pose a great challenge to farmers if not minimize.

Keywords: Biochemical, Groundwater, Irrigation.

1. INTRODUCTION

It is obvious that most agricultural activities cannot be done without adequate and good quality water supply. The major sources of water for agriculture remained the surface water from rivers, lakes, ponds and rain and the ground water present in aquifers. Surface water served as the cheapest source of water for agriculture but may not always be available throughout the year. Where surface water became scarce the use of underground water remained the only alternative. The practice of irrigation farming in the area is mostly done during dry season when surface water is difficult to access. Groundwater is the water that is present beneath the earth in rocks and soil pores or aquifers which are layers of permeable rock or soil that hold and transmit water. It remains a significance source of water for irrigation especially in areas where surface water unreliable. It is the most dependable source of water especially that it cannot be affected by seasonal variations. Because of the filtration process it pass before being seep out for used it tend to have more quality parameters than the surface water.

The most important consideration in ground water sources for Agriculture includes the depth of water, the volume as well as its biological and physicochemical composition which are sum as water quality. There were assertions that Groundwater water quality of almost every region has widely been deteriorated due to several geogenic and anthropagenic factors followed by climatic and aquifier conditions (Mukherjee et at., 2021). The quality of water therefore depends on the concentration level of most chemical and biological component present in it. It was asserted that prolonged usage of such poor quality groundwater for irrigation may accumulate and transport undesirable elements to the soil which eventually can alter the physico-chemical and biological properties of the soil which may in turn affect the soil quality of soil for agriculture (Muhkerjee and Singh, 2018). Poor quality water for irrigation is associated with problem of toxicity, sodicity and salinity which can affect soil permeability, fertility as well as productivity. pH is one of the physicochemical parameters of ground water of greater concern for irrigation. It is the concentration of hydrogen ions (H+) and hydroxyl ions (OH-) in the water used to determine the acidic, basic or neutral conditions of water. The pH water and soil cannot directly affect the plant but the efficiency of coagulation and flocculation process (Kahlown et al., 2006).

Sodium is one of the most important element of concern if poorly concentrated in the water can affect the quality of water for irrigation affecting soil permeability when reacting with soil. It can alter the osmotic activities of the crop plant thereby interferes with nutrients absorption. Apart from sodium concentration other chemicals when poorly concentrated can in one or other affect the quality of ground for irrigation purposes.

The most microbial compositions of ground water are the bacteria and fungi. These types of organism have the ability to survive even in an extreme environment where oxygen is low. Fungi for example can be found in almost all environmental niches (Hussein, 2018). Ground water may be less contaminated with microbial content than surface water with plenty of oxygen. This means that the shallow the ground water the more microbial content it should contain. The common fungi usually isolated from ground water are members of *Hyphomycetes, Ascomycetes* and *Zygomycetes.* Fungi filtered from ground water may remain in the soil dormant for years without having any effect to the environment. Most fungi are pathogenic plants during the life cycle affecting plant growth.

Rice irrigation farming is currently the major agricultural activities in the study area and which specifically depend on groundwater source derived through tube wells. On like other irrigation farming Areas in kebbi State, Suru local government ground water is very shallow ranging from 3m-6m deep which may easily accumulate high chemical and biological elements from other human activities. This research work was specifically designed to evaluate the biological and chemical component of ground water used for irrigation in the area for sustainable food production and water quality management in the area

2. MATERIALS AND METHOD

2.1 Sample Collection

Water samples were collected in 100ml sterilized bottles in triplicates. Water samples were collected from two major irrigation areas in Suru Local Government comprising of Suru (Lat. 11.9238, N11°55'26.232" and log. 4.18034, E4°10'48.768") and Barbarajo (Lat. 11.55705, N11°33'28.878" and Log. 3.98675 E3°59'13.11",). In general a total of 26 samples were collected from 26 tube wells in the irrigation farm. Water sample was collected in May, 2024 during dry season. All samples were labeled appropriately before being taken to the laboratory for analysis.

2.2 Sample Analysis

All samples were analyzed following standard procedure. EC and pH digital electric meters were used to determined Electrical conductivity and pH value. Other chemical parameters were determined at chemistry laboratory of Usmanu Danfodiyo University Sokoto. For microbial content only Fungi were determined. Fungal isolation was done using serial dilution techniques with Potato Dextrose Agar as the media. Isolated fungal colonies were sub cultured and 3identified to the genus level morphologically with aid of pocket led microscope connected with PC for proper view.

SAR value was calculated using the following formula $SAR = \text{Na}/\frac{\sqrt{\text{ca}-\text{Mg}}}{2}$

3. RESULTS AND DISCUSSION

4.1. The result from table1 below indicated the pH, TDS, EC and SAR value of the ground water samples from the study area. pH ranges from 4.8-6.7 with overall mean of 5.7. indicating that the ground water sample in the area fell below the normal pH range (6.5-8.4) for irrigation water. Even though there are narrow ranges of pH values obtained from different samples. 4 samples out of the 15 water samples have pH range within the normal pH value for irrigation purposes. The low pH value recorded in the area may be due continuous farming activities in the area and shallow nature of the tube wells (3-6m) used to generate the water in the area.. Water pH below the normal range needs further amendment to adjust the water for proper crop growth. Ojo *et,al* (2014) reported similar result in some selected local government areas of Kebbi State. Irrigation water pH value below the normal range may lead to nutritional imbalance or soil toxicity. Continuous used of this water may eventually damage the soil and render it in effective. Electrical Conductivity (EC) of the water sample showed a range of value between 114- 732. EC measure the ability of water to transmit electrical charge current. The higher the EC of water the higher the concentration of ions it contains. The classification of irrigation water base on EC indicated that water with EC value of 100-250 is an excellent water for irrigation while water with EC value from 250-750 is classified as good for irrigation and EC of 750-2000 is the permissible limit. EC value above 2000 is considered very and not suitable for irrigation (Tiwari P., 2017, WHO 2011). The result obtained from this study indicated the water is suitable for irrigation and for drinking in terms of its electrical conductivity. This findings is different from the result of Oloruntowa, *et,al.,*(2018) who recorded Electrical Conductivity (EC) values of the groundwater range from 81 – 3200 S/cm with an average of 726.6 S/cm above the maximum permissible limit of WHO (2011) for drinking water quality. This result may also confirm the report of Augie *et,al* (2022) that 98% of water in Kebbi State has low electrical Conductivity.

The important consideration in ground water quality for irrigation is the salinity level of water. Salinity which is the measure of the total amount of salt in the water (Peterson H.G, 1999) may be too high resulting in salinity hazard which proportionately affect crop growth. The relative proportion of sodium cations to other cations can give rise to soil permeability problems which can infer stress to crop growth. For example Sodium Adsorption Ratio (SAR) describes the amount of excess sodium in relation to calcium and magnesium. TDS level below 700 mg/L and SAR below 4 are considered safe while TDS level above 1,750mg/L and SAR level above 9 are considered hazardous (Peterson H.G, 2000, FOA and WHO, 1999) as opposed to 10-18 SAR value and 640 to 1728 and EC 1.0-2.7 by Ronald Kaiser 2018. The SAR value of the water samples obtained in this study area ranges from 1.5 21.0. Out of the 15 samples examined 3 samples fell above WHO permissible limit with SAR value of 12.1, 13.1 and 21.0 respectively. Total Dissolved Solids (TDS) of all the water sample in the area are within the permissible limit of <700dS/m

Table1.Physicochemical parameters of ground water (pH, TDS, EC and SAR) obtained from 15 water sample in the study area.

Sample	pH	EC (uS/cm)	TDS (Mg/L)	SAR (dS/m)
1	5.4	441	78.0	7.2
2	5.0	362	98.0	1.5
3	5.7	371	325.0	21.0
4	6.3	247	53.0	6.0
5	6.7	652	55.0	6.0
6	5.0	148	34.0	7.8
7	5.1	561	42.0	6.2
8	6.6	732	28.0	9.3
9	4.8	225	57.0	4.3
10	5.5	126	74.0	7.7
11	5.5	658	42.0	9.5
12	6.4	721	97.0	13.1
13	6.6	114	79.0	10.4
14	5.0	481	43.0	7.6
15	5.2	213	107.0	12.1

4.2. The concentrations of sodium (Na), potassium (K), magnesium (Mg) and calcium (Ca) in the groundwater samples obtained in this area range between 26.76- 305.16, 30.98-353.26, 14.92-170.16 and 21.92- 75.76 respectively. Only 1 sample is above WHO permissible limit of 200Mg/L for **Na**, 2 samples for **K** above WHO limit of 55Mg/L, 3 sample for **Mg** were above WHO limits of 50Mg/L. This means that most samples of the ground water are suitable for irrigation purposes in the area. The values of Na, Ca, K, and Mg were all below the critical limits and considered safe for irrigation. The findings and conclusion of this work were similar to that of Manasseh E.A., *et,al*, (2022) and Olaruntola *et,al* (2017)

Higher sodium effect on soil result in hard compacted soils, reduced water infiltration and reduced root growth Ronald Kaiser 2018. Excess Na in water can also cause toxicity in sensitive plants mostly in recirculating irrigation systems. Potassium concentration may not affect plant growth but concentration above 10mg/L indicates contamination mainly from fertilizers and other interventions. This indicated the concentration of K is an important determinant for fertilizer requirement of the plants receiving the irrigation water. Magnesium also occurs in the parent rock material where the water will be derive for any irrigation purposes. Mg generally causes problems to crops when it is below 25mgL indicating that there is need for application of fertilizer. It was therefore observed that 5 samples of water from the study area have Mg concentration below the recommended limits. Calcium levels below 40mg/L in the soil require soil remediation to improve Ca level of the soils to prevent crop from deficiency problems associated with Ca. however four samples out of the 15 samples analyze show Ca level below the normal range indicating the need for soil improvement for Ca. Higher calcium concentration above 100mg/L may lead to deficiency of other elements such as Mg and Phosphorus (Swistock B. 2022)

Table2. Concentration of ***Cations*** Ca mg/l, Mg mg/l, K mg/l and Na mg/l of ground water in Suru Local Government

SAMPLE	**TDS (ppm)**	**Ca (mg/l)**	**Mg (mg/l)**	**K (mg/l)**	**Na (mg/l)**	**Cl (mg/l)**	**NO_3 (mg/l)**	**SO_4 (mg/l)**	**Total N (%)**	**PO_4**
A	78.0	60.0	40.84	84.78	73.24	72.89	135.65	101.29	0.42	0.75
B	98.0	75.76	51.57	107.07	92.49	92.06	171.30	127.92	0.28	0.67
C	325.0	250.0	170.16	353.26	305.16	303.73	565.22	422.07	0.28	0.71
D	53.0	41.15	28.01	58.15	50.23	50.00	93.04	69.48	0.45	0.80
E	55.0	42.69	29.06	60.33	50.23	51.87	96.52	72.07	0.56	0.80

F	34.0	26.53	18.06	37.50	52.11	32.24	60.00	44.80	0.42	0.82
G	42.0	32.30	21.98	45.65	32.39	39.25	41.73	54.54	0.36	0.82
H	28.0	21.92	14.92	30.98	39.44	26.64	49.56	37.01	0.36	0.87
I	57.0	44.23	30.10	62.50	26.76	53.74	100.00	74.67	0.42	0.86
J	74.0	56.92	38.74	80.43	53.99	69.16	128.69	96.10	0.48	0.84
K	42.0	32.30	21.99	45.65	69.48	39.25	73.04	54.55	0.57	0.85
L	97.0	74.61	50.79	105.43	39.44	90.65	168.69	125.97	0.4 3	0.86
M	79.0	61.15	41.62	86.41	74.65	74.29	138.26	103.24	0.42	0.90
N	43.0	33.08	22.51	46.74	40.38	40.19	74.78	55.84	0.40	0.90
O	107.0	82.69	56.28	116.85	100.94	100.45	186.96	139.61	0.36	0.96

4.3. The microbial analysis of the ground water samples involves only the mycoflora with exception of bacterial fauna. This is not because the bacteria are not important in the analysis but due to certain challenges that limited the appropriate bacterial culture. This time around the analysis was base on the study location areas namely, Suru and Barbarejo farming areas. The table below indicated that a total of 11 fungal genera were isolated from the ground water samples in the area. The isolated genera include *Aspergillus* Spp, *Alternaria* Spp, *Mucor* Spp, *Rhizophus* Spp, *Fussarium* Spp, *Trichodema* Spp, *Pythium* Spp, *Rhizoctonia* Spp, *Phoma* Spp, *Penicillium* Spp and *Penicillium* Spp. Fungi from these genera were known to survive in aquatic condition especially the *Mucor, Phythium* and *Aspergillus.* Faheem *et al* (2021) reported *Phythium* and *Aspergillus* in the study of aquatic fungi and important fungal pathogens farmed fish. Halena (2016) also recorded *Penicilium,Aspergillus, Fusarium* and *Trichodema ground water in Brazil.* Five (5) species were also recorded by Ren W. and Wen (2023) which included all the species ground water fungi recorded in the current study area.

Fungi are among the microbial contaminant of groundwater but are less in number than bacteria. The deeper the groundwater sources the lesser the abundance of fungi. The depth of ground water is between 3-5m deep which may be the reasons why these type fungi were discovered in the present groundwater samples. Fungi are common in ground water near the land surfaces where flenty of oxygen is present Hussein (2018 study)

The recorded fungi Spp in this current study were among the potential pathogenic fungi that can cause several plant diseases in the area. Pahnwa *et al.*, (2023) revealed the occurrence of different fungal species with leaf spot and fruit rot disease that may cause severe losses to vegetables. Groundwater contamination by pathogenic fungi can result in distribution and accumulation of pathogens in the soil which can lead to the spread of diseases to plant.

Table4.2. Microbial isolate from Ground water for irrigation in Suru local Government Area of Kebbi State

SN	Fungal Species Isolate Suru	Fungal Species Isolate Barbarejo
1	*Aspergillus* Spp	*Aspergillus* Spp
2	*Alternaria* Spp	*Alternaria* Spp
3	*Mucor* Spp	*Mucor* Spp
4	*Rhizophus* Spp	*Rhizophus* Spp
5	*Fussarium* Spp	*Fussarium* Spp
6		*Trichodema* Spp
7		*Pythium* Spp,
8	*Rhizoctonia solani*	*Rhizoctonia* Spp
9	*Collectriticum pormoides*	*Collectriticum* Spp
10	*Phoma Spp*	*Phoma* Spp
11	*Penicillium* Spp	*Penicillium* Spp

5. CONCLUSION

Most groundwater samples from irrigations tube wells were chemically safe for irrigation purposes but attention should be given in some areas because of the possible hazard implication from a greater chance of chemical contamination. Few samples were above WHO standards for all the chemical parameters evaluated. Attention should also be paid to fungal contamination because of the occurrences of one or two pathogenic fungi from the each water sample in the area so as to achieve sustainable agriculture through the use of groundwater for irrigation farming.

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