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Physicochemical analysis of irrigation water obtained from Babani quarters in Bauchi metropolis: Nigeria

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Abstract
Physicochemical parameters and metals concentrations of water used for irrigation at Babani Quarters in Bauchi metropolis, Nigeria were determined in October 2013 to find its suitability for irrigation purpose. In this study, it was found out that most of the parameters were within WHO/FAO maximum limit set for irrigation water. But, among all the five sampling locations, Pb, Cd and NO_3^- levels exceeded WHO/FAO limit and hence pose a threat to receiving soil and vegetation.

Keywords: physicochemical parameters, irrigation water, Babani quarters, Bauchi, Nigeria, WHO/FAO

Introduction
The increase in population being experienced around the globe is causing high demand for food. This effect is more pronounced in urban centres of developing countries. In order to bridge the food needs of the rising population, more farmers engage themselves into dry season farming using all sorts of available water to irrigate their farmlands.
Nigeria is among developing countries that is battling hard to attain food sufficiency. Rainy season farming, in Nigeria, is not sufficient enough to provide the food needs of its teeming population. Therefore, many farmers, particularly in Northern Nigeria, engage themselves in dry season farming in order to cultivate more crops and also as a means of livelihood.
In Northern Nigeria cities, especially Zaria, Jos, Kano, Jigawa, Bauchi and Gombe, where rainfall is inadequate and quality irrigation water is scarce, Farmers uses all sorts of available water for irrigation. Sometimes sewage water, gutters or ponds are put to use to irrigate Farmlands. For example, in Bauchi Metropolis, farmers use sewage water from drainage channels to irrigate small scale vegetable farmlands in order to cultivate crops and vegetables during the dry season [1].
However long term use of sewage water may lead to trace metals accumulation in soil and and subsequent transfer to vegetables over time. It was observed that application of sewage water for irrigation leads to accumulation of cadmium (Cd), lead (Pb), nickel (Ni), mercury (Hg), chromium (Cr), manganese (Mn) and iron (Fe) in the top soil [2] and hence in the tissues of plants grown on them [3]. Although some of the metals (Zn, Mn, Ni, Cu) act as micronutrients at lower concentrations, they could become toxic at higher concentrations According to a study on the assessment of trace metal levels in vegetables irrigated with sewage water in Bauchi metropolis, it was revealed that vegetables irrigated with sewage water have higher levels of some trace metals (Pb, Cd) than those irrigated with pump water [1]. This implies that consuming vegetables grown on sewage water irrigated soil could result in metal toxicity and other health related issues.
Thus, this study was aimed to assess trace metal concentration in water used for irrigation at Babani quarters in Bauchi metropolis in order to find out its suitability or otherwise for irrigation purposes.

Materials and methods
Sampling areas
This study was carried out within Babani quarters along Gombe road in Bauchi metropolis. Important human activities around the study area are domestic waste disposal, car washing, Mechanic workshops, and filling stations. Five farmlands were selected for the study viz:
1. Baban Rabi Farmland (Site 1)
2. Malam Yahaya Farmland (Site 2)
3. Malam Amadu Farmland (Site 3)
4. Malam Tela Farmland (Site 4)
5. Malam Yunusa Farmland (Site 5)

Sample collection, Storage and Pretreatment
All samples of irrigation water were collected from the five irrigation sites in October, 2013. Glass wares and plastic containers used for sample collection were washed with liquid soap, rinsed with distilled water and then soaked in 10% HNO_3 solution for 24hrs [4]. All containers were then washed with distilled water and stored in Memmert drying oven at 80^{o}C for 5hrs.
Sewage water samples ($1dm^3$) were collected in labeled plastic containers at a point closest to were water is being pumped on to the farmlands. pH was measured immediately before acidifying with $1.5cm^3$ concentrated HNO^3/dm^3 of sample [5]. The samples were kept on ice and subsequently transported to the laboratory, frozen in a deep freezer until finally analyzed.

Analysis of water samples
Digestion
Digestion of sewage water was carried out using standard

methods [5]. All physicochemical determinations were based on the digested samples obtained.

Measurement of pH
Measurement of pH was done using a pH meter (model S358236) which was calibrated before being used to measure this parameter.

Determination of Nitrate – nitrogen
Spectrophotometric method was applied in the determination of Nitrate – Nitrogen.

Determination of chloride
Chloride content of the irrigation water was determined by titrimetric method using silver chloride and potassium dichromate as indicator

Determination of total dissolved solid (TDS)
TDS was determined as described by APHA *et al.* [5]

Determination of heavy metals
Metals were determined according to standard procedures described in Standard methods for the examination of water and wastewater [5] immediately after the water samples were transported to the laboratory.

Results and discussion
The values of physicochemical parameters of water and metals concentration are presented in table below.

Physicochemical Parameters of irrigation Water Samples
PH
From Table 1, it is observed that the pH values in this study fall within the range of 7.20 –7.32, slightly neutral values, which are within the recommended range (6.50 – 8.40) set by FAO for irrigation water. The pH recorded in the study area were lower than the range (8.11 – 8.40) reported by Sarkinnoma [6] for sewage water used for irrigation in Bauchi metropolis. The pH value recorded in this study is safe for irrigation because they are within the safe limit given by FAO [7].

Total Dissolved Solids (TDS)
Total Dissolved solids(TDS) indicate the salinity behaviors of water and in the study area it varies between 45.60 and 152.01 mg/L. Davis S. N, [10] classified groundwater on the basis of TDS, up to 500 mg/L (desirable for drinking); 500–1,000 mg/l (permissible for drinking) and 1,000 to 3,000 mg/L (useful for agricultural purposes).
Based on this classification, it is observed that TDS values from this study were far below the permissible limit for agricultural purposes and hence the water is suitable for irrigation.

Nitrate – Nitrogen
Values obtained for NO_3^-N may serve as an indicator of the fertility level of the irrigation water used for irrigation at Babani quarters in Bauchi metropolis. From table 1, in all the five study areas, sites 3 and 5 revealed highest levels of 30.10 mg/dm^3 and 30.40 mg/dm^3 respectively for NO_3^- - N. These levels were higher than the FAO recommended values (5mg/kg) for safe irrigation water and still higher than the values (11.44 mg/dm^3) obtained in a study by Sarkinnoma [6]. This implies that the irrigation water in this study is rich in nitrogen content.

Determination of chloride
The origin of Cl^- derives mainly from the non-lithological sources and can also be contributed, especially, from the surface sources through the domestic wastewaters, septic tanks, irrigation-return flows and chemical fertilizers [8, 9]. Values obtained for chloride have not exceeded the maximum permissible limit set by WHO 1997 [11].

Table 1: Physicochemical Parameters and Metal Analysis of Irrigation Water

Sites	pH	TDS(mg/L)	NO_3^- N(mg/L)	Cl^- (mg/L)	Fe (mg/L)	Mn (mg/L)	Cu (mg/L)	As (mg/L)	Zn (mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)
1	7.21±0.41	490.4±54.89	29.60±10.01	135.0±24.50	0.24±0.16	0.03±0.21	0.14±0.12	0.05±0.01	0.14±0.06	0.90±0.67	0.24±0.13	0.06±0.03
2	7.31±0.40	478.0±30.35	24.60±2.5	150.0±12.35	0.04±o.01	0.28±0.13	0.06±0.06	0.10±0.04	0.21±0.12	1.20±0.14	0.17±0.06	0.10±0.09
3	7.30±1.20	492.1±27.28	30.10±5.17	152.0±9.5	0.20±0.13	0.11±0.10	0.11±0.11	0.01±0.01	0.05±0.04	0.60±0.17	0.09±0.03	0.02±0.01
4	7.32±0.30	456.0±15.19	23.50±3.65	215.0±33.11	0.16±0.11	0.30±0.07	0.18±0.13	0.16±0.11	0.32±0.20	1.50±1.10	0.22±0.11	0.08±0.05
5	7.31±0.50	487.2±33.41	30.40±7.50	204.0±17.87	0.12±0.01	0.15±0.05	0.15±0.06	0.04±001	0.14±0.11	0.80±0.10	0.19±0.13	0.21±0.12
FAO	6.50 – 8.40	500 – 300	5.00 – 6.50	250-600	0.50	0.20	0.01	0.10	0.20	0.55	0.06	0.01

Conclusion
The results of this analysis revealed that most values obtained were within the limit set by FAO and WHO. The only exceptions were the high nitrate - nitrogen content and also the elevated Pb and Cd concentrations. This implies that caution must be taken in prolong use of this water for irrigation purposes because of fear of accumulation of Pb and Cd in plants irrigated with such water.

Recommendation
There is the need for further studies in order to monitor the heavy metal content of this study area particularly with respect to Pb and Cd concentrations. If possible, the use of this type of water for irrigation should be discourage and possible alternative be provided to the farmers.

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