

Analysis of Physicochemical Parameters of Sewage Water used for Irrigation in Bauchi Metropolis - Nigeria

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Abstract
This study was carried out to investigate the physicochemical parameters of sewage water used to irrigate vegetable farmlands along one of the major drainage channels in Bauchi metropolis - Nigeria. Sewage water was collected from six different sampling sites. Temperature (23 – 25 ^{o}C), pH (8.11 – 8.4), electrical conductivity (850 µScm^{-1} – 1524 µScm^{-1}) hardness (210 mg/L – 298 mg/L), alkalinity (63 mgCaCO$_3$/L – 95.5 mgCaCO$_3$/L), nitrate-nitrogen (4.72 mg/L - 11.44 mg/L) and phosphate-phosphorus (1.00 mg/L - 2.38 mg/L) were determined in sewage water samples in the study areas. In the control sample, Temperature (30.7 ^{o}C), pH (7.41), electrical conductivity (320 µScm^{-1}) hardness (125 mg/dm^3), alkalinity (54 mgCaCO$_3$/ dm^3), nitrate-nitrogen(3.8 mg/ dm^3) and phosphate-phosphorus (0.10 mg/ dm^3) were determined.. All the physicochemical parameters determined were found to be within FAO/WHO standard limit for irrigation water except for electrical conductivity, hardness and nitrate-nitrogen. The high values of these three parameters obtained from the study areas may indicate that the sewage water samples contain more plant nutrients in it than the control area water sample, where these values were all lower than the permissible limits. It may also indicate a higher pollution level compared to the control area.
Keywords: Bauchi metropolis, pollution, physicochemical parameters, sewage water, irrigation.

1. Introduction

The use of sewage water to irrigate farm lands during dry season provide a lot of vegetables (like spinach, tomato, onion, lettuce, carrot and cabbage) and hence a means of livelihood for many people. Municipal wastewater is often used in most cities in Nigeria for dry season's vegetables production. In many other countries including even some developed countries reuse wastewater is used to cultivate vegetable farmland (Aljaloud, 2010 and Wajahat *et al*., 2006). Besides providing supplemental irrigation, sewage water has been reported as a useful source of plant nutrients particularly the nitrogen, phosphorous and organic matter for improved fertility and physical properties of soil (Nauman and Khalid, 2010 and Gibbs *et al*., 2006). However, besides these beneficial effects, wastewater often contains appreciable amounts of organic and inorganic toxic materials. The organic pollutants being biodegradable are less persistent, and presumably have transient and less serious effects in soil environment as they eventually metabolize to carbon dioxide and other simpler products. The inorganic substances, such as heavy metals are often present in substantial quantities chelated by the organic matter in sewage water (Nauman and Khalid, 2010).

Crop production involves a complex interaction between the environment, soil parameters, and nutrient dynamics. Failure to understand these complexities has resulted in lack of good crop production and management techniques; hence agricultural production has tended to be low (Ololade *et al*., 2010)

In the present study, physicochemical characterization namely, Temperature, pH, electrical conductivity, hardness, alkalinity, nitrate-nitrogen and phosphate-phosphorus were determined in sewage water in the study and control areas.

Thus the specific objective of the study was to evaluate the physicochemical parameters of sewage water in some parts of Bauchi metropolis in order to find out its fertility level and/or suitability for crop production.

2. Materials and methods

2.1 Sampling areas

Six sampling sites were selected for the study namely; kofar idi (KID), Gwallaga (GWA), State Secretariat (SSE), Federal Low cost (FLC) and Zango (ZAN) which are situated along one of the major drainage channels in Bauchi metropolis and Gubi lake (GUB) was taken as control. The map of the sampling sites is as shown in Figure 1.

2.2 Samples Collection, storage and Pre-treatment

2.2.1 Pre-treatment of apparatus

All samples of sewage water were collected twice daily (morning and evening) from one of the major drainage channels in Bauchi metropolis in the month of February, 2011. Glassware, plastic containers, crucibles, pestle, mortar, watch glasses and some other tools used for sample collection were washed with liquid soap, rinsed with distilled water and then soaked in 10 % HNO$_3$ solution for 24 hrs (Todorovi *et al.*, 2001). They were then washed with distilled water and stored in memmert drying oven at 80 ^oC for 5 hrs.

2.2.2 Collection of Sewage Water Samples, Pre-treatment and Preservation

Sewage water samples (1.0 dm^3) were collected in labelled plastic bottles at a point closest to where sewage water is being pumped on to the farmlands. Temperature, pH and conductivity were measured immediately before acidifying with 1.5 cm^3 concentrated HNO_3/dm^3 of sample (APHA, 1992). The samples were kept on ice and subsequently transported to the laboratory where they were frozen in a deep freezer until finally analysed.

2.3 Analysis of sewage water samples

2.3.1 Digestion

Digestion of sewage water was carried out using standard methods (APHA, 1992). Three replicate digestions were carried out for each sample. All physicochemical analysis conducted was based on the digested samples obtained.

2.3.2 Measurement of pH, Conductivity and Temperature

Measurement of pH, conductivity and temperature was done using a pH meter (model S358236) which was calibrated before being used.

2.3.3 Determination of total Alkalinity, Hardness, Nitrate – nitrogen and Phosphate - phosphorus

Titration method was used to determine total Alkalinity (Allen, 1974; Muir, 1973) and total Hardness (APHA, 1992) while spectrophotometric method was applied in the determination of Nitrate – Nitrogen (APHA, 1992) and Phosphate – Phosphorus (APHA, 1992; Lind 1979).

3. Results and Discussion

3.1 Physicochemical Parameters of Sewage and Control Water Samples

The values of the physicochemical parameters observed may serve as an indicator of the fertility or pollution level of the study area sewage water as compared to the control area clean water and international standards for water suitable for irrigation. The pH of the water is known to influence the availability of micro-nutrients as well as trace metals (Kirkham, 2006). Alkalinity measures the amount of carbonate in water and reflects the ability of water to neutralize the acidity of soil. Alkalinity also serves as pH reservoir for inorganic carbon. It is usually taken as a productive potential of water (Manahan, 1994). Alkalinity is an indicator of the ability of the sewage water to support algal growth. The EC is a measure of dissolved solid in a solution. Determination of hardness helps to reveal the nature of the water to be classified as hard or soft. The NO_3^-N and PO_4^{3-} P values may imply fertility or otherwise of the sewage or clean water.

3.1.1 pH

From Table 1, it is observed that the temperature and pH values in this study fall within the range of 23 – 25 ^oC and 8.11 – 8.40 respectively as recommended by FAO for irrigation water. The pH values from the study areas revealed a slightly alkaline nature of the sewage water samples, while that of the control was slightly neutral (7.41). The pH recorded in the study areas were higher than the range (7.38-781) reported by Das and Acharya (2003) but lower than the range (8.94 -10.34) reported by Akan *et al*., (2008) for waste water. The pH value recorded in this study is safe for irrigation because they are within the FAO (1985) safe limit.

3.1.2 Electrical Conductivity

Electrical conductivity from the study area was highest at Zango (1524 Scm^{-1}) while the lowest was at Kofar Idi (850 μScm^{-1}). The least value of EC (320 μScm^{-1}) was recorded in the control area. The EC being the measure of dissolved solid in solution implies that Zango had more dissolved solid than other sites.

3.1.3 Hardness

Hardness of sewage water ranged from 210 mg/dm^3 at Zango to 298 mg/dm^3 at Kofar Idi. The values obtained from the study areas revealed hardness when compared to standard given by Nath (2003). The control area water sample is soft (125 mg/dm^3).

3.1.4 Alkalinity

Alkalinity measures the amount of carbonate in water and reflects the ability of water to neutralize the acidity of soil. Alkalinity also serves as pH reservoir for inorganic carbon. It is usually taken as a productive potential of water (Manahan, 1994). Alkalinity is an indicator of the ability of the sewage water to support algal growth. The sewage water is truly waste water because of the high values of alkalinity obtained in this study. The alkalinity obtained ranged from 63 (Zango) – 95.5 (Kofar Idi) $mgCaCO_3/dm^3$.

3.1.5 Nitrate – Nitrogen and Phosphate - Phosphorus

In all the five study areas under investigation, highest values obtained for NO_3^-N (11.44 mg/dm^3) and PO_4^{3-} P (2.38 mg/dm^3) were found at Zango while lowest for NO_3^-N (4.72 mg/dm^3) and $PO_4^{3-}P$ (1.00 mg/dm^3) was at Kofar Idi. At the control site, values of 3.8 mg/dm^3 and 0.10 mg/dm^3 were recorded for NO_3^-N and PO_4^{3-} P respectively. Values obtained in the study areas for NO_3^- N were higher, except at Kofar Idi, than the recommended limit of 5mg/dm^3 set by FAO for irrigation water, while PO_4^{3-} P values were all within the limits (0 – 2 mg/dm^3), except at Zango. This implies that the sewage water supplies more enough nitrogen than required. All values of NO_3^-N and PO_4^{3}- P from the control area were within the recommended limits for irrigation water.

The higher values of the physicochemical parameters observed at the study areas indicate higher pollution level compared to the control area. This might not be unconnected to the fact that waste from domestic, mechanic workshops, filling stations, block making industries, blacksmith workshops, car wash and other trade wastes find their ways into the drainage channels thereby resulting into higher pollution levels.

4. Conclusion

Values obtained in the study areas for NO_3^- N were higher, except at Kofar Idi, than the recommended limit of 5mg/dm^3 set by FAO for irrigation water, while PO_4^{3-} P values were all within the limits (0 – 2 mg/dm^3), except at Zango. This implies that the sewage water supplies more enough nitrogen than required. All values of NO_3^-N and PO_4^{3}- P from the control area were within the recommended limits for irrigation water.

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5. Recommendation

The higher values obtained for some physicochemical properties of sewage water revealed that Necessary mechanism should be put in place to monitor and evaluate periodically sewage water content used for irrigation purposes in order to prevent potential risk to the receiving soil and subsequent transfer to vegetables grown on such sewage water irrigated soils. Other sources of irrigation water like boreholes, tube wells should be developed by the farmers or be provided to the farmers by government and other environmentally concerned national/international organizations.

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Table 1: Mean Values of Physicochemical Parameters of Sewage and Control Waters

	Temp (°C)	**pH**	**EC (μScm^{-1})**	**Hardness (mg/dm^3)**	**Alkalinity ($mgCaCO_3/dm^3$)**	**NO_3^-N (mg/dm^3)**	**$PO_4^{3-}P$ (mg/dm^3)**
Kofar idi	32 ±0.91	8.40 ±0.31	850 ±5.18	298 ±16.57	95.5 ±12.91	4.72 ±1.95	1.00 ±0.03
Gwallaga	32.2 ±1.14	8.45 ±0.41	1468 ±10.11	274 ±8.89	90 ±13.97	10.12 ±1.45	1.67 ±0.05
State secretariat	30.6 ±0.81	8.20 ±0.21	1510 ±16.89	221 ±9.65	64 ±8.55	5.69 ±0.22	1.10 ±0.02
Federal Low cost	31.6 ±0.87	8.11 ±0.14	1090 ±8.85	269 ±4.50	58 ±5.14	7.92 ±1.38	1.45 ±0.11
Zango	31.2 ±0.61	8.17 ±0.15	1524 ±7.42	210 ±6.16	63 ±8.96	11.44 ±1.92	2.38 ±0.35
Gubi (control)	30.7 ±0.63	7.41 ±0.40	320 ±12.50	125 ±10.39	54 ±10.21	3.8 ±1.00	0.10 ±0.01
Standards	23-35 (d)	6.5-8.4 (a)	350 (c)	20-200 (b)	80-200(b)	5 (a)	0-2 (a)

a. FAO Limit for Irrigation Water b) NATH (2003) c) ANZECC and ARMCANZ (2000) d) UNEP (1999)

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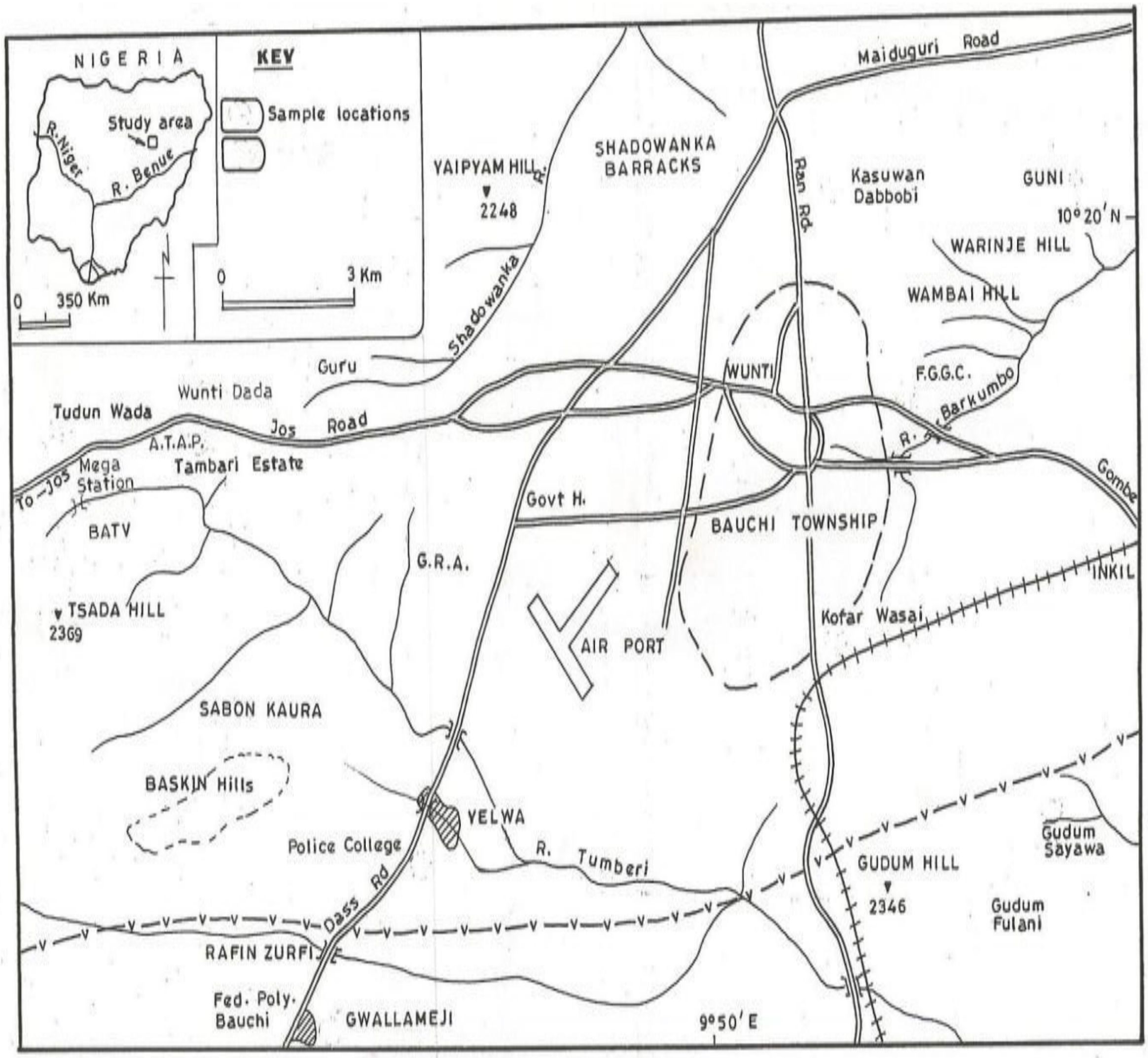

Fig. 1 Map of Bauchi Urban area showing sampling locations.

Figure 1: map of Bauchi metropolis showing sampling sites