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ASSESSMENT OF PHYSICO-CHEMICAL CHARACTERISTICS OF DOMESTIC WASTE WATER USED FOR IRRIGATION IN URBAN KATSINA

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ABSTRACT

Direct use of domestic waste water generated from especially urban homes and service centres to irrigate lands around streams is a common practice in many towns especially in areas with low fresh water supplies in arid and semi-arid regions. This study examined seasonal and spatial variations in quality of domestic waste water used to irrigate lands around River Ginzo in Katsina urban area, Nigeria. Domestic waste water samples were collected during dry and rainy seasons at upstream, midstream and downstream locations of the river and analysed for TDS, Temperature, EC, COD, $NO_{3,}$ NO_2, PO_3 BOD, pH and DO. The results obtained showed that domestic waste water levels during the dry and rainy season of TDS(1419-1852mg/I; 2013-2344mg/I),BOD (12.8-16.4mg/I;15.2-19.4mg/I),pH(7.3-8.46;6-6.9),DO(21.8-27.8mg/I;15.7-19.9mg/I),Temperature (39.3-46.7; 28.3-31.5), EC(1093-1379µ/cm; 1093-1376 µ/cm), COD(52.8-57.7mg/I; 50.1-53.1mg/I) NO_3(36-48.23mg/I; 27.04-35.6mgI) NO_2 (26.8-31.5mg/I; 16.8-28.2mg/I) and PO_3 (25.6-42.8mg/I;17.4-31.4mg/I). The levels of Temperature, pH, TDS, EC and DO are elevated beyond the limits permissible for irrigation during the dry season. However, during the rainy season, the levels of EC and Do are above the permissible limits. The values for NO3, NO2 and PO3 were all higher in the dry than rainy season, it is evident that the some of the parameters analyzed do not comply with national and international standards, for the irrigation water. It was thus concluded that the domestic waste water is polluted and quite unsafe for direct use in irrigation without treatment. The study recommends that proper protective measures, including construction of modern and efficient waste water treatment plants to reduce the potential influence of physicochemical parameters on domestic waste water used for irrigation for the future sustainability of mankind around the study area.

Keywords: *Domestic waste water; physico-chemical; irrigation; River Ginzo; Urban*

INTRODUCTION

Goal No. 6 of the UN's sustainable development goals (SDGs) which sets to achieve 30 goals by 2030, aims to ensure the availability and sustainable management of water and sanitation for all (United Nations, 2015). The goal was set out of the concern for the magnitude of the problem of water scarcity and access to treated and quality water. Among the various options available for achieving this goal, efficient reuse of waste water is regarded as a water resource management option that could optimize water use, increases drought resistance, reduce pressure on portable water sources, and can nearly double the water availability for human usage (Eriksson, et al., 2002; Jayyousi, 2003; Finley et al., 2009; Qureshi and Hanjra, 2010; Pinto et al., 2021). The term domestic waste water is used here to refer to the kind of waste water that is derived from sources other than toilets (commonly called black water) and industrial manufacturing (commonly referred to as effluent), mostly produced in urban areas where population is high and drains exist that collect the generated water into streams and rivers that drain the urban areas.

In areas with limited freshwater supplies, reuse of domestic waste water can be applied in both indoor (within homes), industrial and outdoor activities that demand potable and non-potable water, such as flushing toilets, agriculture, garden watering and vehicles' washing (Wiel-Shafran et al., 2006; Travis et al., 2010; Boyjoo, et al. 2013; Oteng-Peprah et al. 2018; Haak et al., 2018; Lawan and Surendran, 2020; Ntibrey, et al., 2021). Of these activities, the use of domestic waste water generated from urban areas for irrigation is a century old practice in especially semi-arid ecosystems where freshwater supply for such purposes is limited or not available (Scot *et al*, 2004; Feigin et al. 2012; Inyinbor et al., 2019). Domestic waste water use in irrigation is regarded as a very promising soil and water conservation process, as the water sometimes contain some important plant nutrients which if present within tolerable level can help to improve the soil nutrients reserve, which plants require to grow (Cordell, *et al*., 2009; (Zango, 2010). Beside recycling of nutrients held in the waste water, reducing the direct application of organic fertilizers and minimizing the contamination of water bodies to which the wastewater finally drains, can be a rich source of minerals nutrients and organic carbon and can also produce some positive effects on soil structure leading to higher diversities of organic matter, nutrients and soil microbial organisms (Vasudevan et al., 2010; Guadie, *et al*., 2020). Some (such as Rosenqvist et al.

1997; Murray and Ray 2010; Ghorbani, 2009; Al-Mefleh, et al., 2021) have even argued that direct use of direct use of wastewater in irrigation could create some positive environmental benefits such as increasing efficiency of agricultural production, surface water protection, reducing pressure on groundwater resources, diminishing demand for chemical fertilizers and decrease in wastewater treatment costs.

Domestic waste water is however regarded as unsafe for direct use (in an untreated form) as it contains significant concentrations of materials with potential negative environmental and health impacts (Travis et al., 2010; Mohammed et al., 2013). Such materials have been variously been observed to include salts (Friedler, 2004; Malekian, *et al.*, 2008), surfactants (Wiel-Shafran et al., 2006; Shreya, et al., 2021), oils (Travis et al., 2008), synthetic chemicals (Eriksson et al., 2002) and microbial contaminants (Gross et al., 2007a). It has been noted that materials such as surfactants, food-based oils and high sodium levels can cause water repellency and reduce soil hydraulic conductivity (Lado and Ben-Hur, 2009; Travis et al., 2008; Wiel-Shafran et al., 2006), dispersion of soil aggregates, (Misra and Sivongxay, 2009); microbial risks (Gross et al., 2007a), addition to soil of toxic substances and pathogens (Al-Hamaiedeh and Bino, 2010; Ahmad et al., 2020), residual drugs, organic compounds, endocrine disruptor compounds, active residues of personal care products and pharmaceutical products (WHO, 2006; Compagni, *et al.*, 2020; Tabatabaei, *et al.*, 2020) and enhanced contaminant transport (Graber et al., 2001). Because of problems such as these, it is widely accepted that domestic waste water treatment need to precede its reuse in irrigation. Before decision can be taken on domestic waste water treatment, its quality evaluation need to first be undertaken.

Because of the twin problems of water scarcity and quality of untreated domestic waste water, the research and development community has over the last 50 decades engaged in active research and public policies development on many aspects of its reuse, especially in crop production due to potential impacts on human health though food chain processes. Considering the diversity of the research in the area, Pinto et al., (2021) has recently carried out an analysis of 1,524 publications on domestic waste water indexed in the Scopus database between 1974 and 2021. The results obtained showed that especially from 2013, there has been exponential growth in the number of published research information on it. However, despite the highly geographical scattering of academic production, developed countries, who began research in domestic waste water earlier, had more connections and published more papers; except for Israel, which had the highest average of citations per article. On the other hand, developing countries are just emerging in domestic waste water reuse research. Pinto et al., (2021) thus rightly expect that future research on domestic waste water reuse will take place in developing countries that face water scarcity. There is particularly the need for more research information on domestic waste water for developing countries with particular emphasis on its safety for use in irrigation.

In many urban areas of the developing world, direct use of domestic waste water to irrigate floodplains of rivers along which the water flows from homes, commercial and light industrial complexes, service companies and related human activity area, still continues to be a major economic activity for a variety of reasons. Among the reasons here include high generation of runoff from various landuses supporting the above activities onto major streams and drainage networks, the need to meet the demands of urban dwellers for fresh supply of vegetables that could be grown though domestic waste water-based irrigation, lack of wastewater treatment facilities, wrong perception of the role of soil in 'filtering and decontamination' of the wastewater, lack of effective landuse control and absence of policy on safe irrigation practices. To be able to develop sound policies for reducing the problem of contamination associated with direct use of domestic waste water in irrigation, information is critically and primarily needed from time to time on its quality. Unfortunately, for most areas of active domestic waste water use in irrigation, such an information is not readily available.

This paper makes a contribution in this area by examining the physico-chemical (pH, electrical conductivity (EC), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate and phosphate) characteristics of domestic waste water being used to irrigate farmlands on the floodplains of River Ginzo, the main river into which all the major drainages in urban Katsina drain their contents. Moreover, much of the published research information on quality of domestic waste water being used in irrigation is on heavy metals, perhaps because of the public health concerns of the fact that accumulation of such metals could cause in soils, creating the path for their transfer into edible vegetables which could have direct human-health effects, via the food chain processes. Elevated levels of some physico-chemical parameters like temperature, pH, dissolved solids, oxygen demand and nutrients are considered as equally very critical to public health because besides having some direct and indirect negative consequences on human health, they also play active roles in affecting the availability and mobility of contaminants such as heavy metals (Abbasi et al., 2013; Antoniadis et al., 2017; Guadie, *et al.*, 2020). Thus, the investigations intended in this study will go a long way in helping towards developing some sound policies towards managing the risks associated with domestic waste water in irrigation.

STUDY AREA

Katsina urban area (Figure 1), is one of the ancient Hausa settlements well known for its culture, learning and whose early development is influenced by Trans-Sahara trade. Located at the extreme northern margin of Nigeria. It is the capital city of Katsina State, one of the 36 states of Nigeria and covers a total land area of about 3,370 square kilometers. Demographic data of 2006 census gave a population of 318,459 people in Katsina local government. Male population is 149,551 while that of female is 168,908 (Ruma, 2009; Zango, 2010). The main rivers draining the study area are Ginzo and Tille Rivers. Ginzo River drains the northern part of the city, while Tille River with its dendritic drainage pattern passes through the town in south direction. Of the two, Ginzo River, a third order stream with a total length of 8.2 km is the one whose floodplains are extensively cultivated during dry season using wastewater from residential, commercial, institutional and industrial landuse in the area.

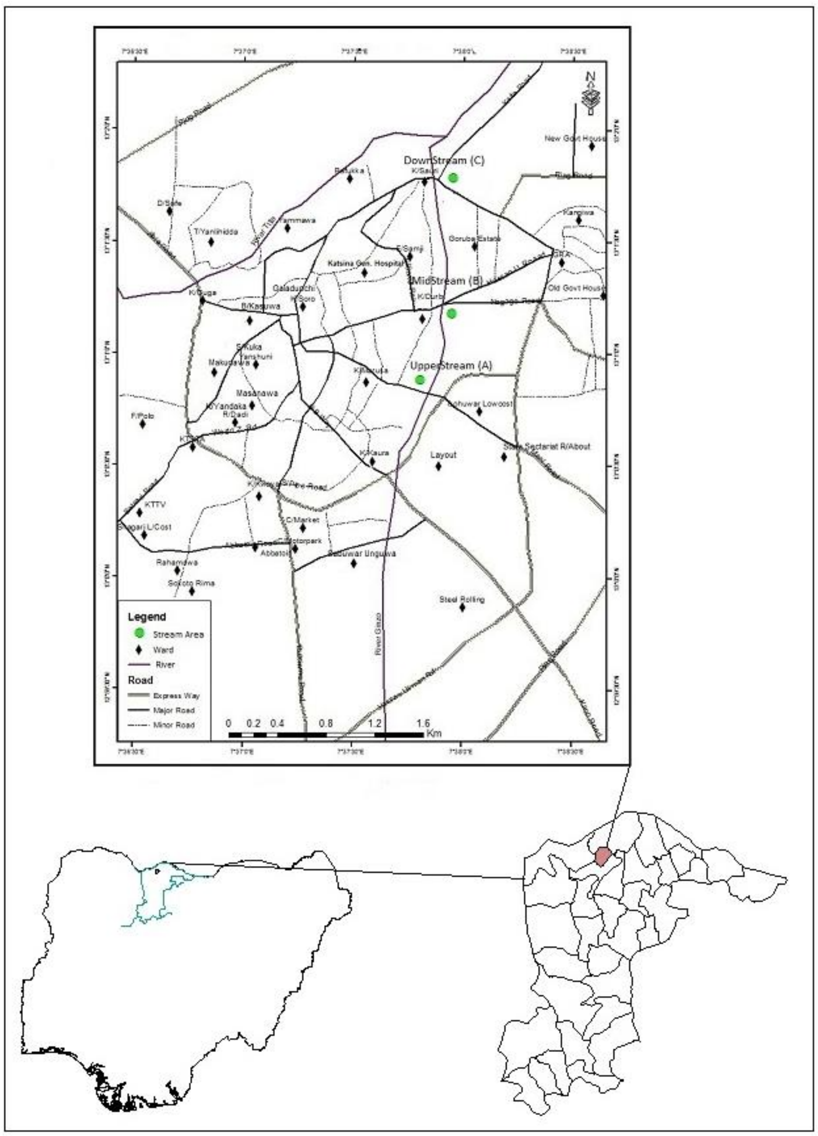

Fig1: Study Area

MATERIALS AND METHODS

Samples collection

The domestic waste water samples from the river were collected weekly over the dry season months (October to May) and rainy season months (June to September) during January 2018/2019. The sampling was conducted over this extended period in order to capture likely variations in domestic waste water quality over the two seasons. The sampling was carried out at three locations where irrigation is actively taking place, namely Kofar Marusa (upstream), Kofar Durbi (midstream) and Kofar Sauri (downstream) that are clearly heterogeneous in landuse and urban form characteristics in the study area. The three locations were labelled as A, B and C respectively for upstream, midstream and downstream locations in Figure 1. During sampling at each location, the domestic waste water samples were collected at two points randomly selected to ensure spatial representativeness over each location. The samples were collected in stopper-fitted polyethylene bottles that were prewashed with dilute hydrochloric acid and then rinsed several times with the effluent sample before filling them to the required capacity. The bottles were subsequently washed three times with the domestic waste water at the sampling sites before filling the bottles with the water samples. Temperature, EC and pH were determined in-situ at the sample collection sites using a portable device (HANNA Instruments H19811 Portable pH-EC-TD Meter, Italian Model). The collected samples were shielded with black cellophane bags to prevent further contaminations and thereafter kept in a cool dry place before taken to the laboratory for analysis, where they were stored at temperature of below 4^0C prior to analysis.

Samples analysis

While in the laboratory, the following wastewater parameters were determined in accordance with standard methods for the examination of water and wastewater (APHA 2012): electrical conductivity, total dissolved solids (TDS), nitrate (NO_3), nitrate (NO_2), phosphate (PO_4), dissolved oxygen (DO), chemical oxygen demand (COD) and biological oxygen demand (BOD). TDS was measured using portable combine electrical conductivity/TDS/temperature meter (HM Digital COM-100) after standardizing with 342 ppm sodium chloride calibration solution before the different samples were tested in regular order. BOD was determined using dilution technique. COD determined using standard open reflux method. The DO was estimated by Winkler method. NO_3 and NO_2 were measured using spectrophotometric technique. PO_4 was measured using Stannous chloride method. The calibration for different chemical constituents was done by preparing low-level standard solutions using AR-grade chemicals and was periodically repeated to check the accuracy.

Statistical analysis

The results obtained were subjected to statistical analysis using the SPSS software package version 20.0. The results were summarized using descriptive statistics to find the mean, variance and standard deviation for effective comparison with the FAO standards. The mean values obtained for every property were then compared with the prescribed permissible limit of Food and Agriculture Organization (Ayers and Westcot, 1985; FAO 1994) for irrigation.

RESULTS OF PHYSICO-CHEMICAL ANALYSIS OF THE DOMESTIC WASTE WATER IN THE STUDY AREA

The result of some selected physicochemical parameters such as Temperature, pH, EC, TDS, COD, BOD, DO, $NO_{2,}$ $NO_{3,}$ and PO_3, collected from three sampling sites (Kofar Marusa (upstream), Kofar Durbi (midstream) and Kofar Sauri (downstream irrigation site), were analyzed in the laboratory. The results were summarized using descriptive statistics to find the mean, variance and standard deviation for effective comparison with the FAO (2006) permissible limits and presented in table 1and 2 for dry and wet seasons respectively.

Table 1: Mean Average Values for Physico-chemical parameters analysis of Dry Season Domestic Wastewater from the 3 Sampling Points (K/Marusa , K/Durbi and K/Sauri)

Parameters	Mean Average			Standard FAO (2006)
	Sampling point (K/Marusa(A)	Sampling point (K/Durbi(B)	Sampling point (K/Sauri(C)	
Temp.	46.7 ±1.94	39.3 ±1.14	42.5 ±0.81	21 ºc-30ºc
pH	7.3 ±1.1	7.59 ±1.4	8.46 ±1.14	6.4 -7.4
TDS	1852±19.2	1507 ±22.4	1419 ±20.9	1500 mg/l
BOD	13.8±8.15	16.4±9.09	12.8±9.29	30 mg/l
COD	57.7±37-7.7	52.8±42.4	56.4±39.1	100 mg/l
EC	1093±14.7	1376±16.5	1272±15.9	1000µ/cm
DO	21.8±9.2	27.8±10.2	22.2±1.12.1	≥10 mg/l
NO_3	36 ±5.2	48.23 ±7.62	47.08 ±8.61	10 mg/l
NO_2	28.7 ±4.04	26.8 ±3.8	31.5 ±5.03	0.2mg/l
PO_3	25.6 ±2.1	32.3 ±1.7	42.8 ±0.14	10mg/l

Source: Field work

Temperature: The table 1above shows that the least temperature was recorded in sampling point B of with 39.3^{0c} followed by 42.5^{0}c of sampling point C, and the highest during the dry season was recorded at sampling point A with 46.7^{0}c and all are above the recommended permissible limits of FAO (2006) of 30^{0c}.

pH: is the hydrogen ion activity and a measure of acidity and alkalinity and the variations were recorded in the pH level. The highest average pH in the dry season was in sampling point C with 8.46mg/I followed by sampling point B of with average of 7.59mg/l and the least average pH was at sampling point A with 7.3mg/l and sample B and C, the values are above the recommended permissible limits of FAO (2006) of 7.4.

Total Dissolved Solid: TDS are a measure of total inorganic substances dissolved in water. The mean average TDS is higher at sampling point A with 1852 mg/l and also above the recommended permissible limits of FAO (2006), followed by sampling point B with the value of 1507mg/l and the least average mean of 1419mg/l was recorded at sampling point C.

Biochemical Oxygen Demand: BOD value has been widely adopted as a measure of pollution in the particular environment and it is one of the most common measures of organic pollutant in water, it also indicates the amount of organic matter present in water**.** The highest average BOD was recorded in sampling point B with 16.4 mg/l, followed by sampling point A with 13.8mg/l and the least was recorded at sampling point C with 12.8mg/l and all the values are within the recommended permissible limits of FAO (2006).

Chemical Oxygen Demand: The COD is another parameter used to characterize the organic strength of wastewater. Table 1 shows that the highest average COD was recorded in sampling point A with 57.7 mg/l, followed by sampling point C with 56.4mg/l and the least was recorded at sampling point B with 52.8mg/l and all are within the recommended permissible limits of FAO (2006) of 100mg/l.

Electrical conductivity: The highest EC was in sampling point B with an average of 2530µ/cm followed by sampling point C with 2192 µ/cm and the least was 1852µ/cm of sampling point A and also all the concentrations exceeded the recommended permissible limits of FAO (2006) of 1000 µ/m. the EC being the measure of dissolved solid in solution implies that sampling point 2 had more dissolved solid than other sampling points

Dissolved oxygen: DO is a measure of the degree of pollution by organic matter, the destruction of organic substances, and the self-purification capacity of the water body. The highest DO was recorded in sampling point B with 27.8mg/l followed by 22.2mg/l of sampling point C and the least during the dry season was recorded at sampling point A with 21.8mg/l and all above corresponded with the ≥10mg/l recommended permissible limits of FAO (2006).

Nitrate: Nitrate represents the highest oxidized form of nitrogen and is very common contaminants in ground and surface water. The highest average of NO_3 was recorded in sampling point B with 48.3 mg/l, followed by sampling point C with 47.08mg/l and the least was recorded at sampling point A with 36.04mg/l and all are above the recommended permissible limits of FAO (2006) of 10mg/l

Nitrite: Table 1 also shows that the least average NO_2 was recorded in sampling point A and B with 28.7 and 26.8mg/l, and the highest was recorded at sampling point C with 31.5mg/l and all are above the recommended permissible limits of FAO (2006) of 0.2mg/l.

Phosphate: As PO_3 sampling point A has the least mean with 25.6mg/l followed by sampling point B with 32.3mg/l and the highest is sampling point C with 42.8mg/l, the present of PO_3 is not a threat to FAO recommended permissible limits of 10mg/l.

Table 2: Mean Average Values for Physico-chemical parameters analysis of Wet Season Domestic Wastewater from the 3 Sampling Points (K/Marusa , K/Durbi and K/Sauri)

Parameters	Mean Average			Standard FAO (2006)
	Sampling point (K/Marusa(A)	Sampling point (K/Durbi(B)	Sampling point (K/Sauri(C)	
Temp.	31.5 ±1.76	29±1.41	28.3±0.81	21 ^{o}c-30^{o}c
pH	6.5±1.14	6±1.09	6.9±1.17	6.4 -7.4
TDS	2344 ±14.4	2175 ±16.5	2013 ±15.0	1500 mg/l
BOD	15.2±7.4	18.3±6.8	19.4±6.9	30 mg/l
COD	50.1±34.6	50.9±42.5	53.1±38.6	100 mg/l
EC	1093±14.7	1376±16.5	1272±15.9	1000μ/m
DO	19.1±9.7	15.7±20.8	19.9±11.5	≥10 mg/l
NO_3	27.04 ±2.4	32.08 ±4.6	35.6 ±7.7	10 mg/l
NO_2	19.4 ±3.52	16.8 ±5.1	28.2 ±7.11	0.2mg/l
PO_3	17.4 ±2.5	21.8 ±4.35	31.4 ±7.11	10mg/l

Source: Field work

Temperature
Table 2 shows that the highest average temperature was recorded in sampling point A of with 31.5^{0c} followed by 28.3^{o}c of sampling point C, and the least during the wet season was recorded at sampling point B with 29^{o}c and all are within the recommended permissible limits of FAO (2006) of 30^o c.

pH
The highest average pH in the wet season was in sampling point C with 6.9mg/l followed by sampling point A of with average of 6.5mg/l and the least average pH was at sampling point B with 6.mg/l and all are within the recommended permissible limits of FAO (2006) of 7.4.

Total Dissolved Solid: The mean average TDS is higher at sampling point A with 2344 mg/l followed by sampling point B with an average of 2175mg/l and the least average mean of 2013mg/l was recorded at sampling point A and also above the recommended permissible limits of FAO (2006).

Biochemical Oxygen Demand: The least average BOD was recorded in sampling point A with 15.2 mg/l, followed by sampling point B with 18.3mg/l and the highest was recorded at sampling point C with 19.4mg/l and all are within the recommended permissible limits of FAO (2006).

Chemical Oxygen Demand: Table 2 shows that the highest average COD was recorded in sampling point C with 53.1 mg/l, followed by sampling point B with 50.9mg/l and the least was recorded at sampling point A with 50.1mg/l and all are within the recommended permissible limits of FAO (2006) of 100mg/l.

Electrical Conductivity: The highest EC was in sampling point B with an average of 1376μ/cm followed by sampling point C with 1272 μ/cm and the least was 1093μ/cm of sampling point A and also all the concentrations exceeded the recommended permissible limits of FAO (2006) of 1000 μ/m.

Dissolved oxygen : The highest DO was recorded in sampling point C with 19.9mg/l followed by 19.1mg/l of sampling point A and the least during the wet season was recorded at sampling point B with 15.7mg/l and all above corresponded with the ≥10mg/l recommended permissible limits of FAO (2006).

Nitrate: The highest average of NO_3 was recorded in sampling point C with 35.6 mg/l, followed by sampling point B with 32.08mg/l and the least was recorded at sampling point A with 27.04mg/l and all are above the recommended permissible limits of FAO (2006) of 10mg/l

Nitrite: Table 2 also shows that the highest average NO_2 was recorded in sampling point C with 28.2mg/l, then followed by sampling point A with 19.4 and the least was recorded at sampling point B with 16.8mg/l and all are above the recommended permissible limits of FAO (2006).

Phosphate: For PO_3 sampling point C has the highest mean with 31.4mg/l followed by sampling point B with 21.8mg/l and the least is sampling point A with 17.4mg/l, the PO_3 is a threat to FAO recommended permissible limits of 10mg/l.

RESULTS AND DISCUSSION

It could be seen from the table 1 that the mean values of pH are consistently higher in the dry than rainy season, with the values increasing with distance downstream of the river. The values across the 3 sampling locations are all within the FAO permissible limits for irrigation (6.5-8.4). The results indicated that pH of the domestic waste water samples is in general slightly alkaline during the dry and slightly acidic during the rainy season. This result agrees with those of Rana et al. (2010) and Bassuony et al. (2014) for water samples collected from northeast Delta-Egypt, as well as the study of Shammi et al. (2016) about surface water of Khulna District, Bangladesh. Irrigation water with pH values located outside the normal range permitted by FAO (6.5-8.4) could cause a nutritional imbalance, and pH lower than this range can cause accelerated corrosion of irrigation pipes (Roy et al., 2015). The general increase in pH with distance towards the downstream is a reflection of addition of more alkaline materials through runoff in the catchment area of the river. During the rainy season, more water received is added to the stream from runoff and direct raindrops which help to dilute the stream water and in this way lower down the levels of alkaline materials which could help reduce the tendency of the water to be alkaline. Hence the higher values of pH observed during the dry season in not unexpected here.

A higher value of TDS can hamper disinfection, clogging of irrigation systems, and deposition (FAO 1994). The values of TDS were higher during the rainy than dry season, and decreasing with distance towards the downstream of the river. The values across the 3 sampling stations are all above the permissible limits for irrigation. The decrease in the TDs values with distance downstream of the river was unexpected as it was rather thought that the concentration of the parameter would rather increase towards the downstream as runoff is discharged towards the river from the irrigated fields. The contrary observation made here suggests that the source of solid materials in the domestic waste water is mainly additions through erosion and transportation by runoff at the source origin of the river. TDS provides a measure of total inorganic substances dissolved in water. Water is considered to be pure if the TDS is less than 1000 mg / L and saline if it exceeds 1000 mg/L (Naser and Ghanem, 2018).

Across the 3 sampling locations, temperature values were higher during the dry than rainy season. There is no consistent pattern of change in mean value of the property with distance downstream of the river. In both the two seasons, the mean value of the property is highest in the upstream sampling location, followed by the downstream and the value for the midstream were the lowest. The values are all above the permissible limits for irrigation. The high temperature values observed during the dry season is not unexpected, as ambient levels are usually higher in the area during the season. Temperature influences the solubility of gases, the dissociation of dissolved salts and the determination of pH (Rodier et al., 2009). High temperature affects the electrical conductivity of water by increasing the mobility of salts (Guemmaz et al., 2019), the pH by displacement of the calco-carbonic equilibrium towards the formation of carbonates under the effect of photosynthesis. However, low temperatures slow down oxidation reactions. Chloride and bicarbonates were high in ours samples, and directly impact crop production measured as yield and quality.

The electrical conductivity (EC) provides the measure of dissolved solids in solution. In both the dry and rainy seasons, the mean values were higher in the midstream and lowest at the upstream location. The property was higher in the dry than rainy seasons across the 3 sampling locations. The mean values are above the permissible limits for irrigation. With EC values higher than 0.7 mS/cm, irrigation water upstream from BHD is highly saline based on the guidelines of the FAO (1994), indicating the presence of high salinity risks for all samples tested for irrigation. The Continuous irrigation with saline waters may lead to gradual or rapid increase in soil salinity. This case was reported from Oued Righ region in the Sahara Desert of Algeria as a result of irrigation with saline water (Koull et al., 2013). The same results were found by Etteieb et al. (2017), and Brindha and Kavitha (2015) in the surface water of Uyyakondan channel (southern India). In fact, the salinity problem is highlighted when the concentration of salt in the soil solution exceed the crop minimum levels for salt tolerance which vary according to the types of crops. Consequently, a high salt concentration in the soil leads to significant reductions in productivity (Ezlit et al., 2010). Hence, the observed increase in EC levels with distance towards the downstream is in agreement with the findings made in the literature by different research workers.

Also the level of EC in both the seasons exceeded the recommended permissible limits and was higher in the dry season than in the wet season due to the stagnation of the water, exhaust carbon from automobiles evaporation and human activities around the area Sachwab *et al* (1981) adopted by Zango (2010), The average doubles the recommended permissible limit of FAO, (2016), he called salinity as the total concentration of soluble salt which may retard and sometimes even prohibit the growth and successful development of crops, making the transportation of solute difficult. Irrigation water with an Electric Conductivity of 1650 microhms/cm and greater is defined as high in salinity. Salt concentration or salinity of irrigation water influences the plants osmotic activities which subsequently reduce absorption of water and nutrients by plants.

DO is a measure of the degree of pollution by organic matter, the destruction of organic substances, and the self-purification capacity of the water body. During the dry season, the mean DO value was highest in the midstream and lowest in the upstream. During the rainy season however, the mean values were highest downstream and lowest in the midstream locations. The mean values are higher in the dry than rainy seasons. The values are all above the permissible limits for irrigation. The observed lower levels of the parameter in the dry season could be due to higher temperature values of the season. Usually, as temperature increases, water becomes warmer and tends to hold less dissolved oxygen leading to lower DO levels. As temperature increases, water tends to hold less dissolved oxygen so dissolved oxygen levels in water tend to decrease when it is warmer. And when it is cooler DO levels tend to increase. The mean values of the property in both the two seasons are all above the permissible limits for irrigation.

BOD is a measure of the amount of oxygen required to remove waste organic matter from water in the process of decomposition by aerobic bacteria. High values of the property in water are caused by high levels of organic pollution. It has thus been widely adopted as a measure of pollution and it is one of the most common measures of organic pollutants in water, indicating the amount of organic matter present in water**.** It could be seen from table above that BOD levels are lower in the dry season than the rainy season across the 3 sampling stations, indicating more pollution levels during the wet season as more water through runoff and raindrops dilute the water to reduce pollution levels. During the rainy season, it is expected that runoff onto the streams from various surfaces in Katsina town will wash several organic materials which could promote pollution in the water. This will promote higher BOD levels during the rainy. The mean BOD values across the 3 sampling stations in both the two seasons are, however, all within the permissible limits for irrigation.

COD refers to the amount of dissolved oxygen that must be present in water to oxidise chemical organic materials, such as wastes of petrochemical products. It increases as amount of the organic materials and also inorganic materials susceptible to oxidant (especially potassium dichromate) are present in high amounts in water. Expectedly, the levels of the property increased with distance towards the downstream, reflecting increase in washout of organic and inorganic materials from urban surfaces onto the river, through runoff. The property is also higher in the rainy than the dry season, perhaps due to the same reason given above. The mean values of the property across the 3 sampling stations in both the two seasons are, however, all within the permissible limits for irrigation.

Nitrate (NO_3) represents the highest oxidized form of nitrogen and is very common contaminants in ground and surface water. The mean values for NO_3, nitrite (NO_2) and phosphates (PO_3) are all above the permissible limits in irrigation water. The values were all higher in the dry than rainy season, and increase with distance towards the downstream. In both the two seasons, the mean values were highest in the downstream and lowest in the upstream location. The values are all above the permissible limits for irrigation. The high values of NO_3, NO_2 and PO_3 in the water samples may be a reflection of high use of chemical fertiliser in soil treatment by farmers of the area. As the irrigation practices are undertaken during the dry season, the value of the property in the domestic waste water samples should be expected to be higher during the season than in the wet season. Guergazi et al. (2008) have explained that rain events transport excess nitrate ions into surface waters from cultivated surfaces. As the farmlands in the study area are cultivated only during the dry season, the contribution of washout of NO_3 and NO_2 by rainfall from the farmlands will be low. Too much PO_3 typically cause increased growth of algae and large aquatic animals, which can result in decreased levels of DO, a process called eutrophication. High level of the property in irrigation water is particularly of much public health concern as it can lead to algae blooms that produce algal toxins which can be harmful to human and animal health.

CONCLUSION

It is clear from the results obtained in this study that the domestic waste water used to irrigate lands on the banks of River Ginzo in urban Katsina contains levels of Temperature, pH, TDS, EC and DO are elevated beyond the limits permissible for irrigation during the dry season. However, during the rainy season, the levels of EC and DO are above the permissible limits. The values for NO3, NO2 and PO3 were all higher in the dry than rainy season. It can thus be concluded that the domestic waste water is in polluted and quite unsafe for direct use in irrigation without treatment. The pollution problem associated with the domestic waste water is higher during the dry season (when the irrigation takes place) and increases with distance towards the downstream of the river. Consequently, domestic waste water should not be reused directly in irrigation, before being subjected to pretreatment, in order to improve its quality by meeting the required standards.

Declaration of conflict of interest
Authors have declared that no conflicting interests exist

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