Determination of Physicochemical Parameters and Some Heavy Metal Content of Hand Dug Wells in Danja Town, Katsina State

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Abstract

Danja is headquarter of Danja Local government area of Katsina state, most of the population depend on hand dug wells as primary source of water for domestic use, as such, there's a need for a study to be carried out to assess the levels of some physicochemical parameters and some heavy metals in well water that is meant for drinking and domestic purposes. Twenty water samples were randomly collected from different sampling site and were analyzed. The results showed that the total mean Temperature is 29.32±0.213°C, pH 7.37±0.012, Turbidity had a mean level of 1.72±0.173 NTU, the TDS mean levels was 564.4±090.9 mg/l, EC have mean level of 634±34.7µS/cm while DO has mean levels of 5.6±0.203mg/L. All the physicochemical parameters tested are within the permissible limit except EC and Temperature. Heavy metals analyzed include Chromium which is within WHO upper limit except in location 3, Lead is only high in location 3 with (0.056mg/L), Cadmium is within the normal range, Iron is also within permissible limit except at location 6 with (0.42mg/L) while Zinc above limit at location 3 and 6 with (0.32 and 0.47 mg/L) respectively.

Introduction

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. As of now only earth is the planet having about 70 % of water. But due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity it is highly polluted with different harmful contaminants. Therefore it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. It is difficult to understand the biological phenomenon fully because the chemistry of water revels much about the metabolism of the ecosystem and explain the general hydro - biological relationship (Basavaraja Simpi *et al*., 2011).

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains different types of impurities are introduced in to aquatic system by different ways such as weathering of rocks and leaching of soils, issolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials (Adeyeye 1994). The increased use of metal-based

fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Also faucal pollution of drinking water causes water born disease which has led to the death of millions of people. (Adefemi and Awokunmi, 2010).

People on globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil. These are related to animal and plants and finally affecting on it (Misra *et al.*, 1991). Industrial development (Either new or existing industry expansion) results in the generation of industrial effluents, and if untreated results in water, sediment and soil pollution (Fakayode *at el.*, 2005).

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water. In many parts of the country available water is rendered non potable because of the presence of heavy metal in excess. The situation gets worsened during the summer season due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems. The recent research in Haryana (India) concluded that it is the high rate of exploration then its recharging, inappropriate dumping of solid and liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality (Guptaa *at el.,* 2009). Most of the rivers in the urban areas of the developing countries are the ends of effluents discharged from the industries. African countries and Asian countries experiencing rapid industrial growth and this is making environmental conservation a difficult task (Agarwal Animesh *at el.,* 2011). Sea water contains large number of trace metals in very small concentration. This is a challenging matrix for the analytical chemist due to the very low concentrations of many important trace metals (Robertson *at el*., 1968,)

LITERETURE REVIEW

Water is a precious natural resource that exists on earth, thus the current concern to quality of environment focused on water because significant role to human and the ecosystem (Adefemi *et al*., 2010) Availability of sufficient drinking water continues to be a major problem in the public health, because of its importance to the environment, which is also essential for the survival of all living things including plants and animals, hence the need to maintain it clean and unpolluted (Adnan *et al*., 2010) Therefore, guidelines and legislation has stated that water suitable for drinking should contain some parameters including microorganisms in low amounts such that the risk for acquiring waterborne infections is below an acceptable limit (Aftab *et al*., 2005) In the industrialized nations, high standards of drinking water are set for its quality and safety.(APHA *et al*., 1985), Rapid urbanization of rural areas, industrialization and population growth have been the major causes of stress on the environment leading to serious problems to human being and climatic changes (ASTM *et al*., 2003).

Physico- Chemical Parameters

It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Water must be tested with different physic-chemical parameters. Selection of parameters for testing of water is solely depends upon for what purpose we going to use that water and what extent we need its quality and purity. Water does content different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical test should be performed for testing of its physical appearance such as temperature, color, odour, pH, turbidity, TDS etc, while chemical tests should be perform for its BOD, COD, dissolved oxygen, alkalinity, hardness and other characters. For obtaining more and more quality and purity water, it should be tested for its trace metal, heavy metal contents and organic i.e. pesticide residue. It is obvious that drinking water should pass these entire tests and it should content required amount of mineral level. Only in the developed countries all these criteria's are strictly monitored. Due to very low concentration of heavy metal and organic pesticide impurities present in water it need highly sophisticated analytical instruments and well trained manpower. Following different physic chemical parameters are tested regularly for monitoring quality of water.

Temperature

In an established system the water temperature controls the rate of all chemical reactions, and affects fish growth, reproduction and immunity. Drastic temperature changes can be fatal to fish.

pH

pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity (Guptaa *at el.*, 2009). The reduced rate of photosynthetic activity the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values coincided with high temperature during the summer month. Various factors bring about changes the pH of water. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico chemical condition (Karanth *at el.*, 1987).

EC (Electrical Conductivity)

Conductivity shows significant correlation with ten parameters such as temperature , pH value , alkalinity , total hardness , calcium , total solids, total dissolved solids , chemical oxygen demand , chloride and iron concentration of water. (Navneet Kumar *et al.*, 2010) suggested that the underground drinking water quality of study area can be checked effectively by controlling conductivity of water and this may also be applied to water quality management of other study areas. It is measured with the help of EC meter which measures the resistance offered by the water between two platinized electrodes. The instrument is standardized with known values of conductance observed with standard KCl solution.

Dissolved Oxygen

Dissolved Oxygen is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. (Premlata Vikal, *et al*., 2009). In the progress of summer, dissolved oxygen decreased due to increase in temperature and also due to increased microbial activity (Moss 1972; Morrissette 1978; Kataria, *et al.*, 1996). The high DO in summer is due to increase in temperature and duration of bright sunlight has influence on the % of soluble gases (O^2 & CO^2). During summer the long days and intense sunlight seem to accelerate photosynthesis by phytoplankton, utilizing CO2 and giving off oxygen. This possibly accounts for the greater qualities of O2 recorded during summer (Krishnamurthy *at el*., 1990). Dissolved Oxygen in sample is measured titrimetrically by Winkler's method after 5 days incubation at 293 K. The difference in initial and final Dissolved Oxygen gives the amount of oxygen consumed by the bacteria during this period. This procedure needs special BOD bottles which seal the inside environment from atmospheric oxygen.

Heavy Metals

Having mainly excessive amounts of heavy metals such as Pb, Cr and Fe, as well as heavy metals from industrial processes are of special concern because they produce water or chronic poisoning in aquatic animals (Ellis *at el.*, 1989). High levels of pollutants mainly organic matter in well water cause an increase in biological oxygen demand (Kulkarni *at el*., 1997), chemical oxygen demand, total dissolved solids, total suspended solids and fecal coli form. They make water unsuitable for drinking, irrigation or any other use (Hari *at el*., 1994).

There are trends in developing countries to use sewage effluent as fertilizer has gained much importance as it is considered a source of organic matter and plant nutrients and serves as good fertilizer (Riordan *at el*., 1983). Farmers are mainly interested in general benefits, like increased agriculture production, low cost water source, effective way of effluent disposal, source of nutrients, organic matter etc, but are not well aware of its harmful effects like heavy metal contamination of soils, crops and quality problems related to health. Research has proven that long term use of this sewage effluent for irrigation contaminates soil and crops to such an extent that it becomes toxic to plants and causes deterioration of soil (Quinn *at el*., 1978)This contains considerable amount of potentially harmful substances including soluble salts and heavy metals like Fe2+, Cu2+, Zn2+,Pb2+. Additions of these heavy metals are undesirable. Plants can accumulate heavy metals in their tissues inconcentrations above the permitted levels which is considered to represent a threat to the life of humans, and animals feeding on these crops and may lead to contamination of food chain, as observed that soil and plants contained many toxic metals, that received irrigation water mixed with industrial effluent (Adnan Amin *at el*., 2010).

Material and method

material

I. Water sample.

ii. Beaker.

iii. Funnel.

iv. Volumetric flask.

v. Atomic absorption spectrometer.

vi. Erlenmeyer flask.

vii. 100ml plastic sample bottles.

viii. Filter paper.

Reagen

i Hydrochloride acid (HCL)

ii Nitric acide (NHO_3)

METHODS.

Sample collection

All the Twenty hand dug wells water sample are collected in different location within Danja Local Government katsina state, Nigeria. These include, G.R.A quaters, hayin asibiti quaters, kukan tumba quaters, and Dan-mahawayi road.

SAMPLE PREPARATION.

The hand dug well water sample are collected and then filtered using filter paper to remove some particles and other suspended of colloids then 100ml of the filtered samples will be collected and sterilized with Nitric acid.

Determination of physicochemical parameters

Physicochemical parameters, which include temperature, pH, electrical conductivity (EC) and total dissolved solid (TDS) of hand dug well water samples are analyzed using Universal Handheld pH meter (PH190A), TDS meter and standard methods (NEERI *at el.*, 1986).

Determination of heavy metals

The heavy metals were Cu, Fe, Pb, and Zn are analyzed using Atomic Absorption Spectrophotometric (AAS) Standard method (AOAC *at el.*, 1998).

Results and Discussion

Samples	pH	TEMP (°C)	EC (µS/cm)	TDS (mg/L)	Turbidity (NTU)	DO (mg/L)
WHO Upper Limit	6.5-8.5	25°C	750 µS/cm	500 mg/L	5NTU	5-7mg/L
1	7.52	30.2	760	452	1.78	5.6
2	7.41	31.9	480	561	1.86	6.7
3	7.31	29.8	560	350	1.64	5.9
4	6.18	27.9	340	673	2.34	5.6
5	8.23	28.5	950	376	1.72	5.6
6	7.64	27.7	920	752	1.55	5.4
7	7.23	29.2	630	665	1.43	5.0
8	6.58	30.5	710	453	1.56	5.3
9	7.10	27.6	430	437	1.67	5.9
10	6.95	29.6	340	332	1.72	5.8
11	7.76	30.7	360	264	1.87	5.8
12	6.88	29.7	700	643	2.01	5.7
13	7.45	28.8	680	450	1.65	5.3
14	7.55	28.7	520	362	1.56	5.8
15	7.52	28.2	830	548	1.78	6.2
16	7.81	27.9	810	554	1.89	6.7
17	7.21	29.5	840	612	1.78	6.3
18	7.23	28.5	790	530	1.09	6.9
19	7.09	27.5	560	451	1.45	5.2
20	7.56	27.9	670	380	1.93	5.4

Table 1: Shows the level of physicochemical parameters in water samples

Samples	Chromium	Lead	Cadmium	Iron	Zinc
WHO Upper Limit	0.05mg/L	0.01mg/L	0.01mg/L	0.3mg/L	0.20mg/L
1	0.031	BDL	0.003	0.06	0.17
2	0.043	BDL	0.002	0.21	0.11
3	0.056	0.021	0.004	0.13	0.09
4	0.042	0.006	BDL	0.25	0.32
5	BDL	0.002	BDL	0.16	0.16
6	0.014	0.001	BDL	0.42	0.47
7	0.042	BDL	BDL	0.47	0.10
8	0.031	BDL	BDL	0.52	BDL
9	BDL	BDL	BDL	0.14	BDL
10	0.072	0.008	BDL	0.08	👇
11	0.031	0.002	BDL	0.30	BDL
12	0.043	0.005	BDL	0.21	BDL
13	0.041	BDL	0.002	0.20	0.14
14	0.046	BDL	0.001	0.24	0.06
15	0.030	BDL	0.007	0.15	0.09
16	0.021	BDL	0.005	0.11	0.12
17	0.031	0.006	BDL	0.07	0.03
18	0.063	0.004	BDL	0.05	BDL
19	0.041	BDL	BDL	0.19	BDL
20	0.014	BDL	BDL	0.28	0.19

Table 2: Shows the level of some heavymetals in water samples

Discussion

Twenty water samples were randomly collected from different sampling sites and were analyzed. The results showed that the total mean Temperature is 29.32±0.213°C, pH 7.37±0.012, Turbidity had a mean level of 1.72±0.173 NTU, the TDS mean levels was 564.4±090.9 mg/l, EC have mean level of 634±34.7µS/cm while DO has mean levels of 5.6±0.203mg/L. All the physicochemical parameters tested are within the permissible limit except EC and Temperature. Heavy metals analyzed include Chromium which is within WHO upper limit except in location 3, Lead is only high in location 3 with (0.056mg/L), Cadmium is within the normal range, Iron is also within permissible limit except at location 6 with (0.42mg/L) while Zinc above limit at location 3 and 6 with (0.32 and 0.47 mg/L) respectively.

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