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Accessibility and Physicochemical Properties of Water for Domestic Purposes in Lafia Metropolis

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ABSTRACT

Water is a precious resource which is essential for life and is ranked next to air as a basic necessity of man. However, one major challenge in Nigeria is the ability for both rural and urban areas to access a clean water supply. This study examined the access and physicochemical properties of water used in lafia metropolis for domestic purposes. This study adopted both the use of questionnaires and collection of water samples for laboratory analysis. The parameters tested include; Temperature (°C), pH value, Electrical conductivity (µs), Total suspended solids (mg/l), Biological Oxygen demand (BOD),Turbidity (NTU), Sulphate (So4), Chloride (Cl), Nitrate (No3), Potassium (K), Sodium (Na), Calcium (Ca), Magnesium (Mg), Zinc (Zn), Iron (Fe) Copper (Cu) and Lead (Pb). The results showed that households in Lafia metropolis have reasonable access to safe water supply and the results of analyses of water samples were compared with the WHO minimum quality standards. The analyses revealed that the quality of water supply is adequate. For instance, electrical conductivity, total suspended solids, biological oxygen demand, sulphate, nitrate, and chloride values were all below the WHO values.

KEYWORDS: *Access, physical, chemical, properties, water*

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1. INRODUCTION

Water is essential to all forms of life and it is about 50–97 percent of the weight of all plants and animals. As important as water may be, yet it is the most poorly managed resource in the world (Fakayode, 2005). About 20 percent of the world's population lack access to good quality drinking water (UNEP, 2000). The importance of water supply for domestic uses cannot be compromised not only because of its social and economic values, but also because water has become critical to the survival and health of most households (Bain *et. al.,* 2014). Safe drinking water and basic sanitation are crucial to the preservation of human health, especially children. Water-related diseases are the most common cause of illness and death among the poor in developing countries (World Water Council, 2005). In Nigeria, (WHO, 2006) reported that approximately 36 percent of urban areas and 65 percent of rural areas are without access to safe drinking water. This has made households to turn to private wells, individual boreholes or street water vendors to meet their drinking water needs; which has exposed consumers to bacterial and heavy metal contamination exceeding local regulatory standards (Global Health Severity, 2012). Studies in Nigeria have shown various sources of drinking water which include streams, lakes, wells, boreholes, municipal water supply, local water vendors and rain water harvesting (Aderogba et al., 2012). WHO in year 2006 set up parameters in which the quality of drinking water can be measured (SON, 2007). The guidelines provide parameters for the maximum allowable concentrations of chemical and organic constituents in drinking water that will have no adverse effects. Physical quality requires that the water be colourless, odourless, tasteless, and not turbid, with a pH range of 6.5-8.5.

Since the creation of Nasarawa State in 1996 from Plateau State, the public water supply in Lafia, has been the responsibility of the Nasarawa State Water Board (NSWB). The NSWB inherited water supply system for Lafia town (then headquarter of lafia local government area) with a capacity of about 3 million gallons per day which fall short of the current demand level of a growing state capital. The existing water distribution system losses approximately 25 percent of its water through pipe leakages and uncollected revenues; the system itself has unreliable data on household water use and insufficient metering system. Thus, bills are based on presumed consumption. Therefore, this type of water supply system in the state has become moribund and death long time ago. The inhabitants of lafia metropolis have resorted to patronizing various sources of drinking water which include: streams, lakes, hand dug wells, boreholes, local water vendors and rain water harvesting during the rainy season. Some of these water sources may fall short of the WHO minimum standard for safe drinking water. The WHO/UNICEF Joint Monitoring Programme (2004), which produced the Global Assessment of Water Supply and

Sanitation data, describes reasonable access to water supply as 'the availability of at least 20 liters of water per person per day from a source within one kilometer of the user's dwelling'. In addition, access to potable water supply also means 'having access to safe drinking water with microbial, chemical and physical characteristics that meet the WHO guidelines'. Therefore, the objective of this study was to investigate the general access of households to safe, potable and qualitative drinking water in Lafia metropolis

2. MATERIALS AND METHODS

2.1. The study area

Nasarawa State is bordered by Kaduna, Kogi, Benue, Taraba and Plateau States as well as the Federal Capital Territory (FCT) Abuja. The State consists of Thirteen (13) Local Governments (see Fig.1) and has an estimated land area of 27, 107.8 sq. Km with Longitude 8° 08' 38" East and Latitude 8° 24' 17" North. Lafia town is the Headquarter of Lafia Local Government with a land area of 2,797.5 sq. Km (Fig. 2). Lafia town is situated on Longitudes 08º 30^1 East and Latitude 08 º 31^1Nnorth. The area is located in the middle belt. It is generally very warm and humid with dry and rainy seasons. It has a mean temperature range of 26 º C to 30 º C, a mean rainfall of 1120mm to 1500mm relative humidity of 60-80% and falls within the guinea savannah kind of vegetation; (NIMET, 2018).

2.2. Structure of Lafia Metropolis and Population

Lafia metropolis consists of three (3) structural units distinguished in terms of age of building as well as density of physical development and population. These structural units are: the old town area, Sabon pegi area, and Millionaires/Bukan sidi/ Tudun Gwandara area. The population of the metropolis is 267,546 (NPC, 2006)

Figure1: Map of Nigeria Showing Nasarawa State

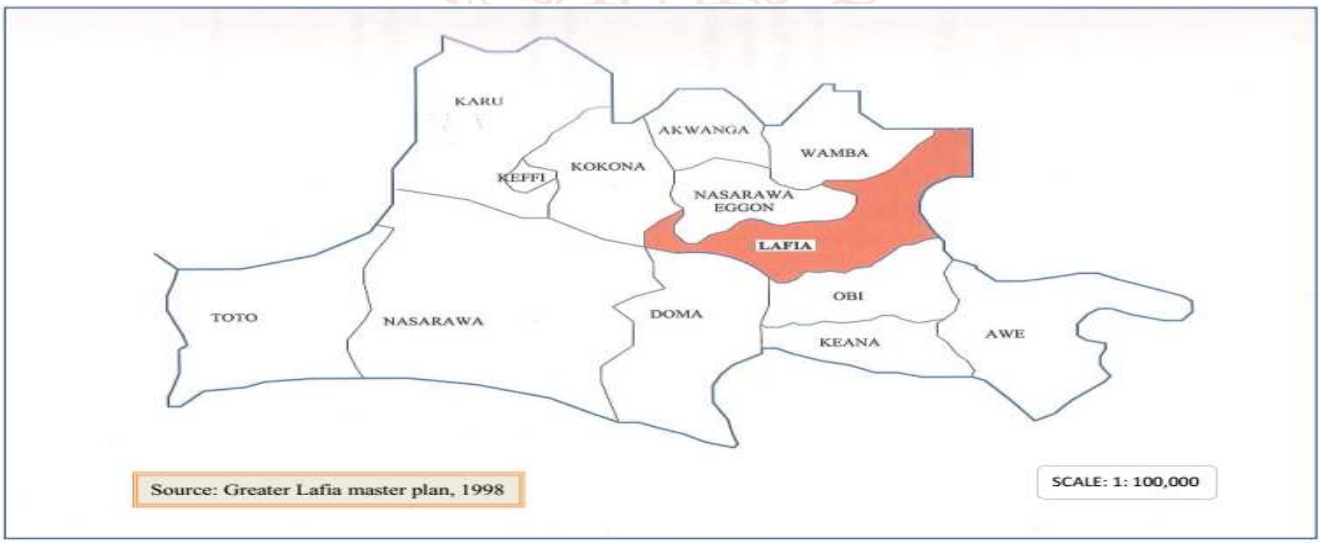

Figure2: Map of Nasarawa State Showing Lafia Local Government Area

2.3. Topography and Drainage

Lafia town and its surrounding settlements are within the Mada River Basin of the Benue valley platform. The area is largely an undulating plain which is drained by River Mada and its tributaries and by some tributaries of Guma and Ankwe Rivers emptying into the Benue River.

2.4. Research Design

This study adopted both the use of questionnaires and collection of water samples for laboratory analysis. This was done in order to determine households' access and the quality of the drinking water in Lafia metropolis.

2.5. Sampling Technique and sampled Population

A total of 50 household in each of the 3 structural neighborhoods (the old town area, Sabon pegi area, and Millionaires/Bukan sidi/ Tudun Gwandara area.) were randomly selected. Therefore, a grand total of 150 households were randomly selected from lafia metropolis for the purpose of this study.

2.6. Data Collection

Standard questionnaires were administered to 150 randomly selected household. The questionnaires were administered directly to female heads of each household. This was done because females are more involved in providing water for their households in the study area. However, in the absence of a female, the questionnaire was administered to the male. Only 140 questionnaires were recovered from the 150 households initially administered.

2.7. Water Sample Collection

Based on a reconnaissance survey earlier conducted; it was discovered that the major source of drinking water in Lafia metropolis was from privately owned boreholes. A total of nine water samples were randomly collected using sterilized 2-litre plastic cans from three boreholes per the three neighborhoods (the old town area, Sabon pegi area, and Millionaires/Bukan sidi/ Tudun Gwandara area). These water samples were taken to the laboratory for analysis

2.8. Laboratory Analysis

The water quality parameters selected for the study were: lead, zinc, iron, manganese, total dissolved solid (TDS), total suspended solid (TSS), pH, turbidity, temperature and dissolved oxygen (DO). The physico-chemical characteristics of the water samples were analyzed using standard methods. pH, temperature and DO parameters were measured in-situ, with an ATI-Orion pH meter, thermometer, probe and meter respectively. While, turbidity, TDS and TSS were measured with: turbidity meter, conductivity and photometric methods respectively. While heavy metals such as Iron (Fe), lead (Pb) and zinc (Zn) were determined with the aid of the Atomic Absorption Spectrophotometer (AAS).

2.9. Data Analysis

The data obtained from administration of standard questionnaire were analyzed using descriptive statistics; while, results obtained from laboratory water analysis were presented in bar graphs.

3. RESULTS AND DISCUSSION

3.1. Demographic Data

The result in (Table 1) revealed that in the old Lafia town, (62.86%) of the respondents have 10 and above persons per household, which represent the highest in population compared with the other neighborhood. This implies that the domestic water usage may be more in Lafia old town than other areas of the metropolis all things being equal. This is in consonance with the result obtained by (Aderogba and Oderinde 2012). The reason for large family size may be attributed to the religious and cultural believes of the people around this neighborhood; since most of them are Muslim and they practice polygamy and no family planning. In the entire three neighborhoods, the greatest numbers of people involved in this study were women. Also, above 50% of these women used for the study were younger and married bellows the age of 40years. It means that most of women are still stronger and have more energy to fetch water for the family usage. Majority of these women involved in this study were full time house wives especially in Lafia old town.

Table1. Demographics of Respondents

Items	Lafia metropolis					
HOUSEHOLD SIZES	Lafia old town		Sabon pegi		Bukan sidi	
	Freq	%	Freq	%	Freq	%
1-3	7	5	3	2.14	5	3.57
4-6	10	7.14	65	46.42	65	46.43
7-9	15	10.71	47	33.57	42	30
10 and above	88	62.86	15	10.71	18	12.86
Total	140	100	140	100	140	100
SEX						
Male	4	2.86	2	1.43	5	3.57
Female	136	97.14	138	98.57	135	96.42
Total	140	100	140	100	140	100
AGE						
20-39	78	55.71	79	56.42	88	62.86
40-59	52	37.14	44	31.42	42	32.14
60 and Above	10	7.14	17	12.14	10	7.14
QTotal	140	100	140	100	140	100
MARITAL STATUS						
Married	85	60.71	72	51.42	85	60.71
Single	10	7.14	48	34.29	38	27.14
Divorced	35	25	12	8.5	4	2.86
Widowed	10	7.14	8	5.71	13	9.28
TOTAL	140	100	140	100	140	100

Source: Authors' Fieldwork, 2018

3.2. Distances to Major Source of Water Supply (Accessibility)

The result in (Table 2) showed that households in Lafia metropolis have reasonable access to safe water supply because the distance of households to their major source of water supply is below one kilometer. Reasonable access to water supply is 'the

availability of at least 20 litres per person per day from a source within one kilometer of the user's dwelling (WWC, 2005). Going by this definition, one may conclude that all the reason for the short distances is because of the indiscriminate sinking of boreholes and wells by some water merchants in the metropolis.

Table2. Distance to Major Source of Water Supply

Distance from Major source of Water supply(m)	Lafia metropolis					
	Lafia old town		Sabon pegi		Bukan sidi	
	Freq	%	Freq	%	Freq	%
0-100	140	100	140	100	140	100
101-200	00	00	00	00	00	00
Above 200	00	00	00	00	00	00
Total	140	100	140	100	140	100

Source: Authors' Fieldwork, 2018

3.4. Physicochemical Properties of Water

The results of physicochemical properties of the water sampled from lafia metropolis are presented on tables below:

4.4.1. Temperature

The analysis of the physical properties of water shows the average temperature of lafia old town area, 26.0°C; Sabon pegi area, 26.4°C; and Bukan side area, 26.2°C for the sampled neighborhood (Fig. 1). This falls within the WHO standard for drinking water. There were no high variability in water temperatures and this may be as result of the all the sampled neighborhoods are found within the same climatic zone. Since temperature is a standard physical characteristic that is important in the consideration of the chemical properties of water, it therefore becomes necessary that the temperature of the water should be ascertained since high temperature is known to increase the toxicity of some toxic substances such as ammonia, reduce the concentration of dissolved oxygen, increase water acidity and influence the activities of some bacteria (Ubogu and Rimomson 2008)

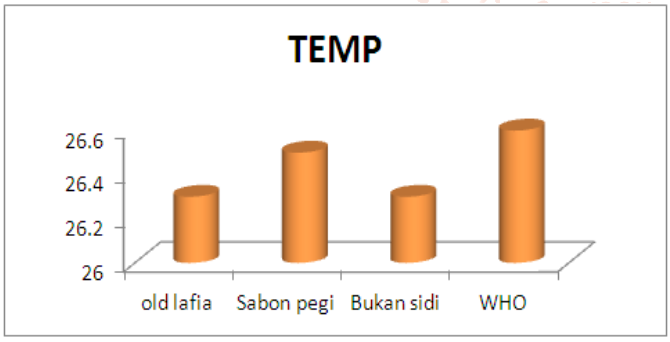

Fig.1: Temperature of drinking water in lafia metropolis

4.4.2. pH value

The pH of all the sampled water was bellow W.H.O recommendation, in Lafia old town, the average pH for all the samples was 5.80. Therefore, the water is mildly acidic (Fig. 2). For Sabon pegi, the pH average was 5.79. The pH affects the solubility and toxicity of metals in the aquatic system, which may have adverse effects on human health. The water becomes acidic, if its pH is less than 7, and becomes alkaline if above 7. In all ramifications, the pH of all the samples was lower than 7-8.5 (WHO Standard).

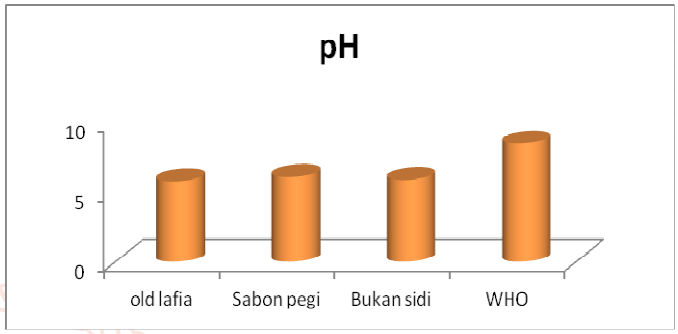

Fig.2: pH of drinking water in lafia metropolis

4.4.3. Electrical conductivity (EC)

The analyses of chemical properties indicate that in Lafia metropolis, electrical conductivity (Fig. 3) range from 2.3µs/cm in old Lafia town to 2.5µs/cm in sabon pegi and Bukan sidi is 2.4µs/cm. All values for electrical conductivity water sample in Lafia metropolis were below the WHO stipulated standard of 50µs/cm. Electrical conductivity is an index of the total ionic content of water, and therefore indicates the increased mineralization of organic matter. It therefore becomes necessary that EC should be measured to give a good estimate of the dissolved solids content of the water.

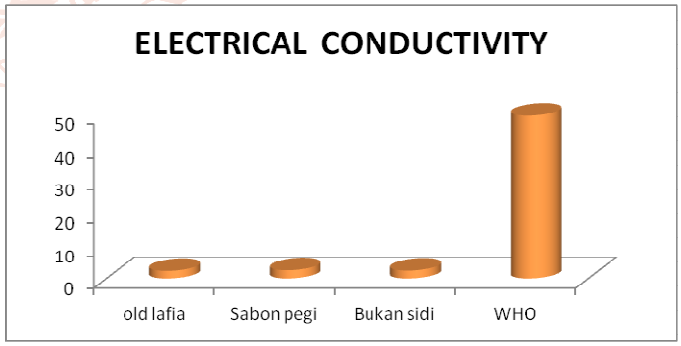

Fig.3: Electrical conductivity of drinking water in lafia metropolis

4.4.4. Total suspended solids (TSS)

The total suspended solids in sampled water in Lafia metropolis varied between 33.6mg/l in Sabon pegi and 34.9mg/l in old lafia town(Fig. 4).Therefore, the samples are lower than the recommended standards for drinking water. In all, results for all the sampled sites were low when compared with the WHO standard of 50mg/l and therefore the water is good for domestic purposes.

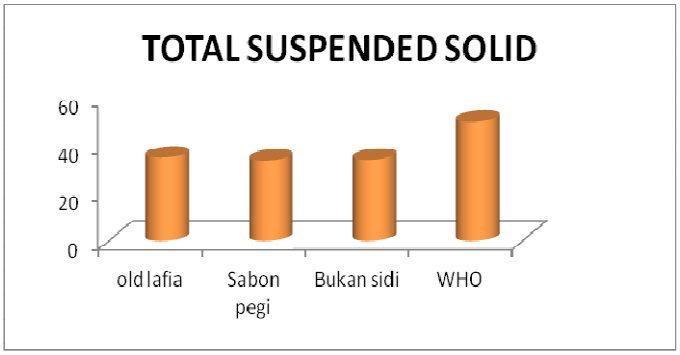

Fig.4: Total suspended solid of drinking water in lafia metropolis

4.4.5. Biological oxygen demand (BOD)

The biological oxygen demand (BOD) value for water sampled in Lafia metropolis varied between 1.01mg/l in old Lafia town and 1.02mg/l in Sabon pegi and Bukan sidi (Fig. 5). All the water samples were lower than the WHO minimum values of 3mg/l. BOD is a measure of the consumption of oxygen by micro-organisms in the oxidation of organic matter. Thus, a high BOD indicates a high concentration of organic matter usually from waste water discharges.

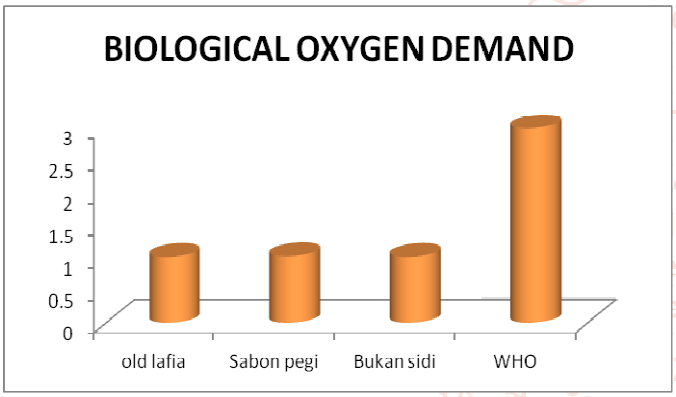

Fig.5: Biological oxygen demand of drinking water in lafia metropolis

4.4.6. Turbidity

The results of the laboratory analysis of water sampld in Lafia metropolis showed turbidity (NTU) ranges between 0.007NTU in Bukan sidi and 0.013NTU in Sabon pegi and 0.014NTU in old Lafia town (Fig.5). Turbidity levels in all the water sampled were lower than WHO standard for domestic water. Since turbidity has an inverse relationship with transparency, the very low turbidity recorded in this study is an indicative of high biological production. The probable reason for the low turbidity values is the low water table, which leads to high depths of most of the boreholes.

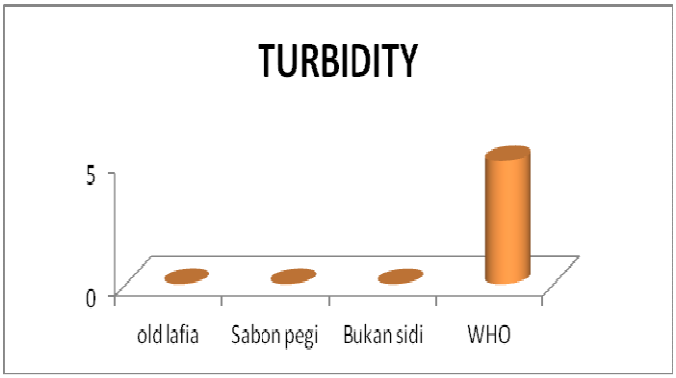

Fig.6: Turbidity of drinking water in lafia metropolis

4.5. Analysis of Elemental Contents of the Water

4.5.1. Sulphate (S04)

The results in (Fig.6) indicate that, the concentration of sulphate ranges between 10.05mg/l in Sabon pegi to 11.09mg/l and 11.37 in old Lafia town and Bukan sidi respectively. In summary, the contents of sulphate in all the sampled water, falls below the WHO quality standards.

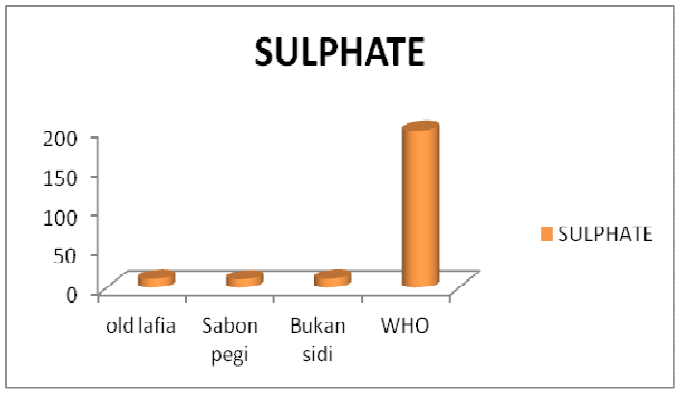

Fig.7: Sulphate of drinking water in lafia metropolis

4.5.2. Chloride (Cl)

Chloride concentrations in the sampled water in Lafia metropolis varied between 22.21mg/l in old Lafia town, 25.12mg/l in Sabon pegi and 22.3mg/l in Bukan sidi (Fig.7). All these values were relatively below WHO maximum limit of 200mg/l. It was observed that the low concentration of chlorides could be associated with the low level of total dissolved solids (TDS) and this indicates the nature of groundwater, which is fresh. Chlorides, most often occurring in the NaCl common salt form, are found in brackish water bodies contaminated by sea water or in groundwater aquifers with high salt content are indicative of sewage pollution from other chloride compounds.

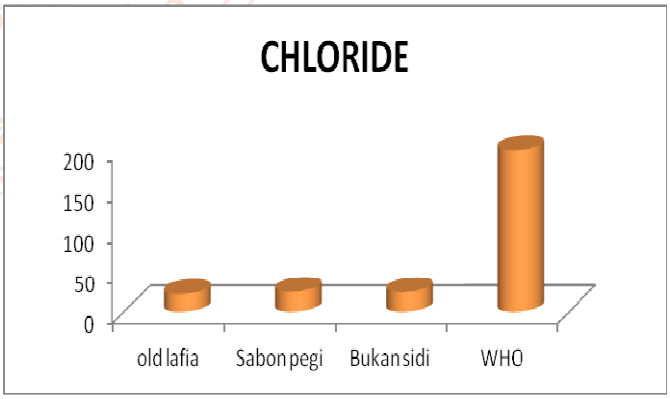

Fig.8: Chloride level of drinking water in lafia metropolis

4.5.3. Nitrate (NO3)

Nitrate content of the sampled locations were low when compared with the WHO maximum limit of 50mg/l (Fig. 8). In old Lafia town the sampled water nitrate was found to occur from a range of 0.45mg/l; in Sabon pegi, it was 0.04mg/l and Bukan sidi was 0. 23mg/l. Nitrates in excessive amount contributes to the illness known as me the mogbinemia (Ocheri, *et al.,* 2008).

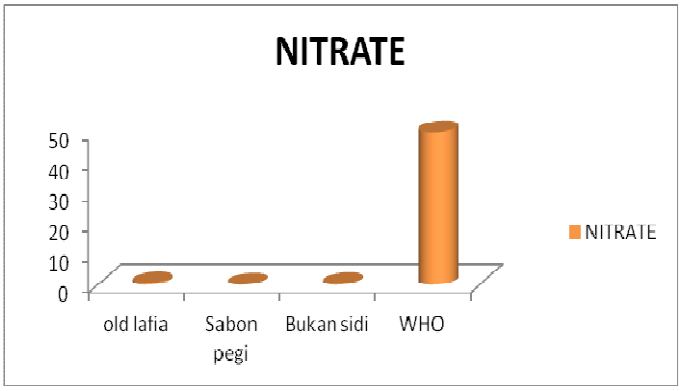

Fig.9: Nitrate level of drinking water in lafia metropolis

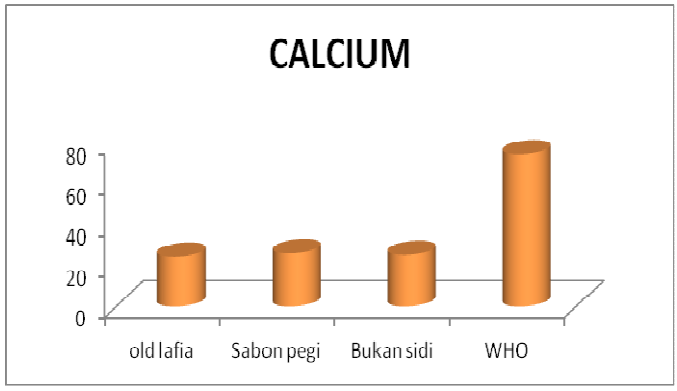

Fig.12: Calcium level of drinking water in lafia metropolis

4.5.4 Potassium (K)

The contents of potassium in old Lafia town varied between the lowest value of 0.23mg/l in Sabon pegi and the highest value of 0.45mg/l in old Lafia town (Fig. 9). Therefore, the potassium content is lower than the WHO desirable limit of 1.0mg/l.

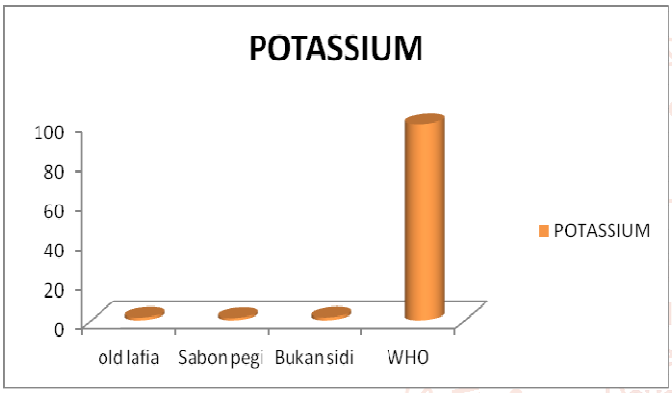

Fig.10: Potassium level of drinking water in lafia metropolis

4.5.5. Sodium (Na)

Sodium concentration in Lafia metropolis varied between 2.12mg/l in Bukan sidi to 2.23mg/l in old Lafia town (Fig.10). The content of sodium in all these sampled water samples in the study areas were less than WHO standard of 100mg/l.

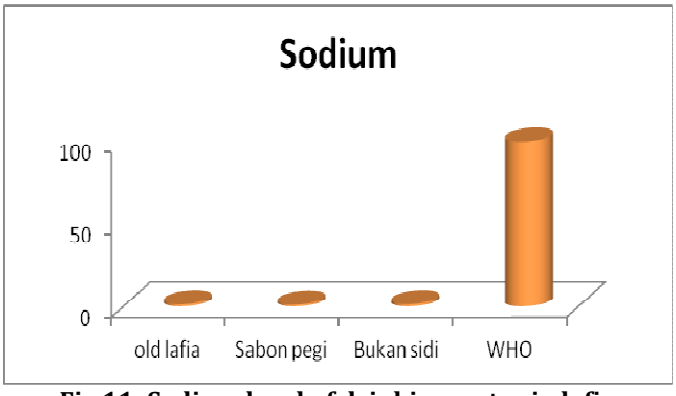

Fig.11: Sodium level of drinking water in lafia metropolis

4.5.6. Calcium (Ca)

In Lafia Metropolis (Fig.11), calcium ranged between 24.45mg/l in old Lafia town to 26.15mg/l in Sabon pegi. In all water sampled in the study areas, the values for calcium were lower compared with WHO standards of 75mg/l.

4.6. Heavy metals

4.6.1. Magnesium (Mg)

The magnesium contents in Lafia metropolis for the sampled water ranged between 7.45mg/l in old Lafia to 9.21mg/l in Bukan sidi; Sabon pegi was also 9.78mg/l. The values were all lower than WHO maximum limit of 50mg/l (Fig. 13). High concentration of calcium and magnesium determine the hardness of water.

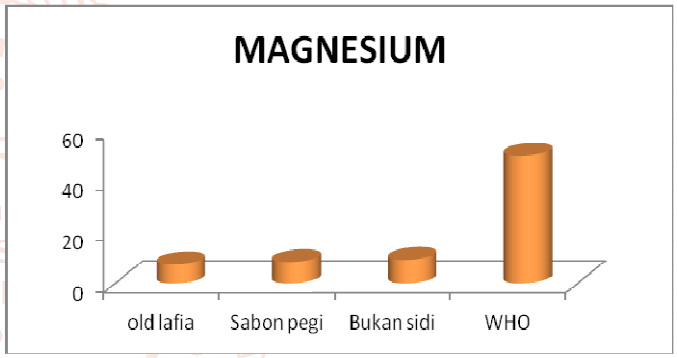

Fig.13: Magnesium level of drinking water in lafia metropolis

4.6.2. Zinc (Zn)

Values for zinc in Lafia metropolis ranged from 0.01mg/l in Sabon pegi to 0.02mg/l in old Lafia town and Bukan sidi (Fig.14). However, these values were lower than WHO standard of 5.0mg/l for zinc (Zn). These values indicate that the water samples are free from zinc pollution.

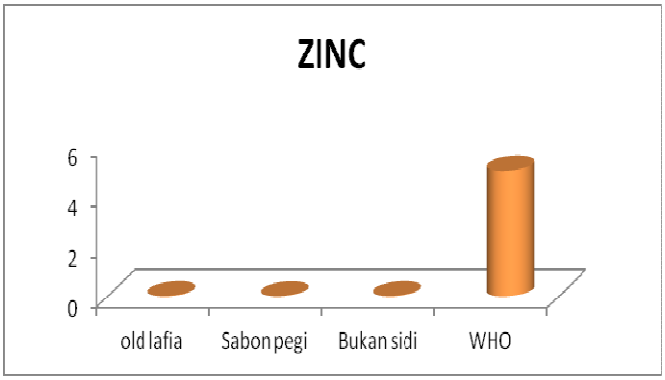

Fig.14: Zinc level of drinking water in lafia metropolis

4.6.3. Iron (Fe)

The lowest value for iron in Lafia is 0.000mg/l in Sabon pegi, 0.001mg/l in old Lafia town and Bukan sidi(Fig.15). The presence of more than 0.3ppm of iron in water will result in the staining of plumbing fixture and laundry and even smaller amounts may be troublesome.

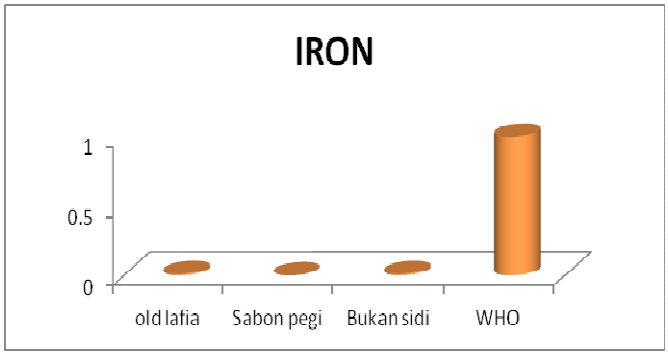

Fig.15: Iron level of drinking water in lafia metropolis

4.6.4. Lead (Pb)

The content of lead was found to be highest with a value of 0.03mg/l in Sabon pegi (Fig.16). While, lowest value of 0.02mg/l was found in old Lafia town, and Bukan sidi was 0.025mg/l which is bellow WHO requirement of 0.5mg/l of Lead in water.

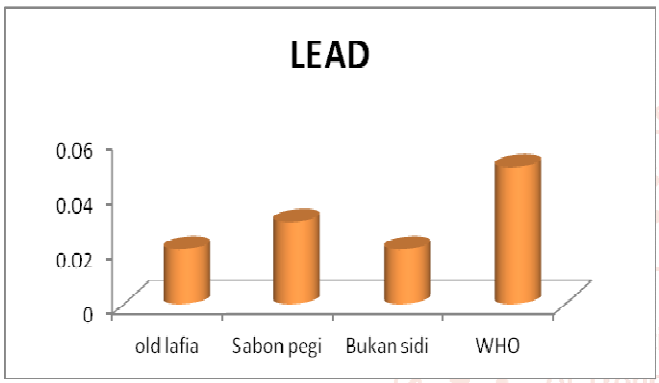

Fig.16: Lead level of drinking water in lafia metropolis

CONCLUSION

In conclusion, this study revealed that households in lafia metropolis have access to potable drinking water and the quality as indicated by the physical and chemical properties of the water are also in conformity with WHO minimum standard. However, most of the sources (bore holes) of this water are owned by private individuals.

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