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Determination of Pesticide Residue in Dug Well and Borehole in Yawa Drinking Water Adamawa State, Nigeria

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Abstract - **This research work is aimed at determination of pesticide residue in dug well and borehole in Yawa drinking water. In this work, water samples collected from Yawa Mubi South Adamawa State were analyzed for physicochemical parameters. After sample collection and extraction, some heavy metal concentrations (Cadmium, Zinc, Iron, Copper) were determined using Atomic Absorption Spectroscopy (AAS) in the water samples and their levels compared with WHO/FAO maximum levels. Gas Chromatography/Mass Spectrophotometer was used to determine the levels of pesticide residues in the water samples. The temperature of water samples was between 24.0 (Kofan Jauro well 25.0^{0}c) and (Yawa community borehole). All water samples were alkaline with pH ranging from 5.07 (Yawabetenga borehole) to 5.46 (Yawa primary well). Yawa primary well showed the highest turbidity (155.3 ± 1.53 NTU), the least turbidity was (1.33 ± 1.55 NTU) observed in Yawa community borehole. The maximum level of TDS was131 ± 1mg/l which was detected in KofanJauro well. The least concentration (12.0 ± 1.01mg/l) of TDS was detected in Yawa primary well which also showed the highest electrical conductivity (226 ± 1A). Yawabetenga borehole showed the least EC (135 ± 1A). Cadmium values ranges from 2.79-3.59 mg/L, cadmium was not detected in KJW and YBB. All the values analyzed for cadmium were found to be above the allowable limit set by EPA, 2018. All the values analyzed for Zn are extremely above the standard set by EPA, 2018. The highest concentration of aldrin was detected in Yawa borehole and the lowest concentration was detected in KofanJauro well. The maximum concentration of pesticide Endosulfan (4.46266 mg/L,) was detected in Yawa Primary well. The least of all detected pesticides is methoxychlor (0.001852 mg/L) in Yawa borehole near River. Heptachlor however was not detected completely in water sample from Yawa borehole near river, Yawa Betenga Borehole and Yawa borehole. P, p' – DDE was not detected in Yawa borehole near river. Water samples from Yawa primary well showed elevated concentration of pesticides (>0.1mg/L) relative to water samples from other wells and boreholes from Yawa Mubi South.**

Keywords: Pesticides, Drinking water, Contaminants, Metals and Pollution.

I. INTRODUCTION

Groundwater normally looks clear and clean because the ground naturally filters out particulate matter. But, natural and human-induced chemicals can be found in groundwater. Water is a naturally occurring chemical compound covering about 75% of the total earth surface consisting of ocean water (96.5%), ground water (1.7%), glacial water (1.5%), and water vapor (0.001%) (Sudi, 2017).

As groundwater flows through the ground, metals such as iron and manganese are dissolved and may later be found in high concentrations in the water (USGS, 2016). Industrial discharges, urban activities, agriculture, groundwater plumage, and disposal of waste all can affect groundwater quality. Organophosphates and other banned organochlorine pesticides such as lindane, aldrin and dieldrin were used by farmers (Abong*et al*., 2014).

Contaminants can be human-induced, as from leaking fuel tanks or toxic chemical spills. Pesticides and fertilizers applied to lawns and crops can accumulate and migrate to the water Table. Leakage from septic tanks and/or waste-disposal sites also can introduce bacteria to the water, and pesticides and fertilizers that seep into farmed soil can eventually end up in water drawn from a well (USGS, 2016).

Surface water could be polluted in rural set up such as Yawa through non-point source (NPS) pollution. NPS pollution involves diffused contamination from different sources. It mostly arises due to the cumulative effect of small amounts of contaminants gathered from a large area (Sudi, 2017).

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Gas chromatography–mass spectrometry (GC-MS) is a method that combines the features of gas-liquid chromatography and mass spectrometry to identify different substances within a test sample 1.

Applications of GC-MS include drug detection, fire investigation, environmental analysis, explosives investigation, and identification of unknown samples. GC-MS can also be used in airport security to detect substances in luggage or on human beings. Additionally, it can identify trace elements in materials that were previously thought to have disintegrated beyond identification, (Rowley, 2001).

This research work is aimed at determination of pesticide residue in dug well and borehole in Yawa drinking water in order to ascertain the presence of pesticide residues in groundwater, assess the physicochemical parameters of the water samples and determine some heavy metals in water samples from Yawa Mubi south Adamawa State Nigeria.

From the results obtained, appropriate conclusions can be drawn on the safety of these dug wells and boreholes as recent literatures revealed little information on the pesticide residues and levels of such heavy metals in dug well and borehole in Yawa drinking water.

II. MATERIALS AND METHODS

Sample Collection

Water samples were collected in clean 1 L amber bottles in triplicate from four boreholes and two dug well in Yawa, Mubi South local government area, Adamawa State, Nigeria. The water samples were immediately carried to American University of Nigeria for Analysis Adamawa State.

Study Area

The study area Yawa as earlier described by Sudi, et al., (2019) and Peter et al., (2015) is a town in Mubi South Local Government area of Adamawa State, Nigeria. It is located at the Lower Contour of Mandara Mountains at the Nigeria – Cameroon boarder at latitude 10o 15’ 98.34” N and longitude 13o 29’ 97.65” E. Yawa shares boundary with Hong LGA west ward Maiha LGA at the Southern coast, and Michika LGA and Cameroon republic in the Eastern region (Fig 1).

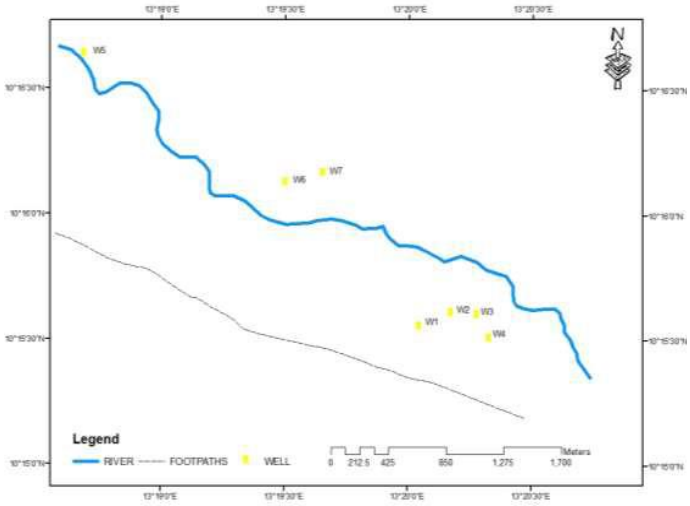

Figure 1: The map of boreholes and dug wells Water in YawaMubi South LGA Adamawa State Nigeria (Adapted from Sudiet al., 2019)

Sample Extraction

The method of Association of Official Analytical Chemists (AOAC), (AOAC, 2000) with little modification was employed in this study. As initially described by Sudi (2017), About 600 ml filtered water samples was transferred into a 1-liter separator and to each 100 ml petroleum ether was added and mixed by shaking for 2 minutes and 10 ml saturated NaCl solution was added until the mixture separates. The aqueous layer was discarded and the solvent layer was gently washed with two 100 ml portion of water. The solvent layer was transferred to glass Stoppard cylinder and the volume recorded. Then, 15 g of anhydrous Na2SO4 was added and mixed by shaking. The extract was concentrated to 10 ml by evaporation to purity.

Physicochemical Analysis

The major water physicochemical parameters that were determined in this study are pH, Temperature, Turbidity, Total Dissolved Solids (TDS), Selected metals and metalloids (C, Zn, Cd, Fe) (APHA, 2019).

GC/MS Analysis

All compounds (pesticide residue) were determined using Gas chromatography equipped with a Mass selective detector (GC/MS) earlier described by Shingguet al., (2015). Helium flow through the column was set at 1.2 ml/min, injections of 1µl was done with injector at 275oC in pulsed split split-less mode at a flow rate of 1.0L/min the MS was operated in electron impact, at an oven temperature and was maintained at 40oc for 1min mode with a detector voltage of 600-700V, and emission current of 150/µV. the transfer line from the GC to MS, the MS was operated in electron ionization (EI) mode. Data was collected at a Selected Ion Monitoring (SIM) mode.

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III. RESULTS AND DISCUSSION

Table1 presents Physicochemical Result of Water Samples from YawaMubi South L.G.A.

Table 1: The physicochemical properties of water samples from Yawa, Mubi South L.G.A Adamawa State

All the pH							
Parameters	**KJW**	**YBNR**	**YBB**	**YCB**	**YBLW**	**YPW**	**EPA (Std)**
pH	5.37±0.03	5.16±0.05	5.07±0.0	75.24±0.0	25.36±0.03	5.46±0.02	6.5-8.5
T. (^{0}C)	24.9±0.00	24.6±0.00	24.7±0.0	25.0±0.00	24.7± 0.00	24.7±0.00	Am
Turbidity (NTU)	-	14.1±0.00	14.7±1.52	1.33±1.55	29.6±1.521	55.3±1.53	-
TDS (mg/L)	131±1.0	95±1.00	77.0±6.70	91.0±15.0	68.0±1.00	12.0±1.00	1000
EC (µs/cm)	214.3±1	189.0±1.5	135±1.00	187±1.50	156.0±1.00	226±1.00	400

KEYS: KJW= Kofanjauro well, YBNR= Yawa borehole near river, YBB=Yawabetenga borehole YCB= Yawa community borehole, YBLW= Yawa borehole less wuro YPW= Yawa primary well, T = Temperature, TDS = Total dissolved solid EC = Electrical conductivity, Am = Ambient, NTU = Nephelometric Turbidity Unit, EPA = Environmental Protection Agency.

Values from all the locations were found to be lower than the allowable limit by WHO, 2008. Sample from YPW (155.3FTU) has the highest value of turbidity; the turbidity values of all except sample from YCB (1.33FTU) are higher than the allowable limit by EPA, 2018 which is 5FTU. Also, all samples analyzed for TDS were found to be extremely below the standard by EPA, 2018. All the values for electrical conductivity analyzed were higher than the standard set by EPA,2018. Having sample from YPW with the highest of electrical conductivity.

Table 2 Presents Metals and metalloids in water samples from Yawa, Mubi South LGA Adamawa State.

Table 2: The heavy metals of boreholes and Dug well water from Yawa, Mubi South L.G.A Adamawa State

Parameters	**KJW**	**YBNR**	**YBB**	**YCB**	**YBLW**	**YPW**	**EPA**	**WHO Std (mg/kg**
Cd (mg/kg)	ND	3.59	ND	3.17	2.94	2.79	0.005mg/l	0.003
Zn (mg/kg)	2.42	3.69	2.48	3.20	3.31	2.65	≤ 5 mg/l	≤ 3
Fe (mg/kg)	37.46	37.50	37.50	37.42	37.54	36.65	0.3mg/l	0.3
Cu (mg/kg)	0.64	1.16	1.00	0.62	1.44	1.07	0-1.3mg	0-2.5

KEYS: KJW= Kofanjauro well, YBNR= Yawa borehole near river, YBB=Yawabetenga borehole YCB= Yawa community borehole, YBLW= Yawa borehole less wuro YPW= Yawa primary well, Cd = Cadmium, Zn = Zinc, Fe = Iron, Cu = Copper

Cadmium values ranges from 2.79-3.59 mg/L, cadmium was not detected in KJW and YBB. All the values analyzed for cadmium were found to be above the allowable limit set by EPA, 2018. All the values analyzed for Zn are extremely above the standard set by EPA (2018).

Table 3 presents result of GC-MS analysis of pesticides in selected wells and boreholes from YawaMubi south, Local Government Adamawa State, Nigeria

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Parameters	KJW (mg/L)	YBNR (mg/L)	YBB (mg/L)	YCB (mg/L)	YBLW (mg/L)	YBW (mg/L)	EPA/WHO (mg/L)
Aldrin	0.584131	0.040082	1.67636	1.17946	4.16967	2.74398	0.002
Alpha lindane	0.55572	ND	0.123061	0.13809	0.132746	04.131432	0.002
Beta lindane	0.57648	0.033542	0.0346757	0.077701	0.575273	0.5571	0.002
Delta lindane	0.55572	0.005468	0.067104	0.075753	0.116124	0.139932	0.002
Gamma lindene	0.133441	0.015874	0.12352	0.015874	0.12352	0.112607	0.002
Heptachlor	0.011631	ND	ND	0.005916	ND	0.006515	0.004
Endosulfan	0.0341267	0.2167	0.34718	0.953689	0.71433	4.46266	0.600
Endosulfan	0.85308	0.0798308	0.34718	0.27291	2.09448	0.508346	0.002
Endrine	0.081692	0.030901	0.126801	0.292316	0.958713	0.643238	0.002
DDDE	0.017037	ND	0.0184	0.043989	0.010134	0.06935	0.01
DDT	0.018782	0.009169	0.043499	0.01763	0.043543	0.035481	0.01
Methoxychlor	0.011901	0.001851	0.007386	0.00689	0.012162	0.007229	0.04

KEYS: KJW= Kofanjauro well, YBNR= Yawa borehole near river, YBB=Yawabetenga borehole YCB= Yawa community borehole, YBLW= Yawa borehole less wuro YPW= Yawa primary well. All values are in milligram /liter (mg/l) DDDE = dichlorodiphenyldichloroethylene, DDT = dichlorodiphenyltrichloroethane.

The presence of pesticides in water sample from YawaMubi South LGA Adamawa State Nigeria at appreciable concentration of the pesticides (aldrin, lindane, endosulfan, endrin DDE, DDT, and methoxychlor) which may be of health concern. The highest concentration of aldrin was detected in Yawa borehole lower wuro well and the lowest concentration was detected in KofanJouro well. The maximum concentration of pesticide Endosulfan (4.46266 mg/L,) among all the pesticideswas detected in Yawa Primary well. The least of all detected pesticides is methoxychlor (0.001852 mg/L: Table 3) in Yawa borehole near river. Alpha lindane was not detected in Yawa borehole near river, the result showed mild concentration of heptachlor (<0.100 mg/L) in the water samples from Yawa wells and borehole. Heptachlor however was not detected completely in were sample from Yawa borehole near river, YawaBetenga Borehole and Yawa borehole Less Wuro. P, p' – DDE was not detected in Yawa borehole near river with minimal concentration detected in the rest of the wells and boreholes. Water samples from Yawa primary well showed elevated concentration of pesticides (>0.1mg/L) relative to water samples from other wells and boreholes from YawaMubi South Local Government Area Adamawa State Nigeria.

Discussion

The result of heavy metal determination is presented in Table2. It shows that water samples from boreholes and wells in YawaMubi South Local Government Area at the lower contour of mandara mountains have appreciable concentration of the selected metals of interest except for water from KofanJauro well in which cadmium was not detected in line with an observation made by Sudiet al., (2019).

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The maximum concentration of cadmium (Table 2 (3.59 mg/l) was detected in water from Yawa borehole near river, lowest concentration of cadmium (Table 2 (2.79 mg/l) was detected in Yawa primary well, cadmium level in Kofanjauro well were below detectable limit. Yawa borehole less wuro the maximum concentration of all iron (Table 2 (37.54mg/l) which is also the highest concentration of metal detected in all water samples. Kofanjauro well showed the least concentration of metal (copper 0.64mg/l Table 2) of the entire water sample. All water sample showed elevated level of iron (> 30mg/l) which may be of health concern. The temperature of water samples was between 24.0 (KofanJouro well 25.00c) and (Yawa community borehole). All water samples were alkaline with pH ranging from 5.07 (Yawabetenga borehole) to 5.46 (Yawa primary well). The highest pH was observed in Yawa primary well, and the least pH was detected in Yawabetenga borehole. Yawa primary well showed the highest turbidity (155.3 ± 1.53 NTU), the least turbidity was 1.33 ± 1.55 NTU observed in Yawa community borehole. The maximum level of TDS was131 ± 1mg/l which was detected in KofanJauro well. The least concentration (12.0 ± 1.01mg/l) of TDS was detected in Yawa primary well which also showed the highest electrical conductivity (226 ± 1A). Yawabetenga borehole showed the least EC (135 ± 1A).

Table 3 showed the presence of pesticides in water sample from YawaMubi South LGA Adamawa State Nigeria at appreciable concentration of the pesticides (aldrin, lindane, endosulfan, endrin DDDE, DDD, DDT, and methoxychlor) which may be of health concern. The highest concentration of aldrin was detected in Yawa borehole lower wuro well and the lowest concentration was detected in KofanJouro well. The maximum concentration of pesticide Endosulfan (4.46266 mg/l,) among all the pesticides was detected in Yawa Primary well. The least of all detected pesticides is methoxychlor (0.001852 mg/l: Table 3) in Yawa borehole near river. Alpha lindane was not detected in Yawa borehole near river, the result showed mild concentration of heptachlor (<0.100 mg/l) in the water samples from Yawa wells and borehole. Heptachlor however was not detected completely in were sample from Yawa borehole near river, YawaBotenga borehole and Yawa borehole LesswerWuro. P,p' – DDE was not detected in Yawa borehole near river with minimal concentration detected in the rest of the wells and boreholes. Water samples from Yawa primary well showed elevated concentration of pesticides (>0.1mg/l) relative to water samples from other wells and boreholes from YawaMubi South Local Government Area Adamawa State Nigeria.

It is vital to access water before for safety reasons. Water in its purest form is odorless, colorless and tasteless (Steven, 2020), the activities of man and animals has distorted water bodies which serve for drinking and other domestic purposes. The GC-MS result of water samples showed concentrations of pesticides of health concern relative to WHO (2008) and EPA (2018) standard. The concentration of aldrin is about 2920 time above the allowed daily intake of aldrin based on EPA guidelines for drinking water. This aldrin level detected in Kofanjauro water associated with cancer risk at probable ranges to humans (EPA, 2018). Aldine readily changes to dieldrin when it enters the environment (ATSDR, 2002). The scientific name for aldrin is 1,2,3,4,10, -hexachloro-1,4,4α5,8α-hexahydro-1,4-endo, oxo-5,8-dimethanonaphthalene, it is abbreviated as HHDN. Trade names include Drinox, Octalen, Seedrin and compound 18. Aldrin production was banned in the 1970s (WHO, 2003) though it was reported that the manufactures of aldrin concealed its famous trade name and produced it for the control of termites (ATSDR, 2002), the presence of this pesticide is possibly from non-point source and may persist for a long time. Lindane is an organochlorine insecticide also called garma-hexachlorobezene,1-α,2-α,3-β,4-α,5-α,6-β-hexachlorocyclohexane, garmahexachlorohexanee.t.c. In acute cases lindane stimulates the central nervous system increasing chances of cardiovascular collapse, convulsion, renal insufficiency respiratory and metabolic acidosis and death may occur (Nantel, 2001). Nantel (2001) reported that adults who ingested contaminated broccoli developed severe convulsion rhabdomyolosis and renal insufficiency. Micheal, (2001) reported that lindane interferes with gama amino butyric acid (GABA) neurotransmitter function by interacting with GABA receptor channel complex at the picrotoxin binding site; it was also reported to affect the liver kidney and a carcinogen. The concentration of the pesticides present in water samples may bioaccumulation and may lead to any of the above mentioned symptoms listed above and may concomitantly lead to cocktails effect.

Endosulfanis among organochlorine pesticide that are non-target specific affecting both insects and humans, EPA, (2015) reported that DDD, DDE, DDT are probable human carcinogens, it was also reported that studies in rats showed that these pesticides mimicked natural hormones affecting reproductive and nervous system. The physicochemical analysis of water samples from Yawa showed readings of parameters of no health implications except for metals determination which was above EPA ADI (EPA, 2015). The pH of water samples where ambient and all other physicochemical parameters analyzed were within range as designated by EPA and WHO. Themetals were however above safe concentrations based on EPA ADI, this may be because of the bed rocks within the region. pH is most important in determining the corrosive nature of water. Lower the pH value, the higher the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity (Gupta and Shukla,, 2009). The concentration of

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iron detected in Yawa borehole lower wuro has concentration which is about 125.133 times above EPA ADI (EPA, 2015) this level of iron may lead to iron overload. Iron overload has been linked to erectile dysfunction and under prolonged consumption may lead to arthritis, liver disease diabetes, hypothyroidism, heart disease and pancreatitis, (Natalie, 2020), consumption of this water may lead to impotency of male individual from this locality and may be correlated to the water they consume. Cadmium has been associated with reproductive issues such as infertility (Thompson and Beennigan, 2008).

IV. CONCLUSION

The presence of pesticides in water bodies implies that they are still in use or have persisted in the environment possibly due to their long half-life. Hence the continual use of these pesticides contributes to the unavailability of clean drinking water. From this analysis it is concluded that water sample from wells and boreholes shows various concentrations of pesticide residue. pesticides though concentrations are of biological implication, this implies that the levels of pesticide residue are of health concern because the wells and borehole water samples analyzed showed concentrations of residues above EPA which are above stipulated maximum residue level (MRLs) apart from methoxychlor. This implies poor water quality. Apart from copper, the physicochemical parameters analyzed were also above ADI in the WHO (2003) Guidelines for drinking-water quality. Hence, direct consumption may attract significant biological implication. The prevalence of the studied pesticides in water samples from YawaMubi South L.G.A implies that this pollutant either persists in the environment or is still in continues usage.

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