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EVALUATION OF THE POTENTIAL EFFECT OF POULTRY LITTER ON GROUNDWATER IN SOME SELECTED AREAS IN EDE

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Abstract: The poultry litter and its effect on the quality of groundwater is now the focus of attention as one of its devastating effects is groundwater pollution, the impair water qualities and ecological communities. This research paper evaluates the effects of poultry litter on underground water in Ede (Ogberin, Agbale and Okeyidi) Osun state Nigeria. Samples of groundwater around the poultry farms (both upstream and downstream) at the study area were taken and laboratory analysis (physic-chemical and bacteriological analysis) was done. The result of these analyses shows that the water within the poultry farms is polluted as a result of poultry activities. Parameters such as pH, Total Solids, Alkalinity, Total Hardness, Turbidity, Magnesium Hardness, Chloride Ions, Nitrate Nitrogen, Copper, Conductivity, and Carbonate were on the rise at the downstream, while Dissolved Oxygen shows decrease in value at the downstream. The Conductivity value of AGD was 1320 µs/cm which is as a result of the dissolved salt present in the poultry waste. Also, high level of coliforms 180+ indicates that the poultry waste has negative effect on the underground water near the farm and this make the water not to be safe for drinking. Since most poultry waste are solid wastes, effective management of solid waste should be topmost priority and should be one of the requirements for the granting of license to poultry farmers, while provision of special dumpsite for poultry farms should be established.

Keywords: Coliform, Conductivity, Downstream, Groundwater, Poultry Litter, Upstream.

1.0 INTRODUCTION

Between 1961 and 2019, the world's poultry production rose rapidly from 9 to over 100 million tons (FAO, 2020; USDA, 2020). In 2018, 46% of the world's poultry meat was produced in the United States, Brazil, and China (ABPA, 2019); Nigeria is not left behind in this sharp increase.

The poultry business is expected to experience the fastest increase in both worldwide meat production and consumption of any livestock sector (USDA Agricultural Projections to 2027, 2018). This experience will result in massive amounts of animal waste (poultry litter), which calls for their proper management to prevent problems with water quality (Chakraborty and Prasad, 2021).

Along with the increase in chicken meat and egg production, poultry litter production also tends to increase. Poultry litter raises soil pH and can introduce contaminants into agricultural settings, such as veterinary medications, particularly antibiotics used as growth promoters (Parente *et al.*, 2021). Water, on the other hand, is the natural resource that is most important to human existence; without it, nothing would survive on the planet. Most of the water that is readily available in consumable forms comes from the earth, springs, rivers, and lakes (Elemile et al., 2019).

When rainwater penetrates the soil surface, it results in underground water. It might also happen as a result of surface water percolating into the soil. When rain hits the ground, the water does not continue to flow; instead, some of it penetrates into the ground while others evaporate and return to the atmosphere or travel along the surface to streams or lakes. It is evident that water will infiltrate into the spaces between sand grains when a glass of water is poured onto a heap of sand. According to science, groundwater is located in the voids and fissures of the rock, sand, and soil. It flows slowly through aquifers, which are layers of rock, sand, and soil

(Modish, 2020). While human activities have an impact on natural water sources, including groundwater, the amount of physical impurities, dissolved gases, chemicals, and pathogens in a particular sample of water is referred to as its quality. One such practice is the careless location of poultry in residential areas in underdeveloped nations (Elemile *et al.*, 2019).

Because it provides over 180 million people with food and nutrition in the form of eggs and meat as well as numerous jobs in Nigeria, the agricultural sector is a crucial component of the livestock business. The siting of poultry farms is not regularly checked and supervised, however, because the majority of poultry farms in Nigeria were inadequately designed and lack infrastructure for the handling of poultry solid waste and wastewater. Sewage sludge, poultry waste, runoff from dairy farm feedlots, grazed pastures, fallow and sod modified with chicken wastes, and grassland treated with dairy manure can all contaminate water bodies. The ecosystem and general public health are seriously endangered by these contaminants (Elemile *et al.*, 2019).

One of Nigeria's most rapidly expanding agro-based sectors is the poultry sector, which can be ascribed to rising demand for poultry meat due to its acceptance and reduced cholesterol level. But the biggest issue facing the chicken industry is the massive buildup of wastes, which, if not properly managed, could be a source of groundwater pollution and other environmental health issues. When poultry are located near residential areas, the situation is made worse because the manure is dumped in gullies, where rainwater washes it downhill and contaminates neighboring streams and groundwater. The water appears drinkable and suitable for eating, thus locals are unaware of the health problem, because the waste water from the poultry operations later percolates into the soil and into the aquifer, shallow wells in this area are vulnerable to contamination. It will be useful to analyze the water quality around poultry in residential areas to assess the consequences on the health of locals who solely rely on well water for drinking and other home needs (Elemile *et al.*, 2019).

The primary cause of mortality and morbidity worldwide is water-related illnesses. These diarrheal illnesses are believed to have killed 1.8 million people annually. Depending on the characteristics of the pollutant, drinking polluted water can have either a chronic or acute effect. (Edward, 2016).
While long-term potential impacts have been connected to cancer and heart disorders, some of the frequent issues caused by drinking unsafe water include but are not limited to gastrointestinal issues, diarrhea, nausea, aches and pains in the stomach or intestines, and intestinal cramping. (Edward, 2016). An excessive amount of waste has been produced as a result of an increase in poultry production brought on by a surge in demand for meat, eggs, and other poultry products. Major problems include the rise in poultry production, its geographic spreading, and potential environmental effects (Abioye *et al.*, 2022).
Due to poor management, poultry waste causes major environmental risks, such as eutrophication, water contamination, and odors. (Ezekoye *et al.*, 2017). Groundwater could be accessed through hand-dug well which according to Orebiyi *et al.* (2010), depending on where groundwater is located, shallow wells with diameters ranging from 0.9 to 1.8 m and depths ranging from 4.5 to 10m.

Poultry feces can contaminate water due to poor waste management through seeping through the soil, runoff, and sites where wastes have been stored for a long time (Abioye et al., 2022). Large flocks of farm-raised birds may generate an excessive amount of waste to be discharged (Ezekoye *et al.*, 2017). Environmental pollution is usually caused by large amounts of poultry waste. The quality of surface and groundwater has decreased as a result of these, which constitute a serious risk (Abioye et al., 2022). The location of poultry farms is not regularly observed and controlled as should be the case. Most poultry farms in Nigeria lack the infrastructure necessary for the efficient treatment of poultry waste and wastewater.

The majority of people in underdeveloped nations think that because water appears to be clean to the naked eye, it has no impact on their health. This study, therefore, wishes to evaluate the potential effect of poultry litter on groundwater in Ede through the shallow wells to determine the portability of well water. To achieve this, groundwater samples were collected close to the poultry farm and taken to laboratory for analysis. The testing covered a wide range of parameters, including bacteriological, chemical, and physical quality.

2.0 MATERIALS AND METHOD

Groundwater samples were collected from six different points at three different locations (Agbale, Ogberin and Okeyidi), within Ede Township in Osun state. Samples of the water were taken from the neighboring wells close to the poultry at both upstream (slightly elevated and a bit farther away to the poultry) and downstream (closer to poultry farm), at a minimum depth of 15m. Clean, 5 liter plastic bottles with tightfitting closures were used to collect the samples, which were then taken to the lab for analysis. The samples were labeled as AGU, OGU and OKU for the upstream of Agbale, Ogberin and Okeyidi respectively, while AGD, OGD and OKD were for the downstream of Agbale, Ogberin and Okeyidi respectively. The poultry distances to the wells were 40.4m and 37.1m for AGU and AGD respectively. The OGU and OGD were 49 m and 40 m respectively, while OKU and OKD were 30.9 m and 30.2 m respectively. The physico-chemical test and bacteriological test were carried out on the samples at Osun State Water Corporation Central Laboratory, Ede.

3.0 RESULTS AND DISCUSSION

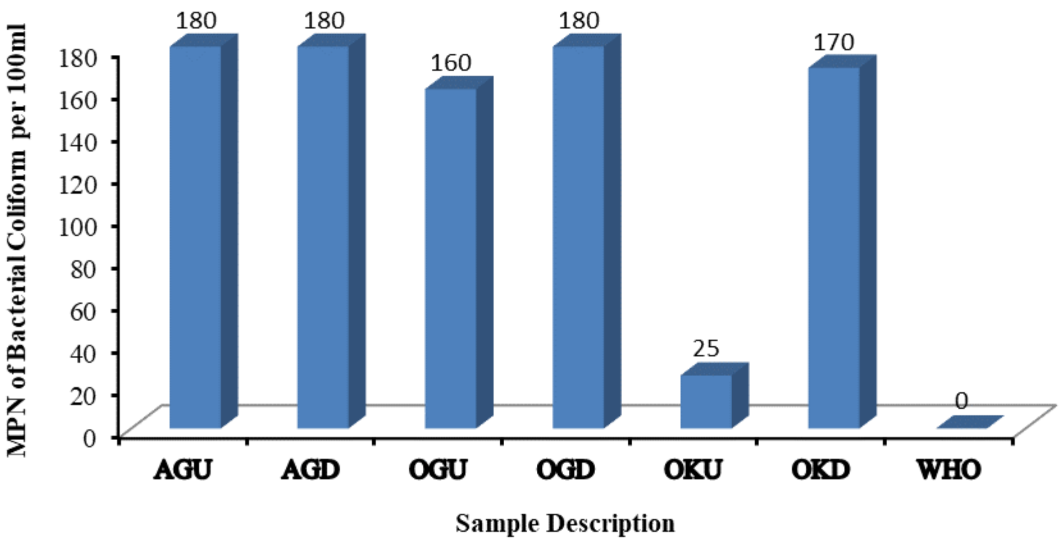
All of the water samples' biological and physico-chemical characteristics were examined and presented in Tables 1 and 2. It could be deduced from the Tables 1 and 2 that the poultry waste contributed to the physico-chemical and biological properties of the well water even though, naturally, the composition of well water tends to be different due to the soil properties at the capillary fringe, so with this in mind, the distance between the wells was ensured to not greater than 60 m.

Table 1: Bacteriological Results of Upstream and Downstream

Sample Description	Colonies Per CC Growing on Nutrient Agar at 37^0C in 24hrs	Presumptive Result of Bacterial Coliform Organism at 48hrs of Incubation			Most Probable Number of Bacteria Coliform per 100ml of water sample
		50 ml	10 ml	1 ml	
AGU	94	1	5	5	180+
AGD	56	1	5	5	180+
OGU	105	1	5	4	160
OGD	72	1	5	5	180+
OKU	104	1	5	0	25
OKD	87	1	5	4	170

3.1 The Total Coliforms

The total coliform's values using most probable number (MPN) of bacteria coliform as shown in Table 1 ranged between 25 and 180+ MPN cfu/100mL with the water samples from AGU, AGD and OGD have the highest values while OKU had the lowest value. These values were lower than the values reported by (Elemile *et al.*, 2019; Abioye *et al.*, 2022). The presence of coliform suggests that the excrement from poultry may have contaminated the water supply. According to Fig. 1, the readings were all higher than the WHO norm of zero.



1.

2. **Fig. 1:** Total Bacteria Coliform result of Water Samples

Table 2: Physico-Chemical Results of Upstream and Downstream

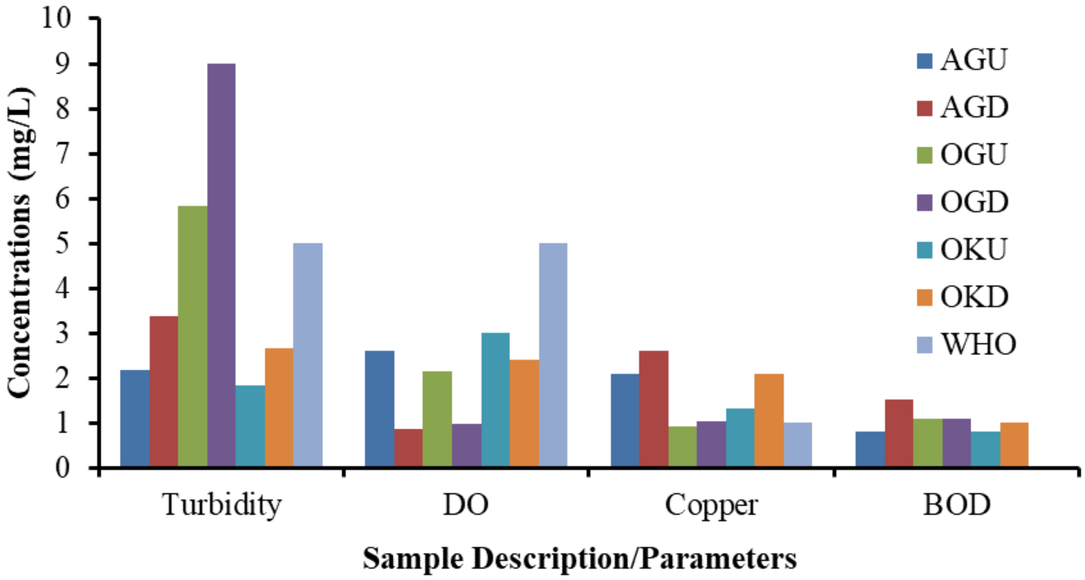
Parameters	Samples					
	AGU	**AGD**	**OGU**	**OGD**	**OKU**	**OKD**
Appearance	Clear	Clear	Clear	Clear	Clear	Clear
Colour	10	15	25	20	5	9
Taste/Odour	UO	UO	UO	UO	UO	UO
pH at Lab	7	7	6.4	6.9	6.3	6.8
Turbidity	2.18	3.38	5.84	9.0	1.84	2.67
Dissolved Oxygen	2.6	0.88	2.16	0.97	3	2.4
Temperature	27	27.1	26.6	27.2	23.4	25.6
Total Alkalinity	122	250	80	214	87	101
Total Hardness	160	236	74	288	135.3	253
Calcium Hardness	24	18	14	140	53.4	53
Calcium Ions	9.6	7.2	5.6	56	10.4	21.6
Magnesium Hardness	136	218	60	148	167.81	212
Magnesium Ions	34	54.5	15	37	43	53
Chloride Ions	51.5	61	26.5	72	46	47
Nitrate	0.014	0.26	0.018	0.09	0.012	0.21
Copper	2.1	2.6	0.93	1.04	1.34	2.1

Conductivity	1282	1320	719	218	1171	1031
Carbonate	122	236	74	214	89.8	236
Bicarbonate	183	866.2	122	329.4	194.3	234
COD	0	15	0	0	0	7
BOD	0.8	1.52	1.1	1.09	0.8	1.01
Total Filterable Solids	0.63	0.48	0.51	0.47	0.43	0.48
Total Non-filterable Solids	363.3	377.3	207.6	636.5	298.8	315

UO – Unobjectionable

3.2 Copper

The copper concentration ranged from 0.93 to 2.6 mg/L, with the highest value being 2.6 mg/L in the water sample from AGD, and OGU have the lowest value of 0.93 mg/L. Only the OGU value was below the 1.0 mg/L Standard Permissible Limit; all other values were over the limit. High copper levels have reportedly been linked to persistent anemia (Iqbal et al., 2011). There were increases in the values of the copper at the upstream as shown in Fig. 2, which is an indication of the contamination from the poultry waste. By directly contaminating well water or through the rusting of copper pipes and components, copper can pollute drinking water.



3.

4. **Fig. 2:** Turbidity, Dissolved Oxygen (DO), Copper and BOD of Water Samples

3.3 Magnesium

Magnesium ion concentrations ranged from 15 to 54.5 mg/L, with the water sample from AGD having the highest value at 54.5 mg/L and the sample from OGU having the lowest value at 15 mg/L. Only the OGU result was below the 20 mg/L WHO acceptable limit, while all other samples were over it. Significant variations in the magnesium ion values between upstream and downstream are an indication of contamination; According to reports, water hardness may be caused by high magnesium levels (Chukwu, 2008).

3.4 Nitrate

The range for the nitrate concentration was 0.26 to 0.012 mg/L, with the greatest value (0.26 mg/L) found in the water samples from AGD and the lowest value found in the OKU. The values were less than those found in the study conducted by Abioye et al (2022), despite the fact that the readings were under the 50 mg/L WHO acceptable limits. It has been observed that excessive concentrations of nitrate and phosphate could cause eutrophication; therefore, the increase in the nitrate ions values at the upstream suggests that contamination from poultry waste is increasing the nitrate ions (Adeolu et al., 2016).

3.5 Calcium

The calcium value ranged from 56 to 5.6 mg/L, with OGD water samples having the highest value of 56 and OGU water samples having the lowest value. In comparison to the values from the study conducted by Elemile et al. (2019), the OGD and OKD values were greater, although the results were under the 75 mg/L WHO acceptable limits, but it should be noted that there was significant difference between the upstream and downstream, a sharp increase.

3.6 Chloride

The range for the chloride value was 72–26.5 mg/L, with the highest value 72 mg/L found in water samples from OGD and the lowest 26.5 mg/L found in samples from OGU. Groundwater contamination from sewage can be detected using chlorides; other causes include stormwater carrying road salts, landfill leachates, septic tank waste fluids, artificial fertilizer use, and animal feeds (Igbinosa and Uwidia, 2018). Each value is within the WHO-acceptable range of 250 mg/L. Although chloride ions are safe at low quantities, well water with high chloride ions concentrations could harm plants if used for irrigation or gardening, and it could also impart an objectionable taste to drinking water if drunk (WHO, 2004).

3.7 Dissolved Oxygen (DO)

The range for DO was 3 to 0.88 mg/L, with water samples from the OKU having the highest value (3 mg/L) and AGD having the lowest. The values were greater than those from a comparable study on poultry waste conducted by Abioye et al. (2022). As shown in Fig. 2, there is a decrease in the DO level in ground water at downstream and an increase in the DO level at upstream, which denotes contamination from poultry waste. The WHO standard of 5.0 mg/L is met by all of the samples.

3.8 Chemical Oxidation Demand (COD)

The COD value ranged from 15 to 0 mg/L, with the water sample from AGD having the highest value (15 mg/L), and all other samples have 0 mg/L, with the exception of OKD, having a value of 7 mg/L. The results were less than those from a research by Abioye et al. (2022), which tracked comparable characteristics in shallow wells near poultry farms. Only AGD and OKD had COD values, which indicated the presence of chemical oxidants in the water at those locations despite the values being within the WHO-permitted limits of 1000 mg/L.

3.9 Biological Oxidation Demand (BOD)

The BOD value ranged from 1.52 to 0.8 mg/L, with the AGD water samples having the highest value at 1.52 mg/L and the AGU and OKU water samples having the lowest values. This may be due to the organic content present in the poultry litter thereby causing pollution of the groundwater around the poultry farm. Though, the values were above the WHO allowed limits of 0.0 mg/L but were lower when compared to the work of Abioye et al. (2022).

3.10 Total Hardness

According to the results of the analysis, OGD and OGU had the highest and lowest values, respectively, and the total hardness ranged from 288 to 74 mg/L. All values were over the 150 mg/L WHO acceptable limits, with the exception of OGU and OKU.

3.11 Turbidity

With OGD having the greatest value and OKU having the lowest value, the turbidity ranged from 9 to 1.84 NTU. When compared to the higher values reported by Abioye et al. (2022), the values were lower. Only OGD and OGU have values above the WHO limit of 5 NTU, others were below the limit. It was noted that there was an increase in the turbidity values at the downstream, an indication of pollution.

3.12 Conductivity

Electrical conductivity values ranged from 1320 to 218 µs/cm, with AGD having the highest value at 1320 µs/cm and OGD having the lowest. This is a measurement of the total dissolved substitution and dissolved ionic component in water (Yilmaz and Koc, 2014). Only OGU and OGD were below the limit; all other conductivity values were over the WHO maximum allowed limits of 1000 µs/cm. As a result of the high quantity of salts dissolved in the water, the results showed that the water samples are salty. Consuming water with values over the permitted limits over time has detrimental effects on human health since it can disrupt endocrine functioning and result in total brain damage (Yogendra and Puttaiah, 2008).

4.0 CONCLUSION AND RECOMMENDATION

This study showed how the quality of groundwater near poultry farms might be impacted by the poultry waste. When compared to those on slightly elevated wells (upstream), the water from shallow wells near farms (downstream) was of poor quality and below the acceptable standard, which is a sign that it is unfit for drinking. For sustainability and continued appropriateness, better water resource management is urgently required. Water purification procedures are vital in areas close to poultry farm sites, and shallow wells should be lined and placed upstream far from poultry farms. Additionally, further analysis work for adequate testing of the tested wells should be done. Since most poultry waste are solid wastes, effective management of solid waste should be topmost priority and should be one of the requirements for the granting of license to poultry farmers, while provision of special dumpsite (where the waste can be converted to manure for other agricultural purposes) for poultry farms should be established.

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