## CAFEi2012-196

# POULTRY WASTE EFFECTS ON SHALLOW GROUNDWATER QUALITY IN SELECTED FARMS IN MINNA, NORTH-CENTRAL NIGERIA.

[1, 4*]Adeoye, Peter Aderemi, [1]Hasfalina, Che Man, [1]Mohd Amin Soom, [2]Thamer Ahmad Mohammed and [3]Christopher Oluwakunmi Akinbile.

[1] Department of Biological and Agricultural Engineering, University Putra, Darul Ehsan, Selangor, Malaysia.
[2]Department of Civil Engineering, University Putra, Darul Ehsan, Selangor, Malaysia.
[3]Department of Agricultural Engineering, Federal University of Technology, Akure, Nigeria.
[4]Department of Agricultural and Bioresources Engineering, Federal University of Technology, P.M.B. 65 Minna, Nigeria.
Email: has@eng.upm.edu.my

## ABSTRACT

Provision of adequate and potable water for both rural and urban dwellers should be seen as a necessity by policy makers. However, this is not so in the developing nations where rural dwellers and farmers living on farms are neglected or forgotten whenever water supply schemes are being contemplated. This study assessed the impacts of poultry waste dumps on shallow groundwater qualities in twenty poultry farms in Minna, North central Nigeria. Twenty wells were assessed within the twenty farms with respect to their distances from the waste dumps. Water samples were collected from the wells and analyzed. Parameters analyzed were pH, electrical conductivity, total dissolved solids, turbidity, phosphate ion, phosphorus, ammoniacal nitrogen, nitrate nitrogen, nitrite nitrogen, total coliform, faecal coliform and faecal streptococci. Results show that physico-chemical parameters of 60% of the sampled well water except pH and temperature were not within the limit recommended by the World Health Organization (WHO) and Nigerian Drinking Water Quality Standards. Micro-biological parameters of the water samples were also present at elevated values of about 80% of the sampled shallow wells which is an indication of faecal contamination and high probability of disease pathogen in water. Data from the bacteriological analysis of the water samples were regressed with distance between the poultry waste dumps site and the sampled wells. The resulting equations with regression coefficient, $R^2$ of 0.91,0.95 and 0.99 was evaluated to establish the minimum safe lateral distance between poultry waste dumps and the shallow wells in the study area. A minimum distance of 11m was found to be adequate in Minna for zero value of microbiological parameters in the shallow wells. The shallow water table of the area and high hydraulic conductivity of the soil exacerbated the pollution potential from the poultry waste dumps in the farms.

***Keywords:*** *groundwater monitoring, poultry waste dumps, physico-chemical parameters, contamination,*

## INTRODUCTION

The need for agricultural development to satisfy food requirements for ever increasing world population has of late become inevitable [1]. It is very common to see poultry, dairy, abattoir and other small agro- allied factories springing up every day. This development, though very commendable, brings with it the generation of huge solid and liquid wastes. The way and manner these wastes are managed is a source of concern to both Environmental and Agricultural Engineers specializing in Soil and Water Conservation. Some measures taken by the government to prevent surface water pollution but little or no attention is given to groundwater pollution effect of these agricultural wastes which have the capacity to cause cancer-related ailments. They can also have mutagenic properties if allowed to accumulate in the body system of the people using this water for their domestic and industrial needs [1]. Groundwater is the main source of potable water; it is an important source of drinking water for more than half of Nigerian population and nearly all its rural population. It could be delivered to the ultimate consumer raw without expensive treatment but highly susceptible to anthropogenic pollution because of over-estimation of protection and purifying functions of the top soil layers especially in areas with extensive land use and vulnerable groundwater. Widespread reports of bacteria, nitrate organic chemicals and other pollutants in groundwater have therefore increased public concern about its quality [2, 3]. [4] observed that the risk of groundwater contamination is determined by the relative rates of degradation within the soil profile, climate, soil properties, farming activities and aquifer depth. Seepage losses from animal waste can affect groundwater quality if not properly sited, designed and constructed.

Poultry industry is one of these largest and fastest growing agro-based industries in Nigeria. This may be attributed to increased demand for poultry meat mainly due to its acceptance and low cholesterol content [5]. However, a major problem facing the poultry industry is the large scale accumulation of wastes which may pose groundwater pollution and other environmental problems if not properly managed. Components of Poultry litter include the bedding material, feather manure and spilt feed. Composition of poultry manure and litter have been shown to vary widely as a function of poultry types, diet and dietary supplements, litter type, handling and storage operations. But the average percentage is estimated to contain 32.8g/kg of nitrogen, 10.8g/kg phosphorus, 15.2g/kg potassium, 18.5g/kg calcium, 6.2g/kg magnesium and 8.5g/kg sulphur [6]. Nitrates and fecal bacteria are two important contaminants associated with agriculture [7]. Consumption of water containing nitrates at level higher than 50mg $NO^{3-}$ /l can lead to methaemoglobinemia or blue baby syndrome in infants and in the long term may be potentially carcinogenic for human beings. Although relatively non-toxic, nitrate may be reduced by bacteria to nitrite in the intestines of newborn infants and cause serious damage. It can also react with amines in the human body to form N-nitrosamines, an inorganic chemical known to induce tumors in animal and can be linked to human cancers [8, 9]. In general terms, the area where groundwater contamination by nitrate is highest is heavily populated area with large poultry and dairy industries as leachate from bird droppings can contribute significantly to nitrate-nitrogen contamination of soil and groundwater, Faecal coliforms on the other hand are also important parameters to consider when assessing the potability of water because of the infectious disease risk. It indicates contamination by mammals and bird waste and signifies the possible presence of pathogenic bacteria and viruses which are responsible for water related diseases [10].

Minna is a city in arid zone of Nigeria. The city is rapidly developing due to its proximity to Abuja, the Federal Capital. This is bringing with it rapid increase in the number of poultry farms. The workers in these farms and people living nearby depend largely on shallow wells for their water needs. Over the years, water from these shallow wells can be contaminated by wastes from poultry waste dumps. There has been irregular monitoring of quality of water from boreholes and shallow wells within these poultry farms with more focus on boreholes. Information on water quality in these shallow wells in Minna has generally been lacking. The potability of dug well water is largely dependent on the concentration of biological, chemical and physical contaminants as well as environmental and human activities [11]. Evidence from literature [3,12,13] indicate that most previous studies on groundwater quality in Minna centred more on effect of leachate from domestic waste dump sites with little or no reference to other on-site sanitary conditions especially the impact of on-farm poultry waste dump. Most farmers live inside the farms; therefore their health condition is very vital to continued food production and economic sustainability. This study was therefore aimed at assessing the effect of proximity of poultry waste dumps to shallow wells inside selected poultry farms on shallow groundwater quality; to determine the minimum lateral distance between the poultry waste dumps site and shallow wells that will guarantee water potability and to recommend appropriate intervention measures aimed at enhancing groundwater protection inside the farms.

## MATERIALS AND METHODS

The study area is Minna, capital of Niger State, North Central Nigeria. It is located on $9^0$ $36'$ $50''$N and $6^0 33' 25''$E, The town has a population of 502,000. Rainfall of 1312mm, maximum temperature $37^0$C and minimum temperature of $19^0$C.Maximum sunshine hours of 9.2. Figure 1. The city has about 43 large scale and 74 medium and small scale poultry farms. (Ministry of Agriculture and rural development, Niger State).The soil in Minna is generally sandy with a shallow water table of between 5 meters in the Northern side and a maximum of 13 meters in the Southern side. The inhabitants of the city depend majorly on groundwater for their domestic activities, with more focus on shallow wells because of shallow water table in the area and the ease and cheap methods of shallow well construction.

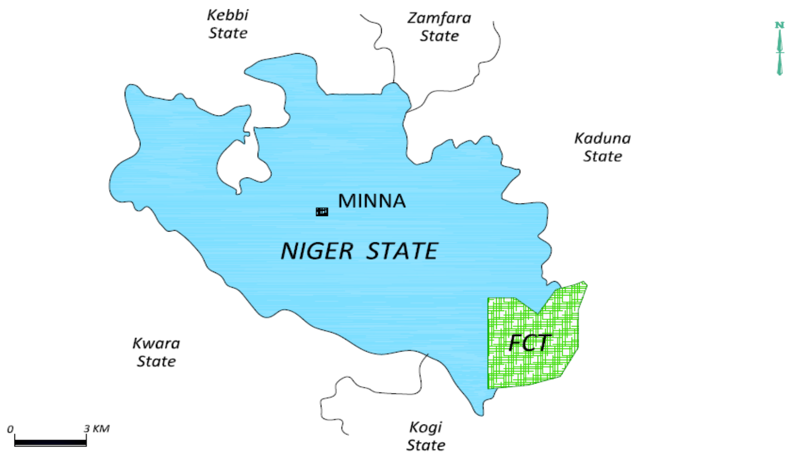


Fig. 1: Map of Niger State showing Minna.

**Methods of Sample Collection and Analysis**

Twenty poultry farms within Minna (figure 2) were selected for this project and water samples were collected from twenty (20) shallow wells within these farms. To eliminate any stagnant water which could have been in the well for long time, water was pumped from sampled wells to waste for 90 seconds after which sampled bottles were rinsed with source water to minimize risk of external contamination before sampling. The sample bottle was then held by a metallic bottle holder and plunged into the well to a depth of 0.3 to 0.5m below the water level to draw water sample [2]. Some physical parameters like turbidity, pH, Temperature, Total dissolved solids and Electrical conductivity assessments were done in-situ with Jenway M470 portable conductivity/TDS meter and Ohaus S2000 bench pH/ Temperature meter respectively. Samples were collected in sterilized bottles and then stored inside ice block to maintain a temperature of below $4^0$C from the point of collection to laboratory where chemical and microbiological analyses were done. For Chemical analysis, Hach DR colorimeter was used with reagent pillow of Phosper 5 for phosphate analysis while Nitriver 3 and Nitriver 5 were used for nitrite and nitrate analysis respectively. Membrane filtration technique was used for bacteriological analysis. A measured volume of the water sample was filtered through a membrane and after one hour recovery period, membrane was then incubated on Slantez and Bartley media at $37^0$C and $45^0$C for 24hours for faecal and total coliform respectively and on Lauryl Sulphate broth (MLSB-OXOID MM0616) at $45^0$C for 48hours for Faecal streptococci. Tests were carried out in triplicate and the results averaged to minimize experimental errors. Wells physical conditions like well depth to water, depth to bottom, diameter, distance to poultry waste dump site, age of the well, pump type, type of lining and cover and headwall height were also assessed. Simple regression analysis was used to determine the minimum distance between poultry waste dumps and shallow wells, while correlation analysis was carried out using SPSS 15.0 to establish inter-element relationships among the water quality parameters investigated.

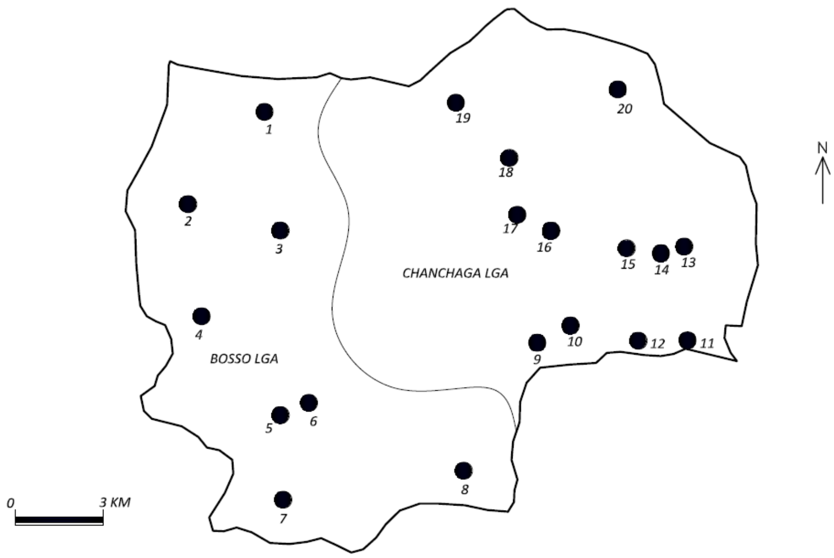


Fig. 2: Map of Minna showing the Poultry farm Wells Sampled.

**Legend**

Nabill farms, 2-,Na- Adama farms, 3- FUT Minna Farms, 4- Niger State pilot Farms, 5-Limawa farms ,6- Joe Farms, 7- Jumik farms, 8- IK farms, 9- Natti Farms, 10-,Jamil Farms, 11- Jumra Farms, 12- Mil Farms, 13- Al- Amin Farms, 14- Bache Farms, 15- Abu Turab Farms, 16- Abdulahi farms, 17- Sarki yakin farms, 18- Nanas Farms, 19- Jamilla Ville Farms, 20- El-Kareem farms.

## RESULTS AND DISCUSSIONS

The grid coordinates of the sampled wells and other parameters are shown in Table 1. From this information, it was evident that the wells conditions were poor. All the wells are shallow with the deepest having 10meters.This shallow water table gave rise to surface/groundwater interaction. Eleven of these hand dug wells are not lined, eight not covered, eighteen are neither having headwalls nor the height not up to 1m recommended by the World Health Organisation (WHO). Coupled with all these is their proximity to poultry waste dump making the water to be susceptible to high degree of contamination from the dumps.

**Phosphates and Nitrates**

Phosphates may enter the groundwater from phosphate containing rocks, fertilizers or percolation of sewage and animal waste. The WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) standard for phosphates in drinking water is 0.1 mg/l and 0.3mg/l respectively. About 65% of well sampled are having their phosphate values higher than this figure. Usually groundwater contains only a minimal phosphorus level because of the low solubility of native phosphate minerals and the ability of soils to retain phosphate as it percolates. Phosphates are not toxic to people and animals unless they are present in very high level. Digestive problem may occur from high level of phosphate. It does not have notable adverse health risk, however, phosphate level greater than 0.3mg/l may interfere with coagulation in water treatment plant and as a result organic particles that harbor microorganisms may not be completely removed [14]. Nitrate is a nitrogenous compound that when it is in excess in drinking water can cause reduction of oxygen capacity of blood, shortness of breath and blueness of skin. The Nigerian Standard for Drinking Water Quality has set 10mg/L for Nitrate. It has a WHO guideline value of 50 mg/l and if exceeded, it is regarded as one of the causes of methaemoglobinaemia (Blue Baby Syndrome) in infants as well as a potential risk of stomach cancer in adults [15]. High concentration of nitrate in both surface and shallow groundwater can probably be due to poor sanitation, fertilizer and other agrochemical use and proximity to animal waste dump. From Table 2, the nitrate values of 50% of the well sampled outside WHO recommended limit while 75% exceeded the standard value by NSDWQ.

**Turbidity and Conductivity**

Turbidity in drinking-water is caused by particulate matter that may be present from water source as a consequence of inadequate filtration. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective. Turbidity is also an important parameter in process control and can indicate problems with treatment processes, particularly coagulation, sedimentation and filtration [16]. No health-based guideline value for turbidity has been proposed; however, it should be below 0.1 NTU for effective disinfection [16]. Table 3 showed that turbidity value was higher than recommended values in 75% of the well sampled. This therefore suggests that some form of primary treatment like flocculation and coagulation need to be carried out on the water source before any disinfection treatment could be carried out. The high levels of conductivity observed in about 55% of the wells sampled could possibly explain the corresponding high values of total dissolved solids (TDS) observed in the water samples. It could be adduced that the nitrate from the wastes dumps are responsible for the high conductivity values since conductivity is a measure of dissolved ions which is similar to those of nitrate ions. This result is consistent with those reported by [17].

**Bacteriological parameters**

Coliforms are most important parameters to consider while assessing suitability of water because of infectious disease risks. They indicate contamination by birds and mammals faeces and signify the probable presence of pathogens which are responsible for water –related diseases. From Table 3, more than 80% of the wells sample are having faecal and total coliforms more than values recommended by WHO and NSDWQ of zero and ten coliform forming units/100ml (cfu/100ml) respectively. This clearly suggests that the wells are highly contaminated with a high possibility of pathogens presence in the water.

e-ISBN 978-967-960-322-4

Table 1: Summary of the Conditions of the Wells Sampled

| | Name of Farms | Depth to water (m) | Depth to bottom (m) | Diameter (m) | Distance from dump (m) | Age (yrs) | Lining | Cover | Headwall height (m) | Coordinate Easting | Northing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Abu Turab | 6.8 | 8.2 | 1.0 | 8.0 | 5 | No | Steel | 0.8 | 235479 | 1053821 |
| 2 | Al-Amin | 4.4 | 5.2 | 0.94 | 3.3 | 5 | No | No | No | 237008 | 1058111 |
| 3 | Bache | 4.4 | 7.8 | 0.84 | 4.9 | 5 | Stone | No | No | 238559 | 1058154 |
| 4 | El-kareem | 4.7 | 6.1 | 0.92 | 4.9 | 6 | Stone | Steel | 0.74 | 240883 | 1066193 |
| 5 | FUT Minna | 5.2 | 7.3 | 0.96 | 7.1 | 14 | Concrete | No | 0.78 | 228757 | 1067787 |
| 6 | I K | 4.6 | 7.8 | 1.1 | 4.3 | 6 | No | Steel | 0.42 | 226249 | 1057999 |
| 7 | Jamilla ville | 6.0 | 10.0 | 1.0 | 11.6 | 13 | Concrete | Steel | 0.81 | 229947 | 1060036 |
| 8 | Jamil | 2.4 | 7.0 | 1.0 | 30 | 3 | Concrete | Steel | 0.94 | 228423 | 1057942 |
| 9 | Joe | 3.6 | 5.4 | 1 | 4.6 | 7 | No | No | No | 223890 | 1058098 |
| 10 | Jumik | 6.2 | 7.3 | 0.94 | 6.8 | 4 | Concrete | Steel | 1.2 | 225805 | 1058309 |
| 11 | Jumra | 3.5 | 6.1 | 0.9 | 6.0 | 5 | Concrete | No | 0.67 | 226432 | 1068632 |
| 12 | Limawa | 3.1 | 5.2 | 1.0 | 5.6 | 2.5 | No | Wood | 0.51 | 223413 | 1057257 |
| 13 | Na Adama | 4.0 | 7.0 | 1.0 | 5.6 | 6 | No | No | 0.26 | 226714 | 1067111 |
| 14 | Nabil | 5.1 | 6.1 | 0.98 | 3.6 | 6 | No | Wood | 0.53 | 226747 | 1068918 |
| 15 | Nanas | 3.1 | 5.6 | 1.0 | 3.2 | 10 | No | No | No | 238897 | 1065620 |
| 16 | Natti | 3.8 | 7.4 | 1.0 | 4.1 | 10 | No | No | 0.56 | 229984 | 1065620 |
| 17 | Niger | 2.9 | 6.5 | 0.9 | 3.3 | 10 | Concrete | Steel | 1.0 | 229625 | 1067548 |
| 18 | Sarkin Yakin | 6.6 | 9.4 | 1.0 | 18.2 | 3 | No | Wood | 0.71 | 236010 | 1066047 |
| 19 | Mil | 1.5 | 3.4 | 0.8 | 8 | 3 | Precast | Steel | 0.68 | 231262 | 1059416 |
| 20 | Abdullahi | 3.5 | 7.8 | 1.0 | 9.0 | 7 | No | Wood | 0.81 | 238452 | 1065101 |

Table 2: Chemical Drinking Water Data for the Wells Sampled

| Well names | $PO_4^-$ mg/l | Phosphorus mg/l | $P_2O_5$ mg/l | $NO_2$ mg/l | $NO_2$-N mg/l | $NO_3$ mg/l | $NO_3$-N mg/l | $NH_3$-N mg/l | $NH_4$-N mg/l |
|---|---|---|---|---|---|---|---|---|---|
| Na- adama | 12.7±3.26 | 2.65±0.84 | 0.887±0.006 | 0.593±0.604 | 6.613±5.361 | 153±3.35 | 91±0.8 | 1.17±0.02 | 0.593±0.305 |
| Nabil | 2.66±0.63 | 5.35±3.35 | 0.411±0.263 | 2.21±0.39 | 0.037±0.015 | 66.3±13.5 | 78.2±11.9 | 1.37±0.14 | 0.69±0.497 |
| Nanas | 4.25±0.06 | 8.58±0.32 | 0.253±0.031 | 6.73±0.955 | 0.783±0.172 | 111±34.3 | 60.6±16.9 | 11.7±5.12 | 0.69±0.07 |
| Joe | 7.66±0.31 | 2.72±0.22 | 0.95±0.306 | 23.8±2.007 | 13.93±2.274 | 189±2.88 | 106±4.84 | 14.3±1.19 | 16.53±1.793 |
| Jumik | 1.87±0.93 | 0.77±0.18 | 0.327±0.076 | 1.403±0.081 | 0.657±0.04 | 9.39±2.75 | 3.54±0.21 | 1.6±1.5 | 0.623±0.293 |
| Jumra | 1.46±0.5 | 0.74±0.42 | 0.803±0.152 | 3.5±0.173 | 2.39±0.036 | 15.3±2.95 | 32.7±2.22 | 3.4±0.62 | 5.583±0.329 |
| Limawa | 2.68±0.88 | 2.32±1.93 | 2.493±0.16 | 3.553±1.812 | 0.84±0.185 | 80.3±3.64 | 48.1±2.52 | 6.83±0.57 | 4.263±0.134 |
| Natti | 4.66±1.79 | 3±0.26 | 0.063±0.021 | 11.27±0.94 | 8.755±1.445 | 121±6.11 | 60.9±0.71 | 2.38±0.11 | 3.7±0.429 |
| Niger | 6.72±1.81 | 5.98±0.34 | 3.493±0.247 | 1.165±1.26 | 0.17±0.026 | 18.2±2.78 | 27.1±3.29 | 0.93±0.06 | 0.585±0.153 |
| Sarkin Yakun | 0.3±0.14 | 0.79±0.59 | 0.007±0.012 | 0.01±0.01 | 0.142±0.12 | 1.27±0.42 | 0.83±0.4 | 0.42±0.31 | 0.461±0.48 |
| MIL | 0.29±0.03 | 0.22±0.11 | 0.04±0.017 | 0.653±0.032 | 0.273±0.021 | 20.9±0.64 | 11.1±0.26 | 1.52±0.27 | 1.453±0.516 |
| EL- kareem | 0.07±0.03 | 0.43±0.32 | 0.632±0.018 | 11.4±0.2 | 16.33±1.537 | 129±2.68 | 53.2±2.63 | 5.45±0.15 | 6.55±0.473 |
| FUT Minna | 1.5±0.59 | 0.77±0.18 | 0.045±0.023 | 16.3±0.794 | 17.2±4.951 | 39.7±3.55 | 35.5±5.97 | 4.02±2.24 | 4.52±1.394 |
| IK | 6.57±0.3 | 3.12±0.62 | 1.733±0.858 | 17.76±0.925 | 22.28±1.331 | 127±26.2 | 83±50 | 11.6±0.43 | 6.543±0.829 |
| Jamila Ville | 0.02±0.01 | 0.57±0.04 | 0.648±0.038 | 1.233±0.012 | 0.972±0.023 | 8.31±4.71 | 7.59±0.87 | 0.54±0.27 | 0.783±0.15 |
| Jamil | 0.02±0.02 | 0.62±0.31 | 0.065±0.006 | 0.93±0.066 | 0.81±0.079 | 1.89±0.06 | 3.32±0.1 | 0.29±0.17 | 0.38±0.14 |
| Abu Turab | 0.05±0.02 | 0.02±0.01 | 2.427±3.45 | 3.387±0.225 | 0.182±0.024 | 5.59±0.26 | 0.04±0 | 0.02±0.02 | 0.007±0.001 |
| AL- Amin | 0.58±0.02 | 1.75±0.04 | 1.28±0.096 | 14.17±0.902 | 16.03±0.751 | 98±1.44 | 68.2±3.75 | 5.41±0.71 | 1.753±0.131 |
| Bache | 0.16±0.04 | 0.53±0.11 | 0.387±0.093 | 15.13±5.644 | 23±1.493 | 100±12.7 | 67±2.14 | 0.64±0.14 | 0.94±0.05 |
| Abdulahi | 0.49±0.15 | 0.75±0.13 | 0.15±0.026 | 0.563±0.215 | 0.627±0.236 | 20.4±1.72 | 14.3±0.26 | 0.67±0.23 | 0.32±0.085 |

The results are presented in the form; mean of three replicates± standard deviation

Table 3: Physical and Bacteriological Data for the Wells Sampled

| Farm Names | PH | Turbidity (NTU) | Electrical Conductivity(µs/cm) | TDS (mg/l) | Temperature ($^{o}C$) | Faecal Coliform (cfu/100ml) | Total Coliform (cfu/100ml) | Faecal Streptococci (cfu/100ml) |
|---|---|---|---|---|---|---|---|---|
| Na- adama | 6.63±0.2 | 20.9±2.47 | 416.3±49.9 | 1720±133 | 33.4±0.8 | 192±3.79 | 766±149 | 114±3.61 |
| Nabil | 9.2±0.66 | 44.5±7.21 | 553.7±17.0 | 1219±16.2 | 34.33±0.67 | 159±3.51 | 178±4.51 | 191±9.87 |
| Nanas | 7.9±0.3 | 31.6±1.46 | 386.3±51.5 | 1110±19.7 | 32.33±0.93 | 47.7±10.6 | 102±1.53 | 22±6.93 |
| Joe | 7.1±0.3 | 2.83±0.75 | 196.8±56.1 | 26.53±2.45 | 32.13±1.50 | 0.67±1.15 | 2±2 | 0±0 |
| Jumik | 6.97±0.2 | 23±4.78 | 313.1±6.73 | 987±3.606 | 30.7±1.682 | 18.3±2.52 | 34±3.61 | 9.67±2.08 |
| Jumra | 6.83±0.5 | 0.65±0.18 | 10.2±1.6 | 21.67±0.71 | 32.27±0.95 | 0±0 | 0.33±0.58 | 0±0 |
| Limawa | 7.53±0.2 | 84.5±1.72 | 583.3±241 | 546.7±131 | 33.17±1.91 | 102±2.52 | 270±1.7 | 79.7±8.5 |
| Natti | 6.8±0.1 | 115±1.87 | 577.9±14.6 | 1654±109 | 32.37±0.87 | 373±30.7 | 507±5.51 | 224±2.52 |
| Niger | 6.73±0.2 | 311±6.48 | 304.7±16 | 1615±95.4 | 32.63±3.29 | 418±20.2 | 655±31.8 | 181±9.45 |
| Sarkin Yakun | 6.03±0.8 | 210±5.6 | 293.2±37.4 | 1027±36.2 | 31.07±0.76 | 103±15.5 | 132±3.21 | 53.3±3.06 |
| MIL | 5.63±0.3 | 14.2±2.6 | 35.37±3.68 | 104.6±3.45 | 29.1±0.624 | 365±15 | 497±72.2 | 200±9.5 |
| EL- kareem | 5.81±0.2 | 30.3±0.76 | 47.63±1.17 | 120.9±0.78 | 29.33±0.45 | 402±3.61 | 513±9.85 | 241±9.17 |
| FUT Minna | 6.97±0.2 | 0.77±0.14 | 73.3±4.44 | 449.5±12.6 | 32.4±0.917 | 0.33±0.58 | 0.33±0.58 | 0±0 |
| IK | 7.23±0.2 | 32.5±2.5 | 431.6±12.6 | 1670±66.8 | 32.43±0.72 | 91.3±9.07 | 416±5.29 | 207±8.19 |
| Jamila Ville | 7.23±0.4 | 4.49±1.11 | 326.5±10.8 | 936.4±18.1 | 31.77±0.32 | 113±9.64 | 320±16 | 80.7±9.45 |
| Jamil | 8.8±0.26 | 17.2±0.32 | 403.7±5.94 | 1142±70.7 | 31.47±0.51 | 186±4.93 | 443±11 | 109±7 |
| Abu Turab | 5.6±0.27 | 25.6±2.68 | 15.17±0.93 | 731±8.46 | 32±0.6 | 64.3±4.51 | 125±7.94 | 82.7±3.06 |
| AL- Amin | 7.2±0.36 | 0.69±0.2 | 134.1±6.59 | 615.8±4.70 | 32.07±0.06 | 1.33±1.15 | 0.33±0.58 | 0±0 |
| Bache | 6.81±0.5 | 0.27±0.05 | 14.6±1.609 | 21.27±1.04 | 31±0.693 | 0.33±0.58 | 0.67±1.15 | 7.33±1.15 |
| Abdulahi | 8.17±0.2 | 0.67±0.06 | 15.23±3.35 | 61.67±0.551 | 32.03±0.06 | 16±2 | 20.3±1.53 | 6.33±1.53 |

The results are presented in the form; mean of three replicates± standard deviation

Table 4: Inter- Element Correlation Matrix for Physical, Chemical and Bacteriological Parameters

| | $PO_4$ (mg/l) | Phosphorus (mg/l) | $Pb_2O_5$ (mg/l) | $NO_2$ (mg/l) | $NO_2$-N (mg/l) | $NO_3$ (mg/l) | $NO_3$-N (mg/l) | $NH_3$-N (mg/l) | $NH_4$-N (mg/l) | pH | Turbidity (NTU) | Electrical Conductivity (µS/cm) | TDS (mg/l) | Faecal Coliform (cfu/100ml | Total Coliform (cfu/100ml) | Faecal Streptococci (cfu/100ml) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $PO_4$ (mg/l) | 1.000 | 0.562** | 0.306 | 0.023 | -0.061 | 0.450* | 0.468** | 0.326 | 0.348 | -0.068 | 0.282 | 0.397* | 0.506** | 0.311 | 0.421* | 0.538** |
| Phosphorus (mg/l) | | 1.000 | 0.493** | 0.008 | -0.179 | 0.266 | 0.348 | 0.521** | 0.281 | 0.025 | 0.328 | 0.306 | 0.237 | 0.541** | 0.582** | 0.485** |
| $Pb_2O_5$ (mg/l) | | | 1.000 | 0.033 | -0.068 | -0.017 | -0.004 | 0.435* | 0.426* | -0.026 | 0.579** | 0.243 | -0.008 | 0.396* | 0.388* | 0.254 |
| $NO_2$ (mg/l) | | | | 1.000 | 0.873** | 0.555** | 0.533** | 0.476** | 0.480** | 0.147 | 0.177 | 0.505** | 0.412* | 0.404* | 0.357* | 0.346 |
| $NO_2$-N (mg/l) | | | | | 1.000 | 0.545** | 0.507** | 0.296 | 0.310 | 0.311 | 0.060 | 0.426* | 0.358* | 0.227 | 0.225 | 0.248 |
| $NO_3$ (mg/l) | | | | | | 1.000 | 0.893** | 0.576** | 0.490** | 0.184 | 0.135 | 0.528** | 0.544** | 0.577** | 0.609** | 0.659** |
| $NO_3$-N (mg/l) | | | | | | | 1.000 | 0.534** | 0.468** | 0.060 | 0.237 | 0.535** | 0.657** | 0.602** | 0.648** | 0.674** |
| $NH_3$-N (mg/l) | | | | | | | | 1.000 | 0.848** | -0.025 | 0.580** | 0.310 | 0.253 | 0.733** | 0.664** | 0.502** |
| $NH_4$-N (mg/l) | | | | | | | | | 1.000 | -0.169 | 0.700** | 0.274 | 0.228 | 0.621** | 0.468** | 0.427* |
| pH | | | | | | | | | | 1.000 | -0.192 | 0.383* | 0.140 | -0.142 | -0.097 | -0.020 |
| Turbidity (NTU) | | | | | | | | | | | 1.000 | 0.406* | 0.315 | 0.495** | 0.421* | 0.327 |
| Electrical Conductivity (µS/cm) | | | | | | | | | | | | 1.000 | 0.811** | 0.345 | 0.514** | 0.502** |
| TDS (mg/l) | | | | | | | | | | | | | 1.000 | 0.262 | 0.504** | 0.456** |
| Faecal Coliform (Cfu/100ml) | | | | | | | | | | | | | | 1.000 | 0.872** | 0.862** |
| Total Coliform (Cfu/100ml) | | | | | | | | | | | | | | | 1.000 | 0.842** |
| Faecal Streptococci (cfu/100ml) | | | | | | | | | | | | | | | | 1.000 |

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

**Inter Element Correlation**

In order to find out the relationship amongst physico- chemical and bacteriological parameters of the water samples, correlation coefficients were worked out as shown in Table 4. There is a very strong positive correlation was found between electrical conductivity, turbidity and bacteriological parameters. A negative correlation was observed for pH turbidity and bacteriological parameters while another negative correlation exist between potassium pentoxide and nitrate. This is in agreement with the findings of [14, 15]. The correlation between turbidity and total coliform is significant ($p < 0.01$) while that of turbidity and faecal coliform was significant at $p < 0.05$. It can be seen from table 4 that pH is having a significant effect on the bacteriological parameters level of the water samples. Also, the level or magnitude of the total dissolved solids (TDS) in the water determines the electrical conductivity of the groundwater. Since the level of the coliform increased with reduced distance of the shallow wells to the waste dumps, it follows that the concentration of these physiochemical parameters follows the same trend the findings of [16].

**Minimum Distance between Poultry waste dumps and Shallow Wells**

In order to establish the minimum distance that should exist between the poultry waste dumps and the shallow wells, the results of the bacteriological parameters obtained were regressed against the measured distances from the shallow wells to the dumps. The resulting regression equations are:

$$Faecal\ coliform = 638.35 + (-95.55 * distance) \quad ; R^2 = 0.99 \quad (1)$$

$$Total\ coliform = 792.64 + (-71.521 * distance) \quad ; R^2 = 0.91 \quad (2)$$

$$Faecal\ \ streptococci = 266.2 + (-37.548 * distance) \quad ; R^2 = 0.95 \quad (3)$$

These equations are linear functions with negative gradient. This implies that as distance from the poultry waste dump increases, bacteriological parameters decreases and vice-versa. For a shallow well to be free from these indicator orgnisms, it follows that faecal coliform, total coliform and feacal streptococci have to be taken as zero [9]. Therefore, equating equation (1,2 and 3) to zero, we have a minimum lateral distance of 6.7m for faecal coliform,7.0 meter for total coliform and 11.1meters for faecal streptococci free shallow groundwater from the wells. Figures 3, 4 and 5 show the graphs of the distance between shallow wells and poultry waste dumps against Faecal coliform, total coliform and Faecal streptococci respectively.

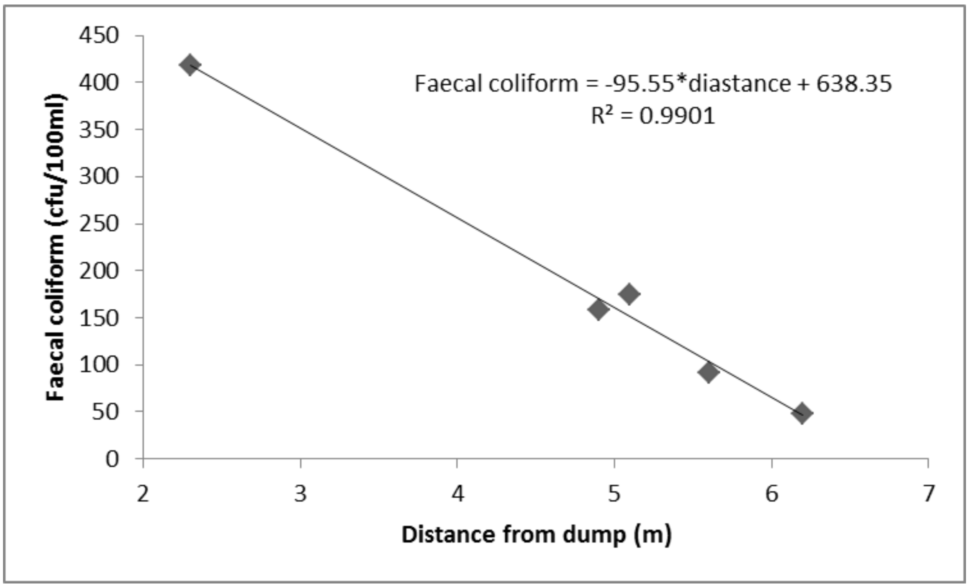


Fig. 3: Graph of Distance between Shallow wells and Poultry waste dumps against Faecal coliform

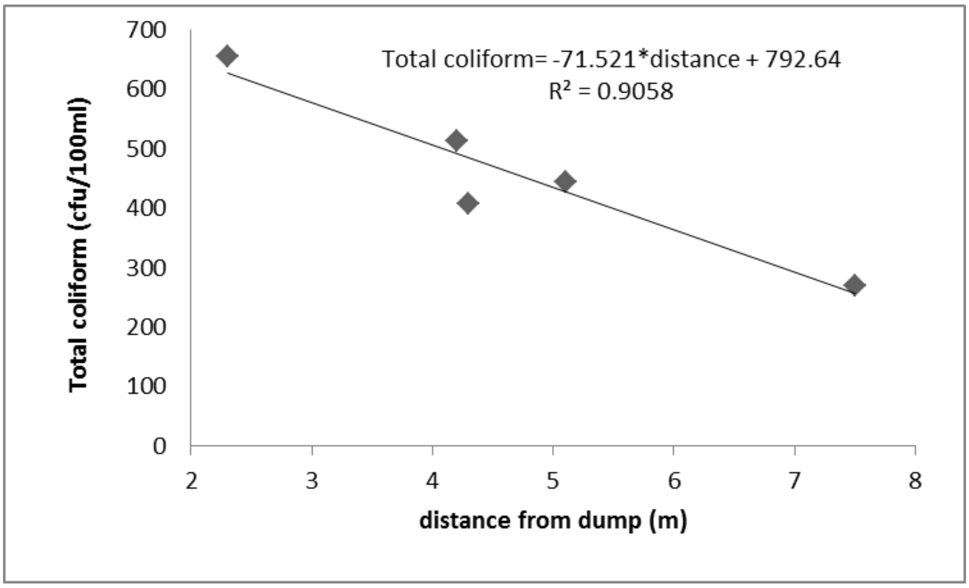


Fig. 4: Graph of Distance between Shallow wells and Poultry waste dumps against Total coliform

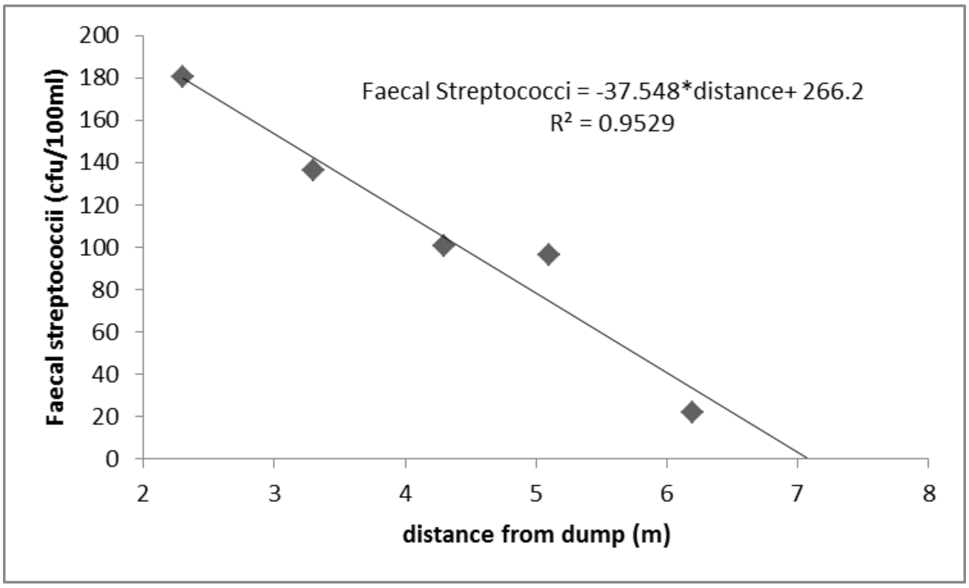


Fig. 5: Graph of Distance between Shallow wells and Poultry waste dumps against Faecal streptococci

## CONCLUSIONS AND RECOMMENDATIONS

Results from this project have shown that physico-chemical and bacteriological qualities of water from shallow wells inside poultry farm in Minna fall short of standards recommended by WHO and NSDWQ and are not fit for human consumption. Higher percentage of the wells sampled have bacteriological contamination which may have fatal consequences if consumed by humans without treatment as relying on natural filtration of local soil alone as the water percolates is evidently not enough to provide potable water from the wells. This was attributed to their proximity to poultry waste dump and the wells poor surroundings like lack of lining, cover, headwall and nearness to the surface. It is recommended that the shallow wells be lined, located at upstream of the poultry waste dump and at a minimum lateral distance of 11m to minimize faecal contamination from poultry waste dumps. Finally, an affordable method of shallow well water purification should be developed soon for the rural dwellers and the people living inside the poultry farms.

## ACKNOWLEDGEMENT

The efforts of Engr. John Musa and Miss Akiga Creda and during field trips for data collection is hereby acknowledged.

## REFERENCES

[1] Loague, K and Corwin, D.L. (2005) Groundwater Vulnerability to Pesticides: An overview of Approaches and Methods of Evaluation. Water Encyclopedia. John Wiley & Sons Inc.
[2] Pritchard, M. Mkandawire, T. and O'Neill J.G. (2008) Assessment of Groundwater Quality in Shallow Wells within the Southern District of Malawi. Journal of Physics and Chemistry of the Earth 33, 812- 823.
[3] Ugboaja, A.N. 2004 Groundwater pollution near shallow dumps in Southern Calabar, South-eastern Nigeria. Global Journal of Geological Sciences, 2(2):199-206.
[4] Guzzella, L., Pozzorri, F. and Giuliano, G. 2006 Herbicides contamination of surficial groundwater in Northern Italy. Journal of environmental pollution, 142, 344-353.
[5] Amanullah, M.M, Sekar, S. and Muthukrishan, P. (2010) Prospect and Potentials of Poultry Manure. Asian Journal of Plant Sciences. 9 (4). 172-182.
[6] Bolan, N.S., Szogi, A.A. Chuasavathi, T. and Panneerselvam, P.(2010) Uses and Management of Poultry Litter. World Poultry Science Journal, 66. 673 – 698.
[7] Bonton, A., Roulean, A., Bouchard, C. and Rodriguez, M. J. 2010 Assessment of groundwater quality and its variations in the capture zone of a pumping well in an agricultural area. Agricultural water management, 97, 824-834.
[8] Delin, G. N. & Landon, M. K. 2002 Effect of surface runoff on the transport of agrichemicals to groundwater in a sand plain setting. Journal of the science of total environments, 295, 143-155.
[9] WHO, 2007 Nitrate and Nitrite in Drinking Water. Background Document for Development of WHO Guidelines for Drinking Water Quality. World Health Organization, WHO press, 29pp.
[10] Bernhart, M, Fasina, O.O. Fulton, J. and Wood C.W.(2010) Compaction of Poultry Litter. Journal of Bioresource Technology. 101, 234-238.
[11] Palamuleni, L.G. (2002) Effect of Sanitation Facility, Domestic Wastes Disposal and Agricultural Waste Management on Surface and Groundwater Quality in Malawi Urban Poor Areas. Journal of Physics and Chemistry of the Earth, 27; 845-850.
[12] Adekunle, I.M., Adetunji, M.T, Gbadebo A.M., Banjoko, O.B., (2007) Assessment of groundwater quality in a typical rural settlement in Southwest Nigeria. International Journal of Environmental Research and Public Health, 4(4):307-318.
[13] Abdulrafiu, O.M., Kasali, A.A. and Ghaniyu, L.O., (2011) Quality assessment of groundwater in the vicinity of dumpsites in Ifo and Lagos, South-western Nigeria. Advances in Applied Science Research, 2(11):289-298.
[14] Ramesh K. and Elango L., (2006) Groundwater quality assessment in Tondiar basin, Indian Journal of Environmental Protection, 26 (6), pp 497-504.

[15] Usharani, K. et al., (2010) Physico-Chemical and Bacteriological Characteristics of Noyyal River and Ground Water Quality of Perur, India, Journal of Applied Science and Environmental Management, 14(2), pp 29-35.
[16] Harter T. (2003) Reference: Groundwater Quality and Groundwater Pollution, FWQP Reference Sheet 11.2, ANR Publication 8084, University of California.
[17] Dzwaizo, B., Hoko, Z., Love, D. Guzha, E., (2006) Assessment of the impacts of pit latrines on groundwater quality in rural areas: A case study from Mawendera District, Zimbabwe. Physics and Chemistry of the Earth, 31: 779-788.