Science Forum (Journal of Pure and Applied Sciences)

Journal Homepage: https://atbuscienceforum.com.ng/index.php/jpas

Evaluation of Physico-Chemical Parameters in Samples from Irrigated Farms at Hweng, Foron District, Plateau State, Nigeria.

Haruna M Chundusu; Istifanus Y. Chindo; Harami M. Adamu; M. A. Kolo

Department of Chemistry, Abubakar Tafawa Balewa University, Bauchi

Abstract

The present research investigated the physico-chemical characteristics of water, soil, and plant samples collected from irrigated farmlands in Hweng, Foron District, Plateau State, Nigeria. Sampling was carefully carried out within the irrigated fields to ensure representative coverage of the local agricultural environment. Standard analytical methods were employed to quantify the concentrations of key parameters that influence water and soil quality, as well as their potential impact on crop health and food safety. The physico-chemical parameters analyzed included pH, electrical conductivity (EC), turbidity, total dissolved solids (TDS), total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), alkalinity, oil and grease (O/G), chemical oxygen demand (COD), nitrate, nitrite, sulphate, and chloride. Results revealed that pH values ranged between 6.5 and 6.9, indicating near-neutral conditions suitable for most agricultural practices. EC values varied from 122–139 µS/cm, suggesting low salinity levels. Turbidity exhibited wide variability (0.83–205 NTU), reflecting differences in suspended particulates across sampling points. TDS concentrations ranged between 80–90 mg/dm^3, while water hardness was in the range of 27–48 mg/dm^3. The dissolved oxygen content (6.8–8.4 mg/dm^3) was generally adequate for sustaining aquatic life, whereas BOD values (1.11–3.4 mg/dm^3) indicated relatively low levels of organic pollution. Alkalinity values (7–44 mg/dm^3) reflected moderate buffering capacity of the waters. Oil and grease concentrations were between 0–2.0 mg/dm^3, while COD values spanned 1.6–48 mg/dm^3, showing some variability in oxidizable matter content. Nutrient parameters revealed nitrate concentrations of 0.3–13 mg/dm^3, nitrite between 0.2–0.4 mg/dm^3, sulphate within 4.9–48.3 mg/dm^3, and chloride between 0–0.1 mg/dm^3. Statistical evaluation using Pearson correlation showed that most parameters exhibited positive relationships with one another, indicating a degree of interdependence among the measured variables. Comparative seasonal analysis further revealed that water samples from the rainy and dry seasons, as well as dry season water samples compared to control samples, did not show statistically significant differences. However, other parameter comparisons displayed statistically significant variations, suggesting that seasonal and environmental factors influence the water–soil–plant system in the study area. Overall, the findings provide baseline data for monitoring the environmental quality of irrigated farmlands in Hweng and contribute to understanding the implications of irrigation practices on soil, water, and crop health.

Keywords
Physico-chemical,
Water,
Soil,
Plant,
Pearson correlation

Corresponding Author: Haruna M Chundusu, Department of Chemistry, Abubakar Tafawa Balewa University, Bauchi
Email: chmusa.pg@atbu.edu.ng

INTRODUCTION

Water is a most abundant physical substance and transparent liquid on earth. It is the foundation of all form of life. All processes of life are directly or indirectly connected to water therefore human beings cannot survive much longer without water. Irrigation was often studied together with drainage, which was the removal of surface and sub-surface water from a given area. Irrigation had been a central feature of agriculture for over 5,000 years and was the product of many cultures. Historically, it was the basis for economies and societies across the globe, from Asia to the Southwestern United States [1].

The physicochemical study of parameters was important to agricultural chemist for water, soil management and plant growth. While organic pollutants occurred naturally, inorganic pollutants such as physicochemical parameters were a result of some human interaction or doing. Organic, which were substance that came from animals or plants sources generally contain carbon. Inorganic were materials such as sand, salt, iron, calcium salts and other mineral materials. The substances were of mineral origin [2].

These water samples from ten (10) sample points of Bauchi were analyzed for their pH, colour, odour, hardness, chloride, alkalinity, TDS and others. The results were pH ranged from 6.5 ± 0.02 to 7.3 ± 0.11, Turbidity ranged from 1.0 ± 0.0 to 2.0 ± 0.0, Hardness ranged from 80.7 ± 0.58 to 296.0 ± 0.0, EC ranged from 131.0 ± 1.0 to 433.0 ± 1.0, Alkalinity ranged from 80.7 ± 0.58 to 225.7 ± 0.58, Chloride ranged from 21.0 ± 0.0 to 60.0 ± 0.06, others were TDS which ranged from 69.7 ± 0.58 to 216.7 ± 0.58, Nitrite also ranged from 0.02 ± 0.0 to 0.2 ± 0.0, Nitrate was found between 4.4 ± 0.01 to 49.8 ± 0.25 and Sulphate was between 5.0 ± 0.1 and 88.3 ± 0.75.On comparing the result against drinking water quality standards laid by Nigerian Standard for Drinking water Quality Maximum permissible level (NSDWQ) and WHO. It was found that some of the samples were non potable for human consumption due to high concentration of some of the parameters determined [3]. When pollutants in the environment were in very minute amount or in low concentrations, they were not toxic to plants and animals so they had short residence time in the environment [5]. The various sources of water pollutants were classified into organic pollutants and inorganic pollutants which are salts and metals, nutrients and agricultural run offs [6].

Saidu *et al.* (2020) [7] said water samples were collected in the early hours of the morning to ensure that the water had not been disturbed much through human activities that could affect TDS content. Minimum limits were seen in Jatai, Rafi yashietc which was due to runoff during the raining season. Water was one of the main important abiotic components of the environment which played a vital role of maintaining human health. Availability of fresh water in the world continued to decrease due to high demand on ground water as a source of drinking water, agriculture, industial and recreational activities.

Plants are the eukaryotes that form the kingdom plantae; they are predominantly photosynthetic. This means that they obtain their energy from sunlight using chloroplasts to produce sugars, carbon (IV) oxide and water, by the use of green pigment chlorophyll [9]

Chiroma *et al.*, 2019 [10] undertook a comparative assessment of heavy metal levels in soil, vegetables and urban grey wastewater used for irrigation. They stated that irrigation was the application of controlled amounts of water to plants at needed intervals. Irrigation helped to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Irrigation also had other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation.

Man had taken into irrigation as a profession to harness and sustain the primary usefulness and the highly priced qualities of the plants in our environment. This was achieved through the cultivation of garden crops, fruits, vegetables and flowers of all kinds. The practice of wastewater 'urban agriculture' occurred because of local demands of fresh food products, and people without jobs and poor ones used the opportunity. Rural dwellers depended on various available water sources. The discharge of waste water into streams and rivers depleted dissolved oxygen and destroyed plants when it was used for irrigation. It rendered streams and rivers unsuitable for community water supply and for other beneficial uses. The qualities of water sources were generally not guaranteed and cases abound where health problems as a result of using such sources of water [6].

According to Yadav, (2016) [12] the pH ranged from 6.8 to 8.0 was recommended optimum for plant growth. Electrical conductivity (EC) was from 0.08 to 1.15 M mhos, organic carbon falled between 0.41 and 0.59 while nitrogen was in the range of 0.036 and 0.049%. The study of physico-chemical parameters was important to agricultural chemist for plant growth and soil management. The results of the study were normal and the information gave farmers to arrange the amount of which fertilizers and nutrients needed to soil for increase in the percentage yield of crops.

When water was referred to as 'hard', this simply mean that it contained more minerals than ordinary water. Because of the presence of magnesium and calcium ions in high concentration, other positively charged substances like them dissolved less easy in the hard water than in water that did not contain magnesium and calcium. This was why soap did not readily dissolve in hard water [2]

Water samples from selected hand-dug wells and Ona River in Itaogbolu area of Akure, Ondo State, Nigeria were collected. Physico-chemical parameters and heavy metals were determined using standard analytical procedure. The results of the physico-chemical analysis were obtained in the following range; pH (6.59-7.68), temperature (21.10-27.10 °C), conductivity (300-1150 µS/cm), chloride (78.10-156.20 mg/dm^3), total hardness (130-298 mg/dm^3), sulphate (82.50-97.00 mg/dm^3), TDS (0.02-0.09 %) and alkalinity (0.92-2.45 mg/dm^3). The highest value of physico-chemical parameters (compared with wells) was obtained in Ona River. The results obtained fell within the maximum allowable limit set by World Health Organization for drinking water except for water from Ona river [13].

Vegetables were important for human health because of their vitamins, minerals, phytochemical compounds, and dietary fiber content. Especially antioxidant vitamins

(vitamin A, vitamin C, and vitamin E) and dietary fiber content had important roles in human health. Adequate vegetable consumption protected people from some chronic diseases such as diabetes, cancer, obesity, metabolic syndrome, cardiovascular diseases, as well as improved risk factors related with these diseases. Basic information was given about the classification of vegetables, preparation and cooking, and their effects on food content of vegetables and effects on health and diseases such as diabetes, obesity, metabolic syndrome, cardiovascular diseases, and cancer [14].

Sunil *et al.* (2023) [15] said the electrical conductivity (EC) measured ions present in soil solution which increased the concentration of ions. If the pH was found to be less than 6 then it was said to be an acidic soil as the result showed that it ranged from 6.0 and 8.5. The study concluded that soil quality was carried out by different parameters and most were quite higher or lower than acceptable limits. Therefore, it was important to put a total ban on the human activities which were responsible for soil quality deterioration. The soil with the highest sand and clay percentage had the highest value of soil compaction value and vice versa. This was with respect to the moisture content and soil texture.

Pramod and Amruta, (2021) [16] studied on the physicochemical parameters of soil sample. Colour, texture, structure, porosity, density, consistency, temperature were the physical properties studied. Soil analysis referred to a set of various chemical processes which helped to determine the available plant nutrients which were either in micronutrients or macronutrient form. pH, salinity level, EC and others were monitored. The temperature ranged between 20 to 25°C, pH ranged from 8.26 to 8.67, conductivity was between 0.307 and 2.53µmho/cm, and chloride content was between 0.0425 and 1.552 mg /dm^3. After the analysis was carried out, it was understood that the properties of soil kept on changing depending on various anthropological activities carried out nearby. The range kept fluctuating, sometimes under ranged, sometimes totally beyond it.

Karande *et al.* (2020) [17] analyzed the soil sample for its physical and chemical parameters. pH value ranged from 6.2 to 7.5, temperature ranged from 22.1 to 22.4 °C, the EC was between 1.15 and 2.78 µS/cm, others were the moisture content which was from 5.54 to 7.46, Alkalinity was 300 to 500 mg/dm^3, Chloride and Organic matter were with the range of 0.38 to 0.48 mg/dm^3 and 1.70 to 6.81 % respectively. Climate, natural vegetation and rocks were the factors that determined the quality of soil in a location. The management of soil testing- based nutrients had emerged as a key issue in efforts to increase agricultural productivity and production. As optimal use of nutrients based on soil analysis would increase crop production and reduced the waste of those nutrients, thereby mitigating environmental impact which led to bias through optimal production. The farmer would find difficulty in knowing the proper use of fertilizers which would match soil of their fields.

Also, soil analysis became the solution to the problem of the farmers. Plant that took up chloride as Cl^- ions from the soil solution played some important roles in photosynthesis, osmotic adjustment and suppression of plant disease. However, high

concentration of chloride could cause toxicity problem in crops and reduced the yield.

Based on scientific evidence, soil pollution can severely degrade the major ecosystem services provided by soil. Soil pollution reduced food security by both reducing crop yield due to toxic levels of contaminants and by causing crops produced from polluted soils to be unsafe for consumption by animals and humans. Many contaminants were transported from soils to surface water, causing great environmental harm through eutrophication and direct human health issues due to polluted drinking water. Pollutants also directly harm soil microorganisms and larger soil-dwelling organisms and hence affect soil biodiversity and the services provided by the affected organisms [18]

These could include treating or removing sources, or cutting off pathways or both, chemical remediation included oxidation, reduction, hydrolysis, solubilication, dechlorination, pH manipulation and bioremediation. Teh *et al.* (2016) [20] said in some countries or regions in the world, there were national, regional or local agencies who were responsible for initiating a preliminary investigation to determine whether or not pollution was present and whether further action was needed, while there were many others where no regulation or protocols had been defined

2. Physico-chemical parameters:

Chemical oxygen demand (COD) is an indicative measure of the amount of oxygen that can be consumed by reactions in a measured solution.

Hardness is the property of water which hampers the lather formation with the soap. Temporary contains bicarbonate and carbonate of Ca and Mg and can be precipitated simply by boiling, although Fe also contributed to actual hardness, while salts of chloride and sulphate produce permanent hardness.

pH which means potential of hydrogen, is a scale used to specify how acidic or basic a water-based solution is. Acidic solutions have a lower pH, while basic solutions have higher pH. Dissolve Oxygen is the amount of oxygen that is present in water. Water bodies receive oxygen from the atmosphere and from aquatic plants. Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eyes, similarly to smoke in air.

Alkalinity is the measure of its capacity to neutralize acids. The salt of weak acids such as bicarbonate and little of carbonate, borate, silicate, phosphate and also salts of humic and fulvic acids are natural alkalinity in water [21]. Electrical Conductivity is the reciprocal of the resistance offered by a solution with platinum electrode immersed in it, each 1 cm square by 1 cm apart. The concentration below 5 mg/l of Nitrate shows its deficiency in natural water and higher quantity of the nitrate are leached out from soil to contaminate water but nitrite is unstable as it is formed mostly by denitrification and nitrification of nitrogenous compounds [22].

Total Dissolved Solid also known as TDS is the measure of the combined total organic and inorganic substances contained in a liquid. Water TDS concentration can be determined

using a digital meter. Total concentration of dissolved substances in water which can pass through a 2-micro filter, it comes from variety of places such as rock bits, from run-off rain water, level of TDS that is too high or low can affect health, the environment and more.

Oil and grease are any material recovered as a substance soluble in the solvent, it is referred to a combination of substances that do not readily mix with water and are commonly oily from the water used in industry and daily activities. Biochemical oxygen demand/biological oxygen demand (BOD), provides an index to assess the effect discharged waste water will have on the receiving environment. In general, maximum allowable concentration for direct environment waste water discharge fall around 10 mg/L BOD [21].

The Precipitation titration for chloride is based on the formation of sparingly soluble salts. The oldest known and still the most widely used is silver nitrate. The method is called argentometry. Sulphate is widely distributed in nature and may be present in natural water in concentration ranging from a few to several thousand milligram/Litre.

1.2 Statement of the problem

The source of the water for the irrigation are the rivers flowing into the dam collecting all kinds of waste, the water treatment plant reservoir where some waste might not be completely treatment, the addition of chemicals in the treatment plant which can form complex harmful compounds and pollutants acquired from the exit of the treatment plant channeled into a stream to the irrigation point. The farm products absorb the pollutants directly from the soil irrigated with the water. Under non-controlled conditions the pollutants can reduce soil productivity and cause health problems to humans and animals.

1.3 Aim and objectives of the Study

The aim of this study is to evaluate the physico-chemical parameters responsible for poor yield of irrigated farm at Hweng, Foron District, Plateau State, Nigeria.

The objectives are to: -

1. sample and prepare the farm produce and other environmental matrices (soil, plant and water).
2. determine the concentration of physico-chemical parameters in the samples.
3. evaluate the uptake of the parameters in the farm produce.
4. provide sustainable remediation approach in the affected environment.

3.0. MATERIALS AND METHODS

3.1 Materials

Some materials used were: -

1. Plastic bottles
2. Hoe
3. Plastic containers
4. Beakers (100, 250 cm^3)
5. Sampler (Local)
6. Soil aulga
7. Volumetric flask (50, 100 cm^3)

3.1.1 Sampling sites

The sampling sites were three (3) inlet sites of the treatment plant from Yakubu Gowon

dam, wastewater Treatment Plant outlet and the irrigated farms, at Hweng- Foron in Barkin-Ladi Local Government Area.

Description of the study area

On the Jos Plateau, mining activities took place and more steams came up, their minerals were washed into streams and as well as farmlands for agricultural possess. Similarly, the streams also passed into the Yakubu Gowon Dam. This dam has its treatment plant at Hweng which treats and supplies drinking water to Jos-South and Barkin-Ladi LGAs of Plateau State. The study area span through Jos-South and Barkin-Ladi covers a total area of about 3,000 km^2. To be specific, the dam is at the eastern side of Bukuru, Jos-South LGA Headquarter and about 12 miles.

Global Positioning System (GPS) was used to identify the actual locations of the sampling sites.

Table 1: Geographical Coordinates of Longitudes and Latitudes shown below

Sampling sites	Latitude	Longitude
Rnorth	09 ° 45′ 57.8″ N	08 ° 58′ 23.6″ E
Rcentral	09 ° 45′ 56.4″ N	08 ° 58′ 22.8″ E
Rsouth	09 ° 45′ 49.5″ N	08 ° 58′ 19.6″ E
P1	09 ° 45′ 24.8″ N	08 ° 58′ 04.7″ E
P2	09 ° 45′ 10.8″ N	08 ° 58′ 24.7″ E

Key: Rnorth – Northern entrance to the Treatment Plant,

Rcentral – Central entrance to the Treatment plant,

Rsouth – Southern entrance to the Treatment plant,

P1 – Wastewater exit from the treatment plant,

P2 – Irrigated farm

3.1.2. Collection of samples

3.1.2.1 Collection of water

Water samples were collected in two parts A and B from three different sites of the Dam, while from the Treatment plant outlet (P_1) and irrigated farm site (P_2) three samples were taken at an interval of thirty minutes. All water samples were collected at about one meter deep. To avoid possibility of contamination, clean empty polythene bottles were used for the collection of the samples and were labeled appropriately. The pH of all samples was measured at the spot and the samples were kept on ice blocks in a cooler for transportation to the laboratory and then in the fridge for analysis.

3.1.2.2 Collection of Soil Samples

The soil samples were collected in polythene bags at about 2-3 cm^3 deep and from different sites of the farm to give a fair distribution of the area.

3.1.2.3 Collection of Plant Samples

Similarly, the plant samples were taken in clean polythene bags from the same places with that of the soil.

3.2 Preparation of Reagents

3.2.1 Preparation of 0.10 mol dm^{-3} of Trioxonitrate (V) Acid

A volume of 0.60 cm^3 of concentrated trioxonitrate (V) acid (percentage purity = 70.00% and specific gravity = 1.42) was measured using a burette into a 100 cm^3 beaker that initially contained 20.00 cm^3 of distilled water and the solution allowed to cool. The resulting solution was quantitatively transferred into a 100 cm^3 volumetric flask and distilled water was added to the graduation mark and further preserved [23].

3.3 Pretreatment of Samples

3.3.1 Sample Pretreatment/Digestion

3.3.1.1 Pretreatment of Water Sample

A 4.00 cm^3 of 0.10 mol dm^{-3} trioxonitrate (V) acid was added to 50 cm^3 water samples in a 250 cm^3 beaker and heated gently at 80°C until the volume reduced to break the complex bonds. The digest was filtered using Whatman filter paper Number 42 into a 100 cm^3 volumetric flask; water was then added to the graduation mark and agitated thoroughly. The sample solution was used for the determination of organic and inorganic pollutants. Three replicate determinations were carried out for each metal and the instrument was recalibrated after the analyses. The filtered solution was stored in sample containers and kept in a refrigerator at 4 °C prior to metal analysis [23].

3.3.2 Determination of hardness:

A volume of 15 cm^3 sample was required to keep the analysis time less than 5 min and the sample was diluted to 50 cm^3 with distilled water. The pH was adjusted by adding 1-2 mL of a pH 10 buffer (NH_4Cl) containing a small amount of Mg^{2+}-EDTA. A volume of 1-2 drops of Eriochrome black T indicator was then added, and titrated with a standard solution of EDTA until the red-to-blue end point was reached.

3.3.3 Determination of alkalinity.

A sample of 50cm^3 was pipetted into a clean Erlemeyer flask and a drop of 0.100 mol/dm^3 sodium thiosulphate solution was added, when residual chlorine was noticed. In the absence of it, two drops of phenolphthalein indicator were added for the colour of the solution to become pink at pH above 8.3, the solution was titrated against standard sulphuric acid (0.0500 mol/dm^3 = 2.8 cm^3 of the acid dissolved in 1 dm^3 CO_2 free distilled water) until the pink colour disappears. Two drops of methyl orange indicator were added to turn it to yellow and was titrated again with the acid until the colour turns from yellow to orange yellow (V).

Alkalinity (mg/dm^3 $CaCO_3$) = (V x 1000)/cm^3 of sample - - - (Equation 1)

3.3.4 Determination of pH

To calculate the pH of an aqueous solution, the need to know the concentration of the hydronium ion in mol/dm^3 (molar concentration), and the pH meter used to determine the pH was pHep pocket- sized pH meter.

The pH was then calculated using the expression:

pH = - log(H_3O^+).

- - - (Equation 2)

3.3.5 Determination of conductivity

The sample was brought to the required temperature by immersion in a water bath and the bottle stoppered. The electrodes were immersed in the sample. The bridge was balanced and the resistance read off. The temperature of the sample was taken just before immersion of the electrodes

Calculation:

Calculate by applying the equation K =C/R - - - (Equation 3) and express the result as μS/cm.

3.3.6 Determination of chemical oxygen demand. Sample was placed in culture tube and digestion solution was added. The sulphuric acid reagent was carefully run down inside of vessel for an acid layer to be formed under the sample-digestion solution layer. The tubes were tightly capped, and were inverted each several times to mix completely.

The tubes were placed in block digester, preheated to 150 °C, and refluxed for 2 h behind a protective shield. It was cooled to room temperature and vessels placed in test tube rack. Some mercuric sulphate precipitated out but this did not affect the analysis. Culture tube caps were removed and small TFE-covered magnetic stirring bar was added. The ampules were used and the contents were transferred to a larger container for titrating. 0.05 to 0.10 cm^3 (1 to 2 drops) ferroin indicator was added and rapidly stirred on magnetic stirrer while titrating with standardized 0.10 mol/dm^3 ferrous ammonium sulphate. The end point was a sharp color change from blue-green to reddish brown, although the blue-green reappear within minutes. In the same manner, the blank containing the reagents was refluxed and titrated and a volume of distilled water was equal to that of the sample.

Calculation

COD as mg O_2/dm^3 = [(A x B) x mol/dm^3x 8000]/cm^3 sample - - - (Equation 4)

where: A = cm^3 Ferrous Ammonium Sulphate (FAS) use for blank,

B = cm^3 FAS use for sample,

Mol/dm^3= molar concentration of FAS, and

8000 = milliequivalent weight of oxygen x 1000 cm^3/dm^3.

Samples were analyzed in duplicate because of small sample sizes. Samples that were in homogeneous underwent multiple determinations for accurate analysis. Results were within ±5 % of their average unless the condition of the sample was dictated otherwise.

3.3.7 Determination of oil and grease in water. The sample was collected within 28 days and preserved at pH < 2 with dilute HCl or to inhibit microbial degradation, and at < 6 °C. 10 cm^3 of sulphuric acid, 50cm^3 petroleum ether and 3cm^3 ethyl ethanol were added to 230 cm^3 of sample in separating funnel (250 cm^3). The funnel was well shock and the sample was allowed to stand until two layers were formed, which were petroleum ether at the top and water sample at the bottom. The sample at the bottom was discarded from the funnel and the petroleum ether at the top was drained through the filter paper

inside the filter funnel into the pre-weighed conical flask.

Some fresh petroleum ether was poured through the filter paper to ensure no oil and grease stuck in the paper. The conical flask was placed in the hot bath to allowed the petroleum ether to evaporate, the conical flask was allowed to cool and weigh.

Calculation:

Oil and grease (mg/dm^3) = [(A-B) x 1000]/ $250cm^3$ - - - (Equation 5)

Where- A= conical flask with oil

B = pre- weighed conical flask

3.3.8 Determination of chloride

In the determination of chloride, the water sample was collected and a few drops of 0.100 mol/dm^3 HNO_3 acid was added to acidify to about pH 1 this was effective in preventing microbial growth. The acid also removed the interferences of CO_3^{2-}, HCO_3^-, SO_3^{2-}, and S^{2-} by converting them to gases. It was kept in an ice cooler at a temperature of less the 7 °C and transported to the lab.

The burette was rinsed with few cubic centimeters (cm^3) of 0.100 mol/dm^3 silver nitrate and filled with the same solution making sure the burette tip was full. 10 cm^3 of the sample was transferred into a 250 cm^3 conical flask and diluted to about 50 cm^3 with distilled water, 2 cm^3 of 0.100 mol dm^{-3} potassium chromate solution was added.

The sample was then titrated with the silver nitrate, swirling the solution constantly, until there was a permanent colour change from yellow of the chromate ions to the reddish of silver chromate precipitate [24].

Calculation:

Cl^- (mol/dm^3) = (0.1mol/dm^3 $AgNO_3$ x Ave. vol. of $AgNO_3$)/10 - - - (Equation 6)

3.3.9 Determination of total dissolved solids

Water sample of 50 cm^3 was transferred into a weighed basin for evaporation and dry at 105 °C to a constant weight; the desiccator was cooled and weighed. The result was expressed in mg/dm^3.

3.3.10 Determination of nitrate-nitrogen in water

Sample was preserved with 40 mg $HgCl/dm^3$ and stored at 4 °C. The pH was adjusted to about 7 with CH_2COOH and was filtered through 0.45 µm filter.

A set of matched tubes was prepared for blanks, standards, and samples. heating was done to correct for colour or for organic matters which cause colour, extra set of tubes were provided to which all reagents were added except Brucinesulphanilic acid reagent (1 g brucinesulphate 7 H_2O and 0.1 g sulphanilic acid- H_2O was dissolved in 70 cm^3 H_2O and stored in dark bottle at 5 °C, the solution was kept stable for several months. Slowly developing pink did not affect usefulness).

A sample of 10 cm^3 was pipetted and diluted to 100 cm^3, into sample tubes, 2.0 cm^3 30 % NaCl (w/v) solution was added to samples, standards, and blank tubes. The tubes were swirled and placed in 0-10 °C bath. 10 cm^3 of 6.5 mol/dm^3 H_2SO_4 was pipetted into each

tube and swirled. All tubes were made to come to thermal equilibrium. 0.5 cm^3 brucine reagent was pipetted into all tubes except colour control tubes and swirled. Then the entire rack containing all tubes was placed in boiling water bath for exactly 25 min., rack was removed and transferred to cold water bath and allowed to cool to 20-25 °C. Tubes were dried and *A* was read against reagent blank at 410 nm.

Set of standards containing 0.1-2 mg N/dm^3 were prepared and standards were conducted along with samples. *A* of colour control was subtracted from *A* of samples.

3.3.11 Determination of sulphate

Nephelometer, spectrophotometer was set at 420 nm with 4-5 cm cell, was used.

Conditioning reagents (50 cm^3 glycerol was mixed with solution of 30 cm^3 HCl, 300 cm^3 H_2O, 100 cm^3 alcohol, and 75 g NaCl) of 5 cm^3 was pipetted into 100 cm^3 sample in 250 ml conical flask, and was mixed on magnetic stirrer. While stirring, spoonful of $BaCl_2$ crystals was added and began timing. It was stirred for exactly 1 min at constant speed. Some solution was immediately transferred into cell and turbidity was measured at 30 s intervals for 4 min. Maximum reading was recorded. Blank determination was conducted without $BaCl_2$ and the reading was subtracted.

Standard curve was prepared by carrying 40 mg SO_4/dm^3 (100 µg SO_4/cm^3. 10.41 cm^3 0.0100 mol/dm^3 H_2SO_4 was diluted to 100 cm^3), in 5 mg increments, through entire determination. Standard solution was introduced with every 3-4 test solutions

mg SO_4/dm^3 = (mgSO_4 from curve x 1000)/cm^3 test portio) - (Equation 7)

3.3.12 Dissolved oxygen (DO)

Dissolved oxygen was analyzed using Azide modification of Winkler's method. 100 cm^3 of water sample was taken in a glass stoppered BOD bottle. 1 cm^3 of alkaline iodide azide solution and 1 cm^3 of alkaline potassium iodide solution were added to it to get brown coloured precipitate which dissolved by adding 2 cm^3 of conc. H_2SO_4. The whole of this treated sample was titrated in a conical flask against 0.025 mol/dm^3 sodium thiosulphate solution using starch indicator. The end point was when blue colour changes to colourless.

Calculation:

DO (mg/dm^3) = (cm^3 x 0.025mol/dm^3 x 8 x 1000)/ V-v - - - (Equation 8)

V = Volume of sample

v = volume of iodide azide solution and KI solution

3.3.13 Determination of biochemical oxygen demand (BOD)

BOD was determined titrimetrically by adopting in toto the procedure adopted for the measurement of DO but only after incubation for five (5) days at 20 °C. BOD was calculated on basis of oxygen depletion when compared to DO before incubation.

3.3.14 Turbidity

Turbidity, been an optical property of water, was measured in Nephelometer, with its unit as Nephelometric Turbidity Unit (NTU). The Nephelometric method was compared how light was scattered in a water sample at 90

degrees angle from the incident light against the amount of light scattered in a reference solution. An electronic meter was used to measure the turbidity.

3.3.15 Nitrite

A 50 cm^3 of water sample was measured and 1 cm^3 sulphanilamide (1 % in 100 cm^3 of 10 % HCl) was added, after waiting for about 3-5 minutes, 1 cm^3 NEDA (1-Naphthylethyenediamine dihydrochloride) was added to it. Diazotization reaction occurred, that was a complex compound formed rendering the mixture brilliant pink in colour. This was measured using a U/V spectrophotometer at 543 nm. The absorbance was the function of the intensity of the colour that was the direct result of the Nitrite present in water. The standard curve was prepared taken sodium nitrite of known concentrations [21].

3.3 Data Analysis

The concentration was analyzed statistically to determine the distribution of OCPs. The results were summarized using descriptive statistics (mean and standard deviation). Pearson Correlation Coefficient (SPSS, 2017 version) in the different environmental compartments and assess potential risk to human health and ecosystems.

4.0 RESULTS AND DISCUSSION

4.1 Physico-chemical parameters in water, soil and plant of the irrigated farm were also evaluated. The results were presented below:

Table 1: Physico-chemical Parameters in Water (D_2) and Soil

	WATER (D2)		SOIL
pH	6.9		7.5
EC (µS/cm)	140		233.30
Turbidity (NTU)	0.83		153.0
DO		7.1	-
TDS	90		158.9
Hardness (mg/dm^3)	40		200.0
BOD	2.8		-
Alkalinity	14.7		38.5
Oil and Grease	2.0		1.5
COD	28		-
Nitrate (mg/dm^3)	13		38.5
Nitrite (mg/dm^3)	4		19.3
Sulphate (mg/dm^3)	48.3		8.0
Chloride (mg/dm^3)	0.1		2.0

Table 2: Correlating Physico-chemical Parameters in D_2 and Soil

		Correlation	
		WATER (D_2)	SOIL
DRY SEASON D_2	Pearson correlation	1	0.686
	Signi. (2-tailed)	-	0.007
	N	14	14
SOIL	Pearson Correlation	0.686	1
	Signi. (2-tailed)	0.007	-
	N	14	14

** Correlation's significant at the 0.01 level (2-tailed).

Pearson correlation coefficient was computed between Water (D2) and Soil to ascertain the relationship and the result was positive linear relationship with r = 0.686, p- value = 0.007 and sample size n = 14. Thus, this signifies that the parameters in both samples had a positive strong relationship and statistically significant since the p-value is less than 1% (0.01). There was no much difference in their parameters.

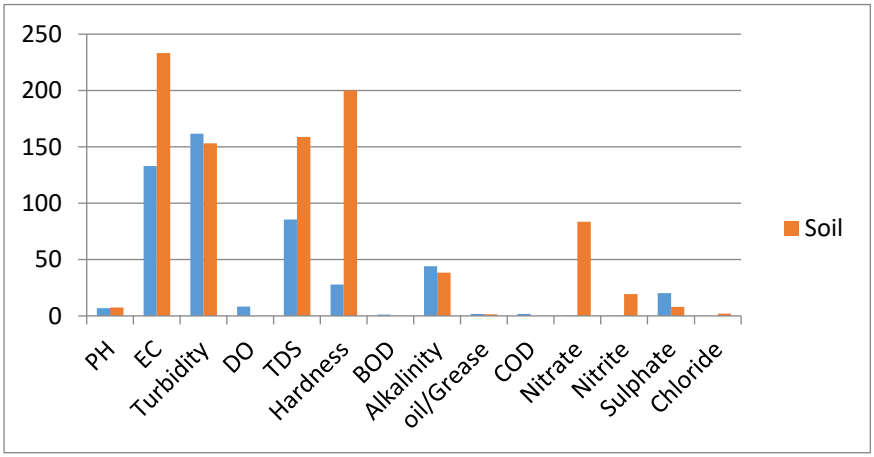

Figure 4: Physicochemical parameters of the Water and soil samples

Table 14: Physico-chemical Parameters in Soil and Plant samples (mg/dm^3)

	SOIL	PLANT
pH	7.5	6.4
EC (µS/cm)	233.3	231.10
Turbidity (NTU)	153	225.0
TDS	158.9	217.3
Hardness(mg/dm	200	650
^{3})	38.5	155.0
Alkalinity	1.5	1.10
Oil and Grease	83.6	88.4
Nitrate (mg/dm^3)	19.3	20.1
Nitrite (mg/dm^3)	8.00	22.7

Sulphate (mg/dm^3)	2.00	3.20
Chloride (mg/dm^3)		

Table 15: Correlation of Physico-chemical Parameters in Soil and Plant

		Correlation	
		SOIL	**PLANT**
SOIL	Pearson correlation	1	0.619
	Signi. (2-tailed)	-	0.000
	N	14	14
PLANT	Pearson Correlation	0.619	1
	Signi. (2-tailed)	0.000	-
	N	14	14

**correlationsignificant at the 0.01 level (2-tailed).

The Pearson correlation coefficient was computed between Soil sample and Plant sample results turn out to be a very strong positive linear relationship with r =0.819, a p-value = 0.00 and sample size n = 14. This signifies that the parameters in both samples have a very strong relationship and are statistically significant since the p-value is less than 1% (0.01). It was observed that the physicochemical parameters analyzed in soil and plant were almost the same as one affected the other.

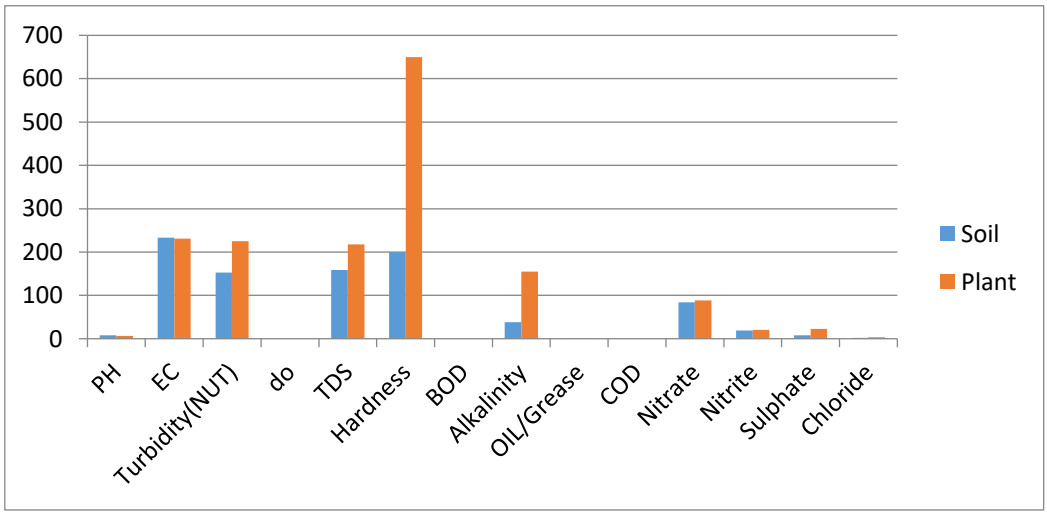

Figure 5: Physicochemical parameters from the soil and the plant samples

Table 16 Summary of Paired Sample Correlation of Physicochemical parameters

		N	Correlation	Sig.
Pair 1	Dry(D_2) & Soil(S)	14	0.686	0.007
Pair 2	Soil(S) & Plant(P)	14	0.819	0.000

Correlation is necessary but not sufficient enough to determine causality. It determines the level of relationship between two variables but does not explain why they are related. It cannot be used to determine the cause and effect of an experiment or the problem. From the table above, paired sample results were given for the correlation between rainy season and soil (D_2 and S) they have a strong relationship of 0.686 and a significant level of 0.007 < 0.01 (1% error rate), finally the relationship between soil and plant (S and P) with correlation of 0.819 and significant level of 0.000 < 0.01 which explains a significant strong positive relationship.

Table 19: Pair Sample Test of Physicochemical parameters

		Paired Differences							
					95% Confidence Interval of the Difference				
Pairs	Seasons	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	D f	Sig. (2-tailed)
1	Water(D2) /Soil(S) 14	-35.56214	64.10204	17.13199	-72.57356	1.44927	-2.076	0.058	
2	Soil(S)/Plant(P) 14	-51.05000	120.39320	32.17644	-120.56296	18.46296	-1.587	0.137	

1. **First column**: The pair of variables being tested, and the order the subtraction was carried out.
2. **Mean:** The average difference between the two variables.
3. **Standard deviation:** The standard deviation of the difference scores.
4. **Standard error mean:** The standard error (standard deviation divided by the square root of the sample size). Used in computing both the test statistic and the upper and lower bounds of the confidence interval.
5. **t:** The test statistic (denoted *t*) for the paired T test.
6. **df:** The degrees of freedom for this test.
7. **Sig. (2-tailed)**: The *p*-value corresponding to the given test statistic *t* with degrees of freedom *df*.
8. If your calculated t value is greater than the critical T-value from the table, you can conclude that the difference between the means for the two groups is significantly different. We reject the null hypothesis and conclude that the alternative hypothesis is correct.

A paired sample t-test was also conducted to ascertain the effect ofthe parameters [pH, EC, Turbidity (NTU), DO, TDS, Hardness (mg$CaCO_3$), BOD, Alkalinity, Oil/Grease,

COD, Nitrate (mg/dm^3), Nitrite (mg/dm^3), Sulphate (mg/dm^3), and Chloride (mg/dm^3)] in the rainy season, dry season, control, soil and plant. The result indicates that:

There was no significant difference in the value of the parameters [pH, EC, Turbidity (NTU), DO, TDS, Hardness (mg$CaCO_3$), BOD, Alkalinity, Oil/Grease, COD, Nitrate (mg/dm^3), Nitrite (mg/dm^3), Sulphate (mg/dm^3), and Chloride (mg/dm^3)] with Water D2 (Mean = 29.1236, SD = 40.8694), Soil (Mean = 64.6857) and Plant (Mean = 115.7357, SD = 179.53705). D_2 - Soil (t (13) = -2.076, p = 0.58) and Soil-Plant (t (13) = -1.587, p = 0.137).

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

In evaluating the physicochemical parameters in water, during the rainy and dry season, from the dam, the wastewater exit-point of the treatment plant and the irrigated farm and also evaluating the parameters in the soil and plant, there was no significant difference in the value of the parameters when correlation coefficient analysis was done. On the basis of the statistical analysis the water, soil and plant were generally low in the physicochemical parameters studied.

In conclusion of the study it was observed that the control sample was contaminated when passing through the treatment plant since there was no much difference in the parameters analyzed at the wastewater exit of the treatment plant and the irrigated farm during the dry season. As the pH increased from the water to the soil, alkalinity and hardness also increased due to the presence of calcium, magnesium, carbonate and bicarbonate from the limestone in geological deposit. Obiofor *et al.* (2018) [5] found that soil fertility decreased with increase in altitude. This was similar to the result of the soil obtained.

It was recommended that the farmers should decide the problems related to soil and use fertilizer that will not enhance the productivity for economy. Chemical remediation included oxidation, reduction, hydrolysis, solubilication, dechlorination, pH manipulation. Bioremediation, reverse osmosis and best management skills could be recommendation for increasing the yield of plants.

REFERENCES:

1. Abel, O. T. and Tosin, J. K. (2019). Ground water Pollution and Remediation.Geology Dept. Ekiti State University, Ado- Ekiti, Nigeria. *Journal of Water Resource and protection*, **11**: 1.
2. Daniel, V.N., Chundusu, E.S., Chup, J.A., Pius, N. D. (2020). Variation of Heavy metals in Agricultural soils irrigated with Tin water in Heipang, Barkin- Ladi, Plateau State, *Nigeria.International Journal of Science and Technology*.**3**:5.
3. Chindo, I. Y., Amanki, E. D., Karu, E. and Ziyok, I. (2013). Physicochemical Analysis of Ground Water of Selected Areas of Dass and Ganjuwa Local Government Areas, Bauchi State, Nigeria. *World Journal of Analytical Chemistry*, **1** (4), 73-79.
4. Obiofor, O.C., Okoye P.A.C and Ekejiuba, I.O. (2018): Impact of textile wastewater on whole plants of Corchorous spp., Telfairiaspp, Celosia argentea and Amaranthus hybridus cultivated within farmlands in

Ibeshe, Ikorodu, Lagos state. *Journal of Chemical Society of Nigeria*. **43**(2), 339- 347.

5. Mohsen and Mohsen, (2018). Investigation of metals accumulation in some vegetables irrigated with wastewater in Shahre Ray-Iran and Toxicological implication. *America-Eurasian Journal of Agricultural and Environmental Science* **4** (1), 86-92.
6. Nnamani, E. V., Akpagu, F. C. and Eze, C. G. I. (2015). The Analysis of Selected Physico-chemical Parameters of water (A case study of Isu and Calabar Rivers in Ebonyi State, Nigeria), IOSR *Journal of Applied Chemistry*. **8**: 1.
7. Saidu, M., Agbese, E., Asogwa, E. and Gbongbo, J. (2020). Physico-chemical Analysis of Ground Water for domestic use in Some selected communities in Minna. *Environmental Technology and Science Journal*, **11**:1.
8. Kavitha, K., Jayanthi, J. and Ragunathan, M. G. (2017). Physicochemical parameters, Phytochemical analysis Acid and Basic radicals. Analysis of Leaf extract of *Hybanthusenneaspermus (L)*F. Muell. Dept of Advance Zoology & Biotech, GurNanak Coll, Chennai. *International Journal of Current Advanced Research*, **6** (11), 7634-39.
9. Yadav, A. K. (2016). *Physicochemical Studies on Assessment of Ground Water Quality of Kata District.A* PhD Thesis in the the Faculty of Science (Chemistry), PG School, Government College, Kata.
10. Chiroma, T.M., Ebewelo, R.O. Hyemore, F.K. (2019). Comparative Assessment of Heavy metal levels in soil, Vegetables and Urban grey wastewater used for irrigation in Yola and Kano. *International Referred Journal of Engineering and Science* **3**(2), 1-9.
11. Adefemi, S. O; Awokunmi, E. E. (2020). Determination of physic-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo state, Nigeria. *African journal of Environmental Science and Technology*.**4** (3):145-148.
12. Shubham, J. (2018). Quality analysis of Drinking Water a case studyof PCMC Pune. *Internetional Journal for Research in Applied Science and Engineering Techno*. (IJRASET) ISSN 2321-9 653.
13. Sunil, Vikas, K. B., Arum, K., Om, P and Prashant (2023). Physicochemical analysis of Soil. Dept. of Civil Engineering, Bansal Inst. of Engineering and Technology, Lucknow, *India.Inter. Journal of Creative Research Thoughts*. (IJCRT).**11**: 2.
14. Pramod, M. G. and Amruta, P. K. (2021). Study on Physico Chemical parameters of Soil sample, *International Advance Research Journal in Science, Engineering and Technology* **8**: 9.
15. Karande, S., Gamit, S and Prajapati, D. (2020). Analysis of Soil samples for its Physical and Chemical parameters from Mehsana and Patan Districts.Botany Dept., Mehsane Urban Institute of Science, Ganapat University.*International Reseach Journal of Science and Engineering* Special Issue A9.

16. Natalia, R.E., Michael, M., Daniel, P. (2018). *Soil Pollution: a hidden reality*. Executive Summary, F.A.O. publication P9.
17. Nwadiaro, P.O., Ogbonna, A. I., Moneme, J. C., Chuku. A. and Makut, M. D, (2015). Physico-chemical parameters and proteolytic potentials of fungal flora of soil stressed by tannery waste in Jos, Nigeria. *European Scientific Journal* **11**(9), 1857-7881
18. Teh, T., NikNorulaini, N. A. R., Shahadat, M., Wong, Y and Moh'd Omar, A. K. (2016). Risk Assessment of Metal contamination in Soil and Ground water in Assia: A review of Recent Treands as well as Existing Environment. Law and Regulation. *Pedosphere*, **26**: 4
19. Vogel, *et al*. (2017). *Textbook of Quantitative Chemical Analysis*, 6th edition, reprinted by Pearson Education Limited.
20. Syed, A. I. and Fethi, K. (2015): *Textbook of Water Chemisrty*, Discovery Publishing house PVT LTD. New- Delhi, India.
21. Uddin, M. A., Yusoff, F. M. and Hussain, M. A. (2016). Comparative Study of Three Digestion Methods for Elemental Analysis in Traditional Medicine Products using A.A.S. *Journal of Analytical Science and Technology*, **7** (6): 1-7.
22. Ojokuku, O. Godwin. (2001). '*Practical Chemistry for Schools and Colleges*'. Gbabek Publication.Ibadan Nigeria. New ed.
23. Shagufta B. Nangia. (2015): *Soil, Plant, Water and Fertilizer Analysis*, APH Publishing Corporation. New-Delhi- 110 002 India.
24. Patil, P. N. and Patil, R. N. (2017). Physico-chemical parameters for Testing of Water. A review. Univ. of technology and Applied Science, Maharashtra. India. *International Journal of Environmental Sciences*, **3**:3
25. Moh'd, A. A., Moh'd, J. M. and Ismail, Y. (2021). Soil Contamination: Risk Assessment and Remediation, Faculty of Sciences, Malaya University, Malaysia. (http://www.intrchopen.com>chapt matric overview, **14:** 964
26. Ismail, M and Umamahesh, M. (2018). *Analysis of Soil samples for its physico-chemical parameters in Adoni region, Kurnool District, (AP)*. Department of chemistry, Rayalasema University, Kurnool A.P. *Journal Emerging Technologies and Innovative Research* **5**: 4