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Research Article

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Special Issue

A Themed Issue in Honour of Professor Clement Uche Atuanya on His retirement.

This themed issue pays tribute to Professor Clement Uche Atuanya in recognition of his illustrious career in Metallurgical and Materials Engineering as he retires from Nnamdi Azikiwe University, Awka. We celebrate his enduring legacy of dedication to advancing knowledge and his impact on academia and beyond through this collection of writings.

Edited by
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Biochemical oxygen demand prediction model from chemical oxygen demand cum-extra principle parameters values in selected fish ponds wastewater around Nekede

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Abstract
Water is the most fundamental substance for the life and sustainability of terrestrial and aquatic organisms. Few issues have a greater impact on human lives in the life of the planet than on the management of the most important natural resources. The study was carried out using fish farming ponds selected around Nekede. Wastewater samples were harvested from five different artificial pond sources. The collected wastewater sample was tested for the following physicochemical parameters. PH. Temperature, BOD, and COD at the water laboratory. The two models one BOD with the expression $\mathrm{BOD} = 722722\delta^{0.196}\mathrm{f}^{-0.744}\mathrm{D}^{-1.785}\mathrm{T}^{1}\mathrm{pH}^{-3.405}\mathrm{COD}^{0.915}$ and COD with the expression $\mathrm{COD} = 0.168\delta^{-0.03}\mathrm{f}^{0.13}\mathrm{D}^{0.29}\mathrm{T}^{-0.27}\mathrm{pH}^{0.66}\mathrm{BOD}^{1.01}$ were successfully obtained through least regression process. For correlation analysis, the predictions were plotted against measured values and the r^2 values obtained are 0.9 and 0.8 which shows a strong relationship. Based on the model fitting comparison analysis using the Student-t test, the null hypothesis Ho was accepted, indicating no significant difference between the measured and predicted BOD and COD values, thus confirming the model's accuracy. Other parameters of the fishpond which include the volume of the pond, quantity of fish, density, feeding quantity per day, duration of the wastewater, and the GPIS data of those ponds were all measured. The COD parameter value was transformed into a model to predict the BOD parameter of pond wastewater. Two models were developed to accurately predict BOD or COD separately, using the measured values of other parameters, for fishpond wastewater.

Keywords: BOD, COD, Model, fish, pond, wastewater, physicochemical,

1.0 Introduction

The water resource is the most life-sustainable development of the human race, because of the scarcity of good water for the healthy living of people. In that aquatic system, poor management will yield to non or low harvest of aquatic animals such as fish, and that has pushed many to resort to the fishponds system of growing fish and other aquatic animals, (Amundson, et al., 2024). This study aims to develop a regression model for predicting BOD and COD in wastewater samples from fishponds by considering additional physicochemical and effluent variables. The motivation for this research stems from the challenges of delayed BOD values, the high costs of obtaining COD machines for small farms, and the resulting poor fish farming yield. The study, conducted around Nekede, seeks to monitor fishponds to identify high BOD and COD levels, facilitating timely water discharge for improved fish growth. The release of wastewater from fish farming ponds in Nekede has significant negative impacts due to high concentrations of nutrients, organic matter, and suspended solids. These issues are exacerbated by frequent pond drainage, leading to contaminated pond environments.

However, the water sample was characterized by water quality, pH, Temperature, and BOD/COD was obtained and the following parameters; Volume, Quantity of fish, Density, Feeding quantity per day, and Duration of the water, was measured and recorded. The above parameters were incorporated in the model prediction of the BOD/COD parameter of pond wastewater in Nekede. Relevant recommendations on the quality of the pond wastewater based on the findings were made.

Furthermore, the impact of fish farming on wild fish populations is significant, as it can lead to the transfer of disease and parasites to migrating fish due to the release of wastewater containing excess nutrients and fecal matter. Additionally, the equipment used in fish farming poses a problem for marine life, as seen in the case of Puget Sound's geoduck clam farming, which has affected the coastal ecosystem. Despite being a source of livelihood for many communities, the lack of information on the water quality condition of fish ponds is concerning, and proper monitoring and management of pond wastewater is essential for conserving natural resources and preventing environmental degradation. Modeling the chemical oxygen demand of pond wastewater is crucial for predicting and treating water quality variables, thereby safeguarding the ecosystem and addressing economic activities' impact on the environment. With a new understanding of the importance of water resources, there is a growing need to manage these natural resources effectively to mitigate their impact on human lives and the planet. (Khaled et al., 2022; Mekaoussi et al., 2023).

It's crucial to effectively monitor and manage the wastewater in the pond to preserve natural resources. Modeling the COD parameter is vital for relating important water quality variables to a common scale, enabling effective monitoring and prediction of the pond wastewater's biochemical condition. Understanding and modeling the chemical oxygen demand of pond wastewater is essential for wastewater treatment and predicting biochemical oxygen demand to protect the ecosystem and prevent environmental degradation. This knowledge is particularly important for Nekede as it supports economic activities that alleviate poverty, create employment, and enhance community development while safeguarding natural resources and food security. It's imperative to understand the extent of damage caused by these activities and implement remedial measures. The management of natural resources, especially water, has a significant impact on human lives and the planet. There is a growing recognition of the vital role of water in our lives, the economy, and the ecosystem (Kılıç, 2020).

In order of importance, water can be rated second after air as a necessity of life. Water is vital to human existence, given that over 90 percent of what is eaten comes in contact with water in some form and that more than 70 percent of waterborne disease pathogens live a fraction of their life cycles in water (World Health Organization, (2022).
Although water is essential for human beings, anthropogenic acts significantly impair quality. Pollution of the aquatic environment means the introduction by man, directly or indirectly of substances or energy which result in such deleterious effects as harm to living resources, hazards to human health, a hindrance to aquatic activities including fishing, impairment of water quality concerning its use in agricultural, industrial and often economic activities and reduction of amenities (Bashir, et al., 2020). Water pollution is a serious problem for the entire world. It threatens the health and well-being of humans, plants, animals, and aquatic life. As the world became more industrial and smaller due to communications and trade, accidental and purposive hazardous ponding especially fish farming ponds has contributed to the problem of water pollution.

All water pollution is dangerous to the health of living organisms, but sea and river pollution can be detrimental to the health of aquatic life and animals. Pollution of water resources by aquaculture effluents has been on the rise and has attracted the greatest amount of official attention in most nations (Bashir et al., 2020). Aquaculture is an important economic activity in many countries and offers opportunities that contribute to poverty alleviation, employment, community development, converting feed into protein for human consumption, and reduction of exploration of natural resources and food security in tropical and subtropical regions. However, environmental degradation from aquaculture practices has been reported especially in fish farming. Pond Fish farm effluents are probably the most common complaint in recent times. Water released from ponds has greater concentrations of nutrients, organic matter, and suspended solids following the majority of food that is completely drained at intervals into the pond. If not consumed by fish, the remnant of these feeds will decompose over time and deplete the water quality.

Water quality parameters alone can directly affect fish health. Exposure of fish to improper levels of dissolved oxygen, ammonia, nitrite, or hydrogen sulfide leads to stress and disease. Unbalanced levels of temperature and pH will increase the toxicity of ammonia and hydrogen sulfide; thus, proper management of ponds and maintaining balanced levels of water parameters is fundamental for both the health and growth of culture organisms and the success of pond operations (Oluborode et al. 2021). Finally, there is more literature on fish pond farming and its water quality, and the factors that affect the aquatic water, over a certain period. However, this study moves ahead to review water engineering works, water quality monitoring, and feed duration chat of fish below.

1.1 Water Engineering Works and Quality Monitoring

The early men did not need engineering work to supply and analyze their water. Rather they get their water from any wet point, stream, lake, etc. Early hunters and nomads settled at points where fresh water was available; the population was low such that much pollution of water did not occur. Horton selected the 10 most commonly measured water quality variables for his index including dissolved oxygen (DO), pH, coliforms, specific conductance, alkalinity, and chloride. The index weight ranged from 1 to 4 and the index score was obtained with a linear sum aggregation function. The function consisted of the weighted sum of the sub-indices divided by the sum of the weights and was multiplied by two coefficients M1 and M2, reflecting temperature and obvious pollution, respectively. Horton's pioneering effort has been followed up by several workers to formulate various WQI and their use has been strongly advocated by agencies responsible for water supply and control of water pollution ("8 Water Quality Goals." National Research Council/ National Academies of Sciences, Engineering, and Medicine. 2000; Akhtar et al., 2021; Melissa, 2023). Like Horton's index, it had a decreasing scale, with values expressed as a percentage of perfect water quality corresponding to 100%. Another multiplicative water quality index specifically designed for decision-making was developed by Kachroud et al. (2019) using an index method introduced by Delphi, (Huichao et al., 2023; Zhang Bike & Wu Ruichang 2023; Wang et al., 2023; Li et al., 2021).

The best water for fish culture is neutral or slightly alkaline (pH 6.5 – 8.5). Notably, pH less or greater than that range is toxic to fish and can induce stress or death. Notwithstanding, the major cause of fluctuation in pH is the presence of Carbon dioxide, dissolved minerals, and ammonia. Fish Pond Liming and treatment is necessary to correct acidic pH while the addition of Sodium bicarbonate to pond water under expert supervision can correct extreme alkaline conditions. You can determine the pH of your pond H20 by the use of pH indicator paper. The paper indicator changes color when dipped in pond water and the color is matched with the color indicated on the chart to determine the pH level of the water. On the other hand, the farm can choose to use an electronic pH meter (Andy et al., 2023).

The temperature of the pond water plays an important role since it affects the rate of dissolution of oxygen. In other words, cold water retains more oxygen than warm water. The optimal range for pond water temperature in aquaculture is 24 to 34 0C and 26 to 28 0C for rearing of fry and egg development. Fluctuations in temperature can induce stress and change to physiological characteristics of the fish. Therefore, the fish farmer is to check the temperature of the pond at intervals with a thermometer. Abnormally high temperatures can be controlled by mixing the water with colder water or by covering part of the pond from direct sunlight. On the other hand, lower temperatures can be controlled by installing a regulated heater, especially after rainfall or cold nights (Claude, 2018).

Lately, Brown and co-workers presented a WQI similar to Horton's index (Xue Han et al., 2022). He proposed a multiplicative form of the index where weights to individual parameters were assigned based on a subjective opinion based on the judgment and critical analysis of the author. The weight assigned reflected a parameter's significance for use and had a considerable impact on the index. Later on, similar indices have been formulated. (Banda and Kumarasamy, 2020; Nguyen et al., 2022). Several researchers have considered similar approaches which brought changes to the methodology depending on the usage and parameters under consideration, (Hamed, 2022). considered 13 different parameters of equal weight in their system (Sadhasivam et al., 2020). Values of these parameters are rated from 0 to 13 with values more than 8 denoting heavy pollution.

In Canada, the water quality index was introduced in mid 90's by the Water Quality Guidelines Task Group of the Canadian Council of Ministers of the Environment (Chidia et al., 2023). Newly developed CCMEWQI has been employed by various provinces and Ecosystems all across Canada to assess water quality (CCME, 2023). Monitoring is defined by the International Organization for Standardization (ISO) as the programmed process of sampling, measurement, and subsequent recording or signaling, or both of various water characteristics, often to assess conformity to specified objectives. WHO (2023), suggested that before the planning of water sampling and analysis can be started, it is necessary to define clearly what information is needed and what is already available and to identify the major objectives of the monitoring program and the gaps that need to be filled.

They recommend the preparation of a monitoring program or study plan that describes in detail the objectives and possible limitations of monitoring programs. They stated that if the objectives and limitations of the program are too vague, and the information needed is inadequately analyzed, the information gaps will be poorly identified and there will be danger of the program failing to produce useful data. They further stated that the monitoring requires some preliminary survey work. Then subsequent monitory identifies problems and problem area, short and long term trend and probable cause of the problems. Once sufficient data have been gathered it is possible to describe the average conduction, the variation from the average, and the extremes of water quality, expressed in terms of measurable physical, chemical, and biological variables. It is also noted that assessment of surface water condition must relate to values and problems of present or potential concern to the public, regulators, and scientists. These issues are referred to as values or endpoints of concern (Mahbubul, 2023); Mishra, 2021)).

In areas where water quality legislation is rudimentary or nonexistent as is the case of Nigeria of which the study area is a case in point, the water authority mandate may be to develop legislation and regulations appropriate to the country's economic development plan. In this case, the monitory objectives will probably focus on acquiring background information on water quality. The objective will change as information on water quality is accumulated, as problems emerge solutions are developed, and as new demands are made in the water resources (WHO, 2017).

1.2 Feed Duration Chart

The feed duration chart provides a feeding guide based on different feeding rates. It suggests the amount of feed you may need to feed your fish every month. However, it's just a guide and may not be entirely accurate. Fish may not consume all the feed allocated for the first and second months, but they may consume and exceed the quantity earmarked for later months. To start with, when feeding, you should ensure that the fish are fed to satiation (to a point when they no longer rush the feed) but do not overfeed them. Do not just dump all the feed you want to give them into the water at once, feed them either as they eat or give them a little and move on to the next pond or tank and come back to the starting point to give them more feed if they have exhausted the feed earlier given to them. Do this continuously until they are all tired of eating. As soon as you notice that there is still feed in a pond or tank after going around, do not feed that tank or pond again. It is an indication that they are tired of eating. Of course, as the day passes by, they should be eating slightly more food but if they eat less, then something is wrong. You should then try and find out what is the problem. Table 1 helps us with the monthly feed for 1000 fish.

Table 1: Present a monthly feeding duration on recommended feeding rates of 45 bags, 50 bags, and 67 bags per 1000 fish stocked,

MONTHS	NO. OF BAGS		
1ST	2	2	2
2ND	4	4	4
3RD	6	7	8
4TH	9	10	13
5TH	11	12	17
6TH	13	15	23
TOTAL	**45**	**50**	**67**

Sources: (**Dosaraf, 2018)**

This chart illustrates the feed distribution for every 1000 catfish stocked according to a recommended feeding rate of 45 bags (675kg), 50 bags (750kg), and 67 bags of feed per 1000 fish. For instance, adhering to the suggested stocking rate and other management parameters with floating feed should yield a total fish weight of approximately 675 kg from the 1000 fish stocked and fed with 750 kg of feed. It's important to note that the average feed conversion ratio for most floating feed is not less than 1kg feed to 900g (0.9kg) fish weight. This can serve as a basis for assessing fish performance. Evaluating your fish's performance solely on the number of fish stocked is incorrect; it should be based on the amount of feed they receive. This is why keeping a record of the quantity of feed purchased and fed to your fish from stocking to harvest is crucial.

2.0 Materials and Methods

2.1 Description of Study Area

The study was carried out at Federal Polytechnic Nekede, Owerri Imo State of Nigeria, using selected fish farming ponds center in Nekede. The area lies within the latitudes of 6o40'N and 1049'W and longitude 6067'N and 8017'W with an elevation of 317ft (97m) above sea level. Wastewater samples were collected at five different artificial pond sources. The collected wastewater Samples were tested for the following physiochemical parameters; pH, Temperature, COD, and BOD, at the water laboratory of the Department of Civil Engineering, Federal Polytechnic Nekede, Owerri.

2.2 Pond Surface Area Calculation

To find the surface area of a pond, you can rely on basic geometry and use the appropriate formula based on its shape; for circular ponds, multiply half of the pond's diameter by 3.14, and for rectangular ponds, multiply the length by the width.

2.3 Calculating Pond Volume

Calculating the volume of a pond requires you to first find the surface area, and then the average depth. To measure the average depth, measure the depth of the pond in at least three areas, including the shallowest and deepest parts of the pond, add them together, and then divide by the number of points you measured. The more points you measure, the more accurate your calculations. Once you've measured the surface area and average depth, multiply the average depth by the surface area.

2.4 pH

This is a measure of the acidity or alkalinity level of water. The pH scale ranges from 0 -14. The neutral pH point is 7, the pH above 7 is alkaline while below is acidic.
However, the cost of using the paper strips is cheaper than the pH meter as shown in Table 2.

Table 2: pH Table and level of risk

pH < 4	Acidic death point
4.0 – 5.0	No reproduction
4.0 – 6.5	Slow growth
6.5 – 8.5	Desirable range
9.0 – 11.0	Slow growth
pH > 11	Alkaline death point

2.5 Temperature

The temperature of the wastewater sample was promptly measured using a thermometer, as the environmental factors caused the temperature to fluctuate quickly after the sample was collected.

2.6 Biochemical Oxygen Demand - BOD

The determination of BOD helps determine the amount of dissolved oxygen required by aerobic biological organisms in water bodies, starting with proper sample dilutions, initial dissolved oxygen readings recorded, followed by a five-day incubation at 20℃ +/- 1℃, and calculations based on the difference between pre-incubation and post-incubation dissolved oxygen readings.

2.7 COD (CHEMICAL OXYGEN DEMAND)

To determine COD, add an excess of the dichromate ion to the sample, measure the amount of the ion through titration with ferrous ammonium sulfate, and express COD as mg/L, indicating the oxygen consumed per liter of solution.
The COD parameters in Nekede will be used to develop a model for predicting the BOD parameter of pond wastewater, resulting in valuable recommendations regarding the quality of wastewater from fish ponds. (Orobator et al., 2020)

2.8 Formulation of Empirical BOD and COD Regression Model

The study is based on the prediction of BOD and COD regression Models of wastewater samples from fishpond around Nekede Owerri Imo State Nigeria. The following parameters were observed which include; Volume of the pond, quantity of fish present in the pond and two help in density determination, quantity of feed the fish eat per day, duration of the water in the pond, temperature of the water sample, pH value, COD and BOD of the sample collected.

$$BOD = e^{\alpha_0} * \delta^{\alpha_1} * f^{\alpha_2} * D^{\alpha_3} * T^{\alpha_4} * pH^{\alpha_5} * COD^{\alpha_6} \quad (1)$$

Taking the natural logarithm of both the left and right hand side of Equation (2) made it a linear function as:

$$ln\ lnBOD = \alpha_0 + \alpha_1\ ln\ ln\ \delta + \alpha_2\ ln\ lnf + \alpha_3\ ln\ lnD + \alpha_4\ ln\ lnT + \alpha_5\ ln\ lnpH + \alpha_6\ ln\ lnCOD \quad (2)$$

$Replacing\ \ ln\ lnBOD, ln\ ln\ \delta\ , ln\ lnf, ln\ lnD, ln\ lnT, ln\ lnpH, and\ \ ln\ lnCOD$ by y x_1, x_2, x_3, x_4, x_5, and x_6 respectively gives:
In order to obtain α_1 (i = 0 to 6) through least square method the equation (3)–(12)
(Nhat-Duc, 2019; Nariman, 2019) as follows

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6\ That\ is:$$

$$y = \alpha_0 + \sum_{i=1}^{n=7} \alpha_i x_i \tag{3}$$

In order to obtain α_i (i = 0 to 7) through least square method the Equations (3.32) – (3.39) were obtain (Nhat-Duc, 2019; Nariman, 2019):

$$\sum y = n\alpha_0 + \alpha_1 \sum x_1 + \alpha_2 \sum x_2 + \alpha_3 \sum x_3 + \alpha_4 \sum x_4 + \alpha_5 \sum x_5 + \alpha_6 \sum x_6 \tag{4}$$

$$\sum x_1 y = \alpha_0 \sum x_1 + \alpha_1 \sum x_1^2 + \alpha_2 \sum x_1 x_2 + \alpha_3 \sum x_1 x_3 + \alpha_4 \sum x_1 x_4 + \alpha_5 \sum x_1 x_5 + \alpha_6 \sum x_1 x_6 \tag{5}$$

$$\sum x_2 y = \alpha_0 \sum x_2 + \alpha_1 \sum x_1 x_2 + \alpha_2 \sum x_2^2 + \alpha_3 \sum x_2 x_3 + \alpha_4 \sum x_2 x_4 + \alpha_5 \sum x_2 x_5 + \alpha_6 \sum x_2 x_6 \tag{6}$$

$$\sum x_3 y = \alpha_0 \sum x_3 + \alpha_1 \sum x_1 x_3 + \alpha_2 \sum x_2 x_3 + \alpha_3 \sum x_3^2 + \alpha_4 \sum x_3 x_4 + \alpha_5 \sum x_3 x_5 + \alpha_6 \sum x_3 x_6 \tag{7}$$

$$\sum x_4 y = \alpha_0 \sum x_4 + \alpha_1 \sum x_1 x_4 + \alpha_2 \sum x_2 x_4 + \alpha_3 \sum x_3 x_4 + \alpha_4 \sum x_4^2 + \alpha_5 \sum x_4 x_5 + \alpha_6 \sum x_4 x_6 \tag{8}$$

$$\sum x_5 y = \alpha_0 \sum x_5 + \alpha_1 \sum x_1 x_5 + \alpha_2 \sum x_2 x_5 + \alpha_3 \sum x_3 x_5 + \alpha_4 \sum x_4 x_5 + \alpha_5 \sum x_5^2 + \alpha_6 \sum x_5 x_6 \tag{9}$$

$$\sum x_6 y = \alpha_0 \sum x_6 + \alpha_1 \sum x_1 x_6 + \alpha_2 \sum x_2 x_6 + \alpha_3 \sum x_3 x_6 + \alpha_4 \sum x_4 x_6 + \alpha_5 \sum x_5 x_6 + \alpha_6 \sum x_6^2 \tag{10}$$

Equations (4) to (10) can be summarized in matrix equations as shown on Equation (11).

$$\begin{bmatrix} \sum y \\ \sum x_1 y \\ \sum x_2 y \\ \sum x_3 y \\ \sum x_4 y \\ \sum x_5 y \\ \sum x_6 y \end{bmatrix} = \left\{ \begin{matrix} n & \sum x_1 & \sum x_2 & \sum x_3 & \sum x_4 & \sum x_5 & \sum x_6 \\ \sum x_1 & \sum x_1^2 & \sum x_1 x_2 & \sum x_1 x_3 & \sum x_1 x_4 & \sum x_1 x_5 & \sum x_1 x_6 \\ \sum x_2 & \sum x_1 x_2 & \sum x_2^2 & \sum x_2 x_3 & \sum x_2 x_4 & \sum x_2 x_5 & \sum x_2 x_6 \\ \sum x_3 & \sum x_1 x_3 & \sum x_2 x_3 & \sum x_3^2 & \sum x_3 x_4 & \sum x_3 x_5 & \sum x_3 x_6 \\ \sum x_4 & \sum x_1 x_4 & \sum x_2 x_4 & \sum x_3 x_4 & \sum x_4^2 & \sum x_4 x_5 & \sum x_4 x_6 \\ \sum x_5 & \sum x_1 x_5 & \sum x_2 x_5 & \sum x_3 x_5 & \sum x_4 x_5 & \sum x_5^2 & \sum x_5 x_6 \\ \sum x_6 & \sum x_1 x_6 & \sum x_2 x_6 & \sum x_3 x_6 & \sum x_4 x_6 & \sum x_5 x_6 & \sum x_6^2 \end{matrix} \right\} * \begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} \tag{11}$$

Rearranging Equation (11) and making the unknown coefficient subject of the equation gives:

$$\begin{bmatrix} \alpha_0 \\ \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} = \left\{ \begin{matrix} n & \sum x_1 & \sum x_2 & \sum x_3 & \sum x_4 & \sum x_5 & \sum x_6 \\ \sum x_1 & \sum x_1^2 & \sum x_1 x_2 & \sum x_1 x_3 & \sum x_1 x_4 & \sum x_1 x_5 & \sum x_1 x_6 \\ \sum x_2 & \sum x_1 x_2 & \sum x_2^2 & \sum x_2 x_3 & \sum x_2 x_4 & \sum x_2 x_5 & \sum x_2 x_6 \\ \sum x_3 & \sum x_1 x_3 & \sum x_2 x_3 & \sum x_3^2 & \sum x_3 x_4 & \sum x_3 x_5 & \sum x_3 x_6 \\ \sum x_4 & \sum x_1 x_4 & \sum x_2 x_4 & \sum x_3 x_4 & \sum x_4^2 & \sum x_4 x_5 & \sum x_4 x_6 \\ \sum x_5 & \sum x_1 x_5 & \sum x_2 x_5 & \sum x_3 x_5 & \sum x_4 x_5 & \sum x_5^2 & \sum x_5 x_6 \\ \sum x_6 & \sum x_1 x_6 & \sum x_2 x_6 & \sum x_3 x_6 & \sum x_4 x_6 & \sum x_5 x_6 & \sum x_6^2 \end{matrix} \right\}^{-1} * \begin{bmatrix} \sum y \\ \sum x_1 y \\ \sum x_2 y \\ \sum x_3 y \\ \sum x_4 y \\ \sum x_5 y \\ \sum x_6 y \end{bmatrix} \tag{12}$$

For COD regression model the above process will be repeated by interchanging COD as the yield value y and BOD as the last element parameter x_6 as follows;
Putting $\delta = x_1$, $f = x_2$, Dur = x_3, Temp. = x_4, Ph = x_5, BOD = x_6, COD = y

$$COD = e^{\alpha_0} * \delta^{\alpha_1} * f^{\alpha_2} * D^{\alpha_3} * T^{\alpha_4} * pH^{\alpha_5} * BOD^{\alpha_6} \quad (13)$$

The whole process was recycled over again.

2.9 Statistics comparison analysis

The purpose of this analysis was to determine if the coefficients of correlation and regression model for the measured BOD and COD values are significantly different from zero, in order to assess the correlation of the predicted BOD and COD values. The statistical analysis involved calculating ;

The average difference, $\bar{d} = \frac{\sum d_i}{n}$ 14

Variance, $S_d^2 = \frac{\sum(d_i - \bar{d})^2}{N-1}$ 15

Standard deviation, $S_d = \sqrt{S_d^2}$ 16

t-Statistic $t = \frac{d}{\frac{S_d}{\sqrt{n}}}$ 17

Ho: $\mu_{1i} = \mu_{2i}$ (for all i), and that each pair of means are equal, any difference may have arisen by chance (or there is no significant difference in the two methods).
Hypothesis statement
Null Hypothesis:
Ho: all di ≠ 0; The null hypothesis stated that there is no significant difference between the measured and predicted BOD and COD values,
Alternative Hypothesis:
H_1: all $d_i = 0$; while the alternative hypothesis suggested a significant difference. Based on the computed t-values and the critical $t_{\alpha,v}$, we could accept or reject the null hypothesis at a specified level of significance.

3.0 Results

3.1 Data collection

The study of survey data and the necessary precaution for the collection of samples from selected fishponds were carefully carried and the result is presented in table form herein, Table 3 shows the information of longitude, latitude, elevation, length of the pond, height of the pond, the quantity of fish in the pond, the water level of the pond, the duration of the water in the pond and date the waste sample was harvested.

Table 3: Fish Pond Survey Data

S/N	SAMPLE	LONGITUDE	LATITUDE	ELEVATION	LENGTH OF POND	WIDTH OF POND	HEIGHT OF POND	QUANTITY OF FISH	WATER LEVEL	QUANTITY OF FEED	FEEDING DURATION	DATE OF WATER INPUT	DATE OF WATER COLLECTION
1.	Sample 1	5º 26' 38" N	7º 01 40" E	560m	3m	3m	1.2m	20 pieces	0.6m	1/2kg	1 day in & 1 day out	10/02/2022	14/02/2022
2.	Sample 2	5º 26' 45" N	7º 01 39" E	557m	1.8m	1.8m	1.2m	15 pieces	0.6m	1kg	Once daily	07/02/2022	14/02/2022
3.	Sample 3	5º 27' 24" N	7º 02 12" E	576m	4.4m	2.4m	1m	50 pieces	0.3m	3kg	2 times daily	10/02/2022	14/02/2022
4.	Sample 4	5º 26' 56" N	7º 02 24" E	576m	1.1m	0.8m	1m	200 pieces	0.35m	2 cups	2 time daily	11/02/2022	14/02/2022

5.	Sample 4	5º 26' 00" N	7º03' 24"E	572m	2.7m	2.7m	0.6m	100 pieces	0.25m	5 cups	2 times daily	12/02.2022	14/02/2022

The information in Table 3 helps the study to compute for Density parameter which is the volume of the pond divided by the number of fish. The feeding quantity and duration parameter. Other parameters which include pH, Temperature, BOD, and COD were carried out in the laboratory and their outcome was tabulated in Table 4.

Table 4: Sample Test Analysis

S/N	PARAMETERS	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
1	PH	5.60	5.93	6.57	5.96	5.92
2	Temperature (ºC)	27.8	27.7	27.7	27.8	27.9
3	BOD	1.04	2.25	0.83	2.50	1.08
4	COD	1.56	3.38	1.25	5.75	1.63

The computation of the parameters used as explained in the methods were carried out in the laboratory chemical parameters were all presented in Table 5.

TABLE 5: Measured valued of volume, density, duration and feeding/day

S/N	SAMPLE	Vol. m^3	ó = v Q	F.g	DURATION DAY	PRE. TEMPERATURE	PH	BOD	COD
1	Sample I	5.4	0.27	1000g	13	27.8	5.60	1.04	1.56
2	Sample II	1.94	0.13	1000g	16	27.7	5.93	2.25	3.38
3	Sample III	3.02	0.006	6000g	13	27.7	6.57	0.83	1.25
4	Sample IV	0.31	0.002	384g	12	27.8	5.96	2.50	3.75
5	Sample V	1.82	0.02	1280g	11	27.9	5.92	1.08	1.63

However, the parameters were further reduced and the temperature and pH value before the sample was deployed to the laboratory of BOD and COD was measured and recorded as pre-temperature and pre-pH value as presented in Table 6.

TABLE 6: Obtain value of density, feeding, duration, pre- temperature, pre-ph and BOD/COD

S/N	SAMPLE	$\delta = {}^{V}{}_{Q}$	F. (g)	DURATION DAY	PRE. TEMPERATURE	PRE. PH	BOD	COD
1	Sample I	0.27	1000	13	24.9	7.29	1.041	1.56
2	Sample II	0.13	1000	16	24.9	7.47	2.25	3.35
3	Sample III	0.006	600	13	24.9	7.66	0.83	1.25
4	Sample IV	0.002	384	12	24.9	7.21	2.50	3.75
5	Sample V	0.02	1280	11	24.9	7.18	1.08	1.63

3.2 Determination of Regression coefficient and Model

The parameters of Table 6 were further re-tabulated in the desired form of the regression model of BOD and COD by taking the natural logarithm of the measured values and representing them as x_1, x_2, x_3, x_4, x_5, and x_6 for the BOD and COD is y when it was used as the dependent variable. So Table 7 shows the starting point of BOD model regression and COD was labeled x_6.

Table 7: Tabulation of Parameters For Model Regression for BOD

YBOD	x_1	x_2	x_3	x_4	x_5	x_6	x_1y	x_1^2	x_1x_2	x_1x_3	x_1x_4
InBOD	Inδ	InF	InD	InT	InpH	InCOD					
0.040	-1.309	6.908	2.565	3.215	1.987	0.445	-0.053	1.714	-9.045	-3.358	-4.209
0.811	-2.040	6.908	2.773	3.215	2.011	1.209	-1.654	4.163	-14.093	-5.657	-6.559
-0.186	-5.116	6.397	2.565	3.215	2.036	0.223	0.953	26.173	-32.727	-13.122	-16.447
0.916	-6.215	5.951	2.485	3.215	1.975	1.322	-5.694	38.621	-36.981	-15.443	-19.979
0.077	-3.912	7.155	2.398	3.215	1.971	0.489	-0.301	15.304	-27.989	-9.381	-12.577

1.66	-18.59	33.32	12.79	16.07	9.98	3.69	-6.75	85.98	-120.83	-46.96	-59.77

Table 7: Continuation

x_1x_5	x_1x_6	x_2y	x_2^2	x_2x_3	x_2x_4	x_2x_5	x_2x_6	x_3y	x_3^2	x_3x_4	x_3x_5
-2.601	-0.582	0.278	47.717	17.718	22.208	13.722	3.072	0.103	6.579	8.246	5.095
-4.103	-2.467	5.602	47.717	19.152	22.208	13.891	8.351	2.248	7.687	8.914	5.575
-10.416	-1.142	-1.192	40.921	16.408	20.565	13.024	1.427	-0.478	6.579	8.246	5.222
-12.277	-8.214	5.453	35.410	14.787	19.131	11.755	7.865	2.277	6.175	7.989	4.909
-7.712	-1.911	0.551	51.189	17.156	23.001	14.104	3.496	0.185	5.750	7.709	4.727
-37.11	-14.32	10.69	222.95	85.22	107.11	66.50	24.21	4.33	32.77	41.10	25.53

Table 7: Continuation

x_3x_6	x_4y	x_4^2	x_4x_5	x_4x_6	x_5y	x_5^2	x_5x_6	x_6y	x_6^2
1.141	0.129	10.335	6.386	1.430	0.080	3.946	0.883	0.018	0.198
3.352	2.607	10.335	6.465	3.887	1.631	4.044	2.431	0.980	1.462
0.572	-0.599	10.335	6.546	0.717	-0.379	4.145	0.454	-0.042	0.050
3.284	2.946	10.335	6.351	4.249	1.810	3.902	2.611	1.211	1.747
1.172	0.247	10.335	6.337	1.571	0.152	3.886	0.963	0.038	0.239
9.52	5.33	51.68	32.08	11.85	3.29	19.92	7.34	2.21	3.69

Considering the model coefficient and anti-natural logarithm in Equation (1) for BOD the matrix Equation (11) was used and the Table 7 summation tabulated variable was substituted in Equation (11) to yield the matrix Equation (18) as shown.

$$\begin{bmatrix}\alpha_0\\ \alpha_1\\ \alpha_2\\ \alpha_3\\ \alpha_4\\ \alpha_5\\ \alpha_6\end{bmatrix} = \begin{bmatrix} 5 & -18.59 & 33.32 & 12.79 & 16.07 & 9.98 & 3.69\\ -18.59 & 85.98 & -120.83 & -46.96 & -59.77 & -37.11 & -14.32\\ 33.32 & -120.83 & 222.95 & 85.22 & 107.11 & 66.5 & 24.21\\ 12.79 & -46.96 & 85.22 & 32.77 & 41.1 & 25.53 & 9.52\\ 16.07 & -59.77 & 107.11 & 41.1 & 51.68 & 32.08 & 11.85\\ 9.98 & -37.11 & 66.5 & 25.53 & 32.08 & 19.92 & 7.34\\ 3.69 & -14.32 & 24.21 & 9.52 & 11.85 & 7.34 & 3.69\end{bmatrix}^{-1} \begin{bmatrix}1.66\\ -6.75\\ 10.69\\ 4.33\\ 5.33\\ 3.29\\ 2.21\end{bmatrix} \quad 18$$

The first dependent parameter of the matrix in Equation (14) is the Model coefficient as shown in Equation (1) the 7 x 7 matrix is the summation of tabulated variables and is now the coefficient of the dependent of the matrix while the constant matrix is the summation of the tabulated yield value and variables. So the inverse matrix was done with the help of Excel and it yielded Equation (19).

$$\begin{bmatrix}\alpha_0\\ \alpha_1\\ \alpha_2\\ \alpha_3\\ \alpha_4\\ \alpha_5\\ \alpha_6\end{bmatrix} = \begin{bmatrix} -3515.84 & -53.21 & 196.80 & 518.98 & -241.15 & 722.47 & 16.55\\ -.53.31 & -0.89 & 3.07 & 10.91 & -0.34 & 1.40 & -0.22\\ 196.80 & 3.07 & -9.62 & -37.04 & 2.44 & -17.52 & 0.80\\ 518.98 & 10.91 & -37.04 & -116.26 & 1.20 & 30.02 & 2.74\\ -241.15 & -0.34 & 2.44 & 1.20 & 21.24 & 75.27 & 2.83\\ 722.47 & 1.40 & -17.52 & 30.02 & 75.27 & -453.27 & -19.62\\ 16.55 & -0.22 & 0.80 & 2.74 & 2.83 & -19.62 & 0.49\end{bmatrix} \begin{bmatrix}1.66\\ -6.75\\ 10.69\\ 4.33\\ 5.33\\ 3.29\\ 2.21\end{bmatrix} \quad 19$$

The product of Equation (15) which is the matrix multiplication of the inverse and the constant matrix yields the values of the matrix-dependent variables which is the model coefficient of Equation (1) of BOD as presented in Equation (20).

$$\begin{bmatrix}\alpha_0\\\alpha_1\\\alpha_2\\\alpha_3\\\alpha_4\\\alpha_5\\\alpha_6\end{bmatrix} = \begin{bmatrix}13.491\\0.196\\-0.744\\-1.785\\1.000\\-3.405\\0.915\end{bmatrix} \quad (20)$$

The coefficient as obtained in Equation (20) was substituted in Equation (1) early and it yielded Equation (21) as presented.

$$BOD = e^{(13.491)} * \delta^{(0.196)} * f^{(-0.744)} * D^{(-1.785)} * T^{(1.00)} * pH^{(-3.405)} * COD^{(0.915)} \quad (21)$$

The same process was also followed in determining the COD model coefficient of Equation (13). Table 8 is the variable re-tabulation for the determination of COD model regression.

Table 8: Tabulation of Parameters for Model Regression for COD

YCOD	x_1	x_2	x_3	x_4	x_5	x_6	x_1y	x_1^2	x_1x_2	x_1x_3
InCOD	Inδ	InF	InD	InT	InpH	InBOD				
0.445	-1.309	6.908	2.565	3.215	1.987	0.040	-0.582	1.714	-9.045	-3.358
1.209	-2.040	6.908	2.773	3.215	2.011	0.811	-2.467	4.163	-14.093	-5.657
0.223	-5.116	6.397	2.565	3.215	2.036	-0.186	-1.142	26.173	-32.727	-13.122
1.322	-6.215	5.951	2.485	3.215	1.975	0.916	-8.214	38.621	-36.981	-15.443
0.489	-3.912	7.155	2.398	3.215	1.971	0.077	-1.911	15.304	-27.989	-9.381
3.69	-18.59	33.32	12.79	16.07	9.98	1.66	-14.32	85.98	-120.83	-46.96

Table 8: Continuation

x_1x_4	x_1x_5	x_1x_6	x_2y	x_2^2	x_2x_3	x_2x_4	x_2x_5	x_2x_6	x_3y	x_3^2
-4.209	-2.601	-0.053	3.072	47.717	17.718	22.208	13.722	0.278	1.141	6.579
-6.559	-4.103	-1.654	8.351	47.717	19.152	22.208	13.891	5.602	3.352	7.687
-16.447	-10.416	0.953	1.427	40.921	16.408	20.565	13.024	-1.192	0.572	6.579
-19.979	-12.277	-5.694	7.865	35.410	14.787	19.131	11.755	5.453	3.284	6.175
-12.577	-7.712	-0.301	3.496	51.189	17.156	23.001	14.104	0.551	1.172	5.750
-59.77	-37.11	-6.75	24.21	222.95	85.22	107.11	66.50	10.69	9.52	32.77

Table 8: Continuation

x_3x_4	x_3x_5	x_3x_6	x_4y	x_4^2	x_4x_5	x_4x_6	x_5y	x_5^2	x_5x_6	x_6y	x_6^2
8.246	5.095	0.103	1.430	10.335	6.386	0.129	0.883	3.946	0.080	0.018	0.002
8.914	5.575	2.248	3.887	10.335	6.465	2.607	2.431	4.044	1.631	0.980	0.658
8.246	5.222	-0.478	0.717	10.335	6.546	-0.599	0.454	4.145	-0.379	-0.042	0.035
7.989	4.909	2.277	4.249	10.335	6.351	2.946	2.611	3.902	1.810	1.211	0.840
7.709	4.727	0.185	1.571	10.335	6.337	0.247	0.963	3.886	0.152	0.038	0.006
41.10	25.53	4.33	11.85	51.68	32.08	5.33	7.34	19.92	3.29	2.21	1.54

However, the variable were also in synonymous with above process were substituted in matrix Equation (11) and it yield Equation (22).

$$\begin{bmatrix}\alpha_0\\\alpha_1\\\alpha_2\\\alpha_3\\\alpha_4\\\alpha_5\\\alpha_6\end{bmatrix}=\begin{bmatrix}5 & -18.59 & 33.32 & 12.79 & 16.07 & 9.98 & 1.66\\ -18.59 & 85.98 & -120.83 & -46.96 & -59.77 & -37.11 & -6.75\\ 33.32 & -120.83 & 222.95 & 85.22 & 107.11 & 66.5 & 10.69\\ 12.79 & -46.96 & 85.22 & 32.77 & 41.1 & 25.53 & 4.33\\ 16.07 & -59.77 & 107.11 & 41.1 & 51.68 & 32.08 & 5.33\\ 9.98 & -37.11 & 66.5 & 25.53 & 32.08 & 19.92 & 3.29\\ 1.66 & -6.75 & 10.69 & 4.33 & 5.33 & 3.29 & 1.54\end{bmatrix}^{-1}\begin{bmatrix}3.69\\-14.32\\24.21\\9.52\\11.85\\7.34\\2.21\end{bmatrix} \quad 22$$

The matrix inverse of Equation (22) was done and it yield matrix Equation (23).

$$\begin{bmatrix}\alpha_0\\\alpha_1\\\alpha_2\\\alpha_3\\\alpha_4\\\alpha_5\\\alpha_6\end{bmatrix}=\begin{bmatrix}-3576.42 & -53.31 & 197.21 & 518.12 & -250.95 & 771.63 & 15.77\\ -.53.31 & -0.87 & 3.02 & 10.75 & -0.36 & 1.86 & -0.24\\ 197.21 & 3.02 & -9.41 & -36.47 & 2.54 & -19.26 & 0.87\\ 518.12 & 10.75 & -36.47 & -114.71 & 1.16 & 26.86 & 2.91\\ -250.95 & -0.36 & 2.54 & 1.16 & 19.66 & 82.98 & 2.71\\ 771.63 & 1.86 & -19.26 & 26.86 & 82.98 & -483.64 & -19.42\\ 15.77 & -0.24 & 0.87 & 2.91 & 2.71 & -19.42 & 0.50\end{bmatrix}\begin{bmatrix}3.69\\-14.32\\24.21\\9.52\\11.85\\7.34\\2.21\end{bmatrix} \quad 23$$

In vain the matrix multiplication operation in Equation (23) yields the coefficient of COD model regression in Equation (13) which is the dependent variable of matrix Equation (24).

$$\begin{bmatrix}\alpha_0\\\alpha_1\\\alpha_2\\\alpha_3\\\alpha_4\\\alpha_5\\\alpha_6\end{bmatrix}=\begin{bmatrix}-1.78\\-0.03\\0.13\\0.29\\-0.27\\0.66\\1.01\end{bmatrix} \quad 24$$

Finally, the coefficient values were substituted in COD raw regression Equation (13) and it yielded Equation (25) as presented herein.

$$COD = \ e^{(-1.78)} * \delta^{(-0.03)} * f^{(0.13)} * D^{(0.29)} * T^{(-0.27)} * pH^{(0.66)} * BOD^{(1.01)} \quad (25)$$

In common expression, BOD and COD predicted models are as follows presented in Equations (26) and (27) respectively:

$$BOD = 722722\delta^{0.196}f^{-0.744}D^{-1.785}T^{1}pH^{-3.405}COD^{0.915} \quad 26$$

$$COD = 0.168\delta^{-0.03}f^{0.13}D^{0.29}T^{-0.27}pH^{0.66}BOD^{1.01} \quad 27$$

3.3: Correlation Comparison Analysis

These two regression models were used in predicting BOD and COD values when other parameters were substituted and their values were tabulated in Table 9. So the measured values are BOD and COD while the predicted values are $BOD_{predicted}$ and $COD_{predicted}$. The correlation comparison analysis of the two model were carried out with the help of graphs were the r^2 values were obtained which shows how strong their relationship is. Secondly T-Student statistic distribution test was also carried out and the significant percentage erro differences, shows how quality of the model is in prediction of BOD and COD value.

Table 9: The measured and predicted BOD and COD values of the fish pond used

S/N	SAMPLE	$\underline{X}_{parameter}$	BOD	COD	$BOD_{predicted}$	$COD_{predicted}$
1	Sample I	209.1	1.0	1.6	1.45	1.46
2	Sample II	209.7	2.3	3.4	1.61	3.52
3	Sample III	129.1	0.8	1.3	0.70	1.26
4	Sample IV	85.6	2.5	3.8	3.03	3.52
5	Sample V	264.6	1.1	1.6	1.08	1.60

However, from Table 9; the Figure 1 through 6 was plotted, for correlation statistics comparisons were the root mean square were obtained of difference relationship.

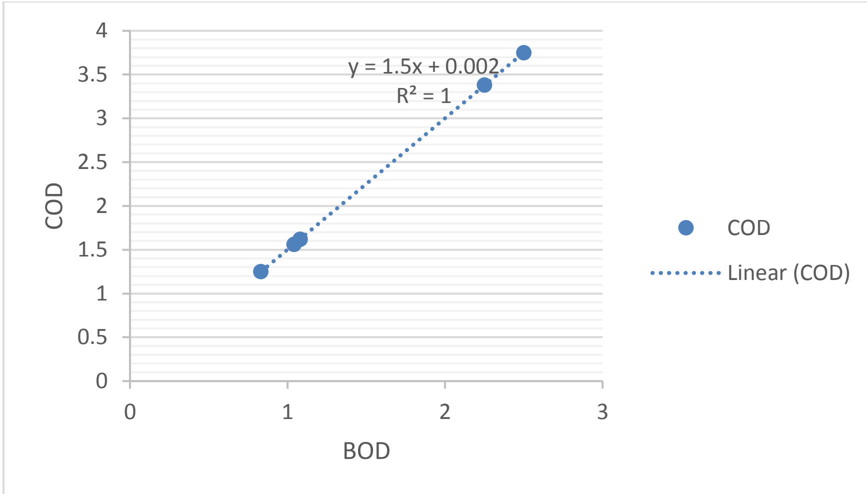

Figure 1: Relation graph of measured COD against BOD

Figure 1 shows the presentation relationship of COD measured against BOD measured from the experiment of the wastewater sample of fish pond and on linear relationship give a perfect r^2 value of 1.
While Figure 2 reviews the presentation of the both measured of BOD and COD against average sum of other contributing parameter of the model. Under the polynomial relationship their r2 values are 0.71 and 0.67 for BOD and COD respectively.

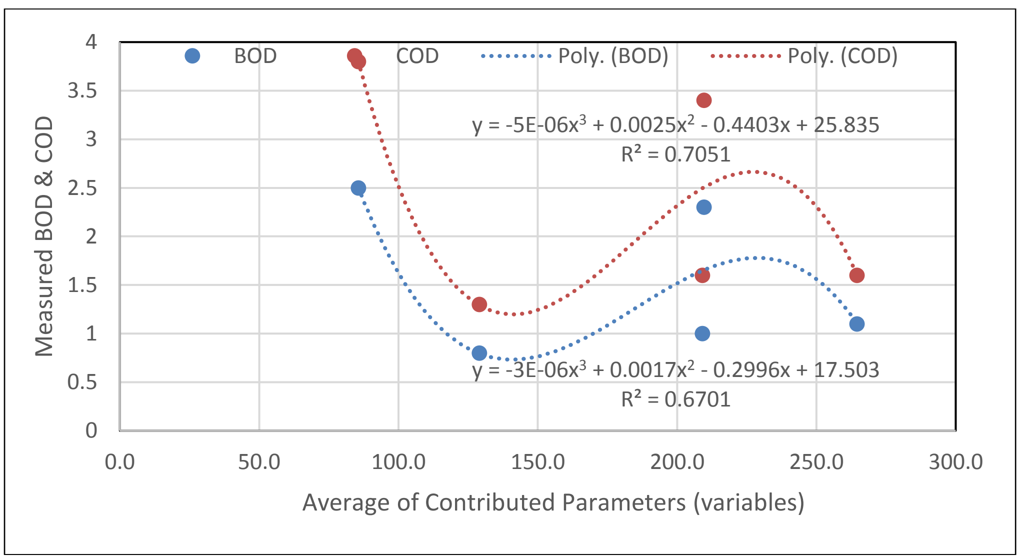

Figure 2: Presentation of Measured BOD/COD against Other Parameters

In continuation, the Figure 3, shows the graphical relationship of the BOD predicted values against BOD measured values, which is a scattered diagram and linear trained of relation was used on it and the r^2 values yield 0.7.

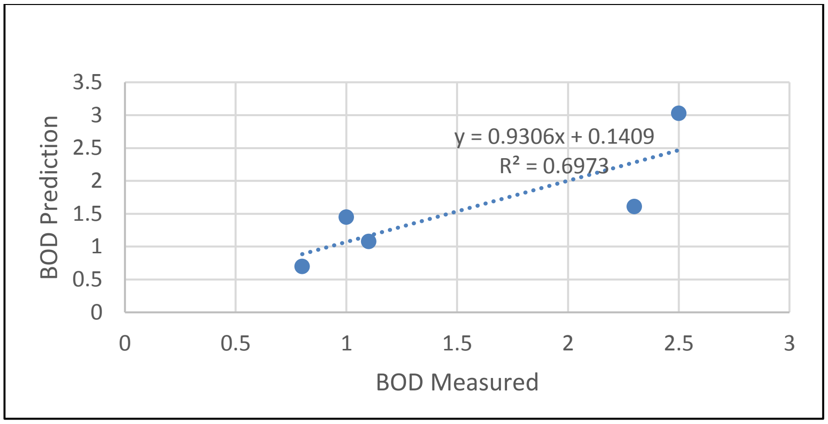

Figure 3: Relation of BOD Prediction value against BOD Measured

In turn figure 4 shows the relationship of COD, the predicted was plotted against measured experimental values, in linear trend relation give r^2 perfect values of 0.983.

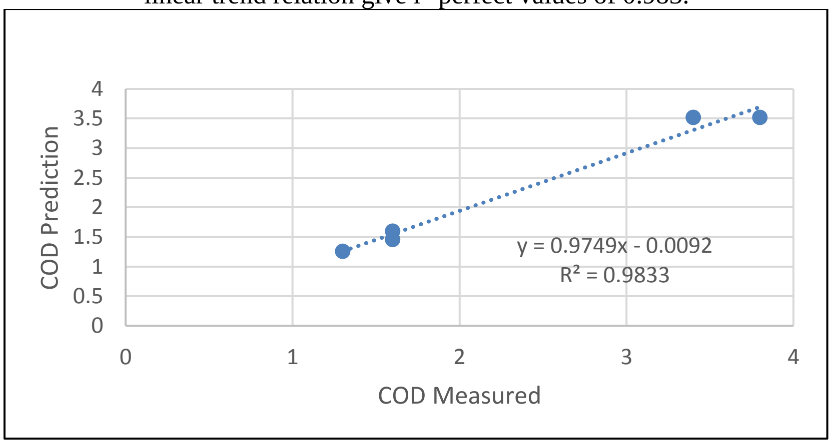

Figure 4: Presentation of COD Prediction value against COD Measured

Further more, Figure 5 shows the comparison of the predicted values of COD and BOD, and in the same linear relation r^2 values is 0.612.

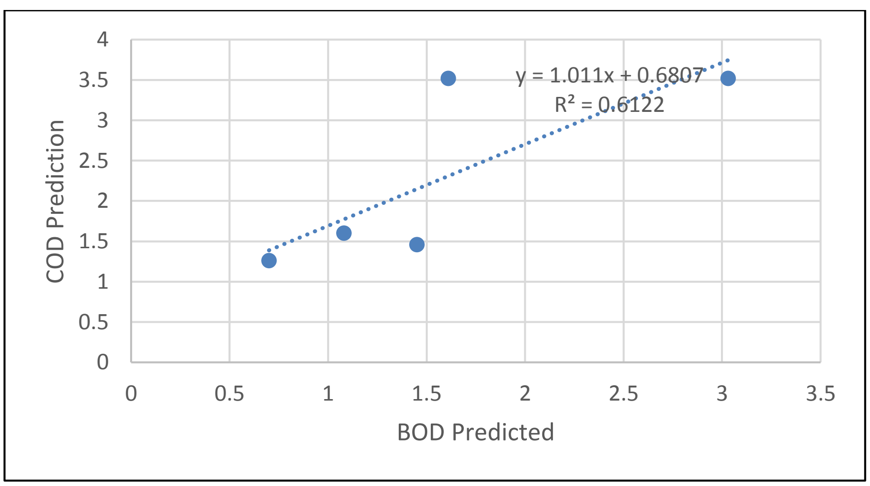

Figure 5: graph representation of predicted COD against Measured COD.

Finally, Figure 6 is graphical presentation of BOD and COD predicted values plotted against the average sum of other parameters of the model. The trend of polynomial relation over the scattered graph gives r^2 values of 0.6 and 0.996 for both BOD and COD respectively.

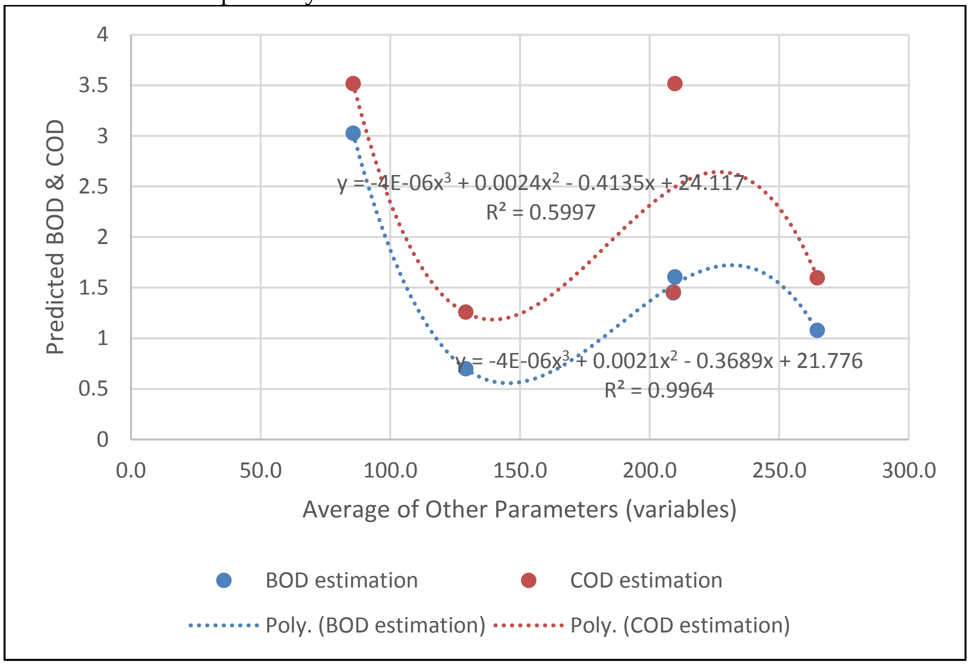

Figure 6: relation of Predicted BOD & COD against other parameters

3.5 Model Fitting of comparison analysis

This statistics analysis was carried out to no the significant difference between measured and predicted BOD and COD. Table 10 was used to obtain the difference of the BOD measured and predicted values which will enable the statistical computation of the variables of statistics for the calculation of T-student test value.

Table 10: Test for the significance of measured and predicted BOD

S/No.	**BODm**	**BODp**	**BmBp**	**BOD_m^2**	**BOD_p^2**	**$d_i = B_m - B_p$**	$d_i - \bar{d}$	$(d_i - \bar{d})^2$
1	1.0	1.45	1.45	1	2.1025	-0.45	-0.551	0.303601
2	2.3	1.61	3.703	5.29	2.5921	0.69	0.589	0.346921
3	0.8	0.7	0.56	0.64	0.49	0.1	-0.001	1E-06
4	2.5	3.03	7.575	6.25	9.1809	-0.53	-0.631	0.398161
5	1.1	1.08	1.188	1.21	1.1664	0.02	-0.081	0.006561
∑	6.7	7.87	14.476	14.39	15.5319	-0.17	-0.675	1.055245

The calculation of the different data value the engagement of equations 14 through 17 was caired out which yield the values of statistical tendancy and T-statistic are as follows. The average Difference is -0.034, Variance is 0.26381125, Standard Deviation is 0.513625593, and t-statistic is -0.148018931

However, for the return of the two tail of the data computation of the T-student test values, excel program was employed in the computation and the statistics variables that was compute using excel were tabulated in Table 11.

Table 11: Excel computation of T-student test for BOD parameters

Statistics Variables	BODm	BODp	difference	T-Test Table Values 1% & 5% at 4 degree of freedom	
mean	1.675	1.574	0.101		
variance	0.7225	0.78613	-0.06363		
Standard Deviation	0.85	0.88664	-0.03664	$t_{0.005,4}$	$t_{0.05,4}$
T-Student		0.958676	1.043106	4.60	2.78
T.Test	0.86719	0.797387			
F.Test	0.984166				
T.Diff	0.091486	%Diff	10%	Ho	Accept
F.Diff	-0.02549	%Diff	-3%		

So, going by the t-statistics which is -0.148018931 and that of excel calculated results, the initial Test of Hypothesis is Accepted base on the fact that the T-Test values that was return by excel by 2,3 tails is 0.86719 and 0.797387 for BODm (which Biological Oxygen Demand measured) and BODp (which is Biological Oxygen Demand predicted) respectively. Comparing it with the T-student calculated results of the two which 0.958676 and 1.043106 which results in 10 and -3% difference. For the Table result of T-test the percentage point for two-tailed test at 1% level and four degree of freedom is $t_{0.005,4}$ = 4.60. Because the computed /t/ is less than $t_{0.005,4}$, the result is not significant at 1% level (that is, accept Ho). Also at 5% level of significance and 4 degree of freedom, $t_{0.05,4}$, = 2.78, the result is not significant, thus Ho is accepted.
However, Table 12 was utilized to calculate the variance between the measured and predicted COD values, enabling statistical computation of the variables for the T-student test value.

Table 12: Test for the significance of measured and predicted COD

S/No.	CODm	CODp	CmCp	Cm^2	Cp^2	**di = C_m - C_p**	$d_i - \bar{d}$	$(d_i - \bar{d})^2$
1	1.6	1.46	2.336	2.56	2.1316	0.14	0.039	0.001521
2	3.4	3.52	11.968	11.56	12.3904	-0.12	-0.221	0.048841
3	1.3	1.26	1.638	1.69	1.5876	0.04	-0.061	0.003721
4	3.8	3.52	13.376	14.44	12.3904	0.28	0.179	0.032041
5	1.6	1.6	2.56	2.56	2.56	0	-0.101	0.010201
$\sum$	11.7	11.36	31.878	32.81	31.06	0.34	-0.165	0.096325

The calculation of the different data values of COD measured and predicted. To known if there is significant different we employed equations 14 through 17 and the values of the statistical tendency and T-statistic are as follows. The average Difference is 0.068, Variance is 0.02408125, Standard Deviation is 0.155181346 and t-statistic is 0.979838279. In other to calculating the T-student test values of the two tail of the data of CODm and CODp, we utilized the Excel program for the computation, and the statistical variables computed using Excel were listed in Table 13. Based on the t-statistics which is 0.979838279 and Excel-calculated results, the initial Hypothesis Test is accepted as the T-Test values returned by Excel for CODm and CODp are 0.1.017178 and 0.983112 respectively, while the calculated T-student results differ by 9% and 4%. The computed /t/ is less than $t_{0.005,4,}$ making the result not significant at the 1% and 5% levels of significance with 4 degrees of freedom, leading to the acceptance of Ho.

3.6 Findings summary

This study has fully shown a successful outcome for all stated to achieve in line with objective. Samples of waste water were successfully harvested from selected fishpond with duration of the water above 10 days around Nekede Owerri Imo State Nigeria. In the process of sample collection the following parameters was tabulated and record down, Volume of fishpond, Quantity of fish, Density, Feeding quantity per day, Duration of the water as well as the GPIS data. The characterize of the waste water samples was carried out with the observation of all the precaution and following the test procedures and the parameters tested includes; pH, Temperature, and BOD/COD. The formulation of the two model regression of BOD and COD was successful carried out using least square regression of polynomial and matrix after the braking down with natural logarithm. Then the coefficient of the regression equation was substitute back into the formulated equation and the equation was also used in carrying out a prediction of BOD and COD. The value of the predicted and Measured BOD and COD was tabulated in Table 9.

Table 13: Excel computation of T-student test for COD parameters

Statistics Variables	CODm	CODp	difference	T-Test Table Values 1% & 5% at 4 degree of freedom	
mean	2.34	2.272	0.068		
variance	1.358	1.31252	0.04548		
Standard Deviation	1.165333	1.145653	0.01968	$t_{0.005,4}$	$t_{0.05,4}$
T.Student		1.017178	0.983112	4.60	2.78
T.Test	0.928156	0.370155			
F.Test	0.974457				
T.Diff	0.089022	%Diff	9%	Ho	Accept
F.Diff	0.042721	%Diff	4%		

The presentation of the result was further presented in Figure 1 through 6, and their r^2 show that there is a strong relation between the measured values, and predicted values. The two predicted regression model equation show the contribution to knowledge is presented as follows.

$$BOD = 722722\delta^{0.196}f^{-0.744}D^{-1.785}T^{1}pH^{-3.405}COD^{0.915} \quad 26$$

$$COD = 0.168\delta^{-0.03}f^{0.13}D^{0.29}T^{-0.27}pH^{0.66}BOD^{1.01} \quad 27$$

Which is the equation (22) and Equation (23) as early presented. Looking at the study a lot of benefit from it is immeasurable and can as well saver as the recommendation as early stated in objective of this study. It was observed in this study the BOD and COD value of the samples collected were have low showing that the fish cannot survived in high BOD and COD aquatic system it can be called a fresh fish aquatic animals. The study has exposed well knowledge of fish training for the novice. We also recommend this system of study to fish farmers to check the parameters of this model regularly and know the state of their pond in other to have a hug harvest.
However, Mekaoussi (2023) worked on the prediction of BOD and COD with model that incorporated TSS (Total Suspended Solids), TDS (Total Dissolved Solids), AMN (Ammoniacal Nitrogen), TOC (Total Organic Carbon), and KJN (Kjeldahl's Nitrogen) in refinery wastewater using multilayer artificial neural Networks. Adel (2018) model an empirical regression model for BOD and COD efficiency removal from sewage treatment in solar enhanced waste stabilization pond (SEWSP) with the following; e-coli, dissolve oxygen DO, Temperature, detention time and coliform as variables of the predicted models.
Finally, comparison statistical analysis of Hypothesis test was carried out and in all the acceptance of the initial hypothesis Ho was uphold because there is no significant difference in all the computed T-test for the predicated and measured values of BOD and COD respectively.

4.0 Conclusion

This study Biochemical Oxygen demand prediction model from chemical Oxygen demand cum-extra principle parameters values in selected fish ponds wastewater around Nekede, has fully shown a successful outcome for all stated to achieve in line with the objective. The study was focus on prediction of BOD and COD model from samples of wastewater harvested from selected fishpond with duration of the water above 10 days around Nekede Owerri Imo State Nigeria. In the process of sample collection, the following parameters were tabulated and recorded down, Volume of fishpond, Quantity of fish, Density, Feeding quantity per day, Duration of the water as well as the GPIS data. The models were formulated, correlation analysis was successfully show a strong relationship, and finally T-student test of significance shows no significant different thus prove the adequacy of the model, the details are as follows;

Firstly, the characterized wastewater samples drone out with the observation of all the precaution and following the test procedures and the parameters tested includes; pH, Temperature, and BOD/COD. The formulation of the two model regression of BOD and COD was successfully carried out using least square regression of polynomial and matrix after the breaking down with natural logarithm. Then the coefficient of the regression equation was substituted back into the formulated equation and the equation was also used in carrying out a prediction of BOD and COD. The value of the predicted and Measured BOD and COD was tabulated in Table 9. The presentation of result was further presented in Figure 1 through 5, and their r^2 show that there is a strong relation between the measured values, and predicted values. The two predicted regression model equations show the contribution to knowledge is presented as follows.

$$BOD = 727722\delta^{0.196}f^{-0.744}D^{-1.785}T^{1}pH^{-3.405}COD^{0.915}$$

$$COD = 0.168\delta^{-0.03}f^{0.13}D^{0.29}T^{-0.27}pH^{0.66}BOD^{1.01}$$

Equation (22) and Equation (23) as early presented. Looking at this study a lot of benefits from it are immeasurable and can as well saved as the recommendation as stated in the objective of this study.

After conducting a comparison statistical analysis of the Hypothesis test, it was found that the initial hypothesis Ho was upheld as there was no significant difference in the computed T-test for the predicted and measured values of BOD and COD.

Finally, in this study the BOD and COD values of the samples collected were low showing that the fish cannot survive in high BOD and COD aquatic systems they can be called fresh fish aquatic animals. The study has exposed well knowledge of fish training for the novice. We also recommend this system of study to fish farmers to check the parameters of this model regularly and know the state of their pond in other to have a huge harvest.

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