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Fluctuation Of Citrobacter Transport Influenced By High Porous Medium In Homogeneous Silty Formation In Saline Environment

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ABSTRACT

This paper monitor the deposition of Citrobacter in high porous medium in saline environment, the study investigate the behaviour of the contaminant in saline environment, the application of deterministic model developed simulation values that express the behaviour and effect from high porous medium, such shallow phreatic bed were observed to experiences fluctuation in soil porosity thus reflecting on the rate of concentration. The simulation developed locations that the concentration generated fluctuation to the depth were it was in significant in the formation, this was observed to be in an area were Citrobacter experiences degradation due to lack of microelement for growth. Moreso its deposition in shallow Phreatic zone has evaluated the rate of transport with respect to time and depth from the study carried out, it was observed to be predominantly influenced by high porosity in the formation, the influences of alluvium deposit in these condition could not influences the aquiferous zone by uniformity of the Phreatic deposited strata. Formation characteristics stated above were found significant in the migration of Citrobacter from surface to phreatic zone. The models were simulated and it produced theoretical values compared with other measured results, both parameters developed a favuorable fits validating the model.

Key words: *Fluctuation, Citrobacter transport, high porous medium, silty formation and saline environment*

Introduction

The effectiveness microbes to be convert ass absorbed soil carbon into microbial biomass have been called the microbial growth efficiency (Y), carbon-use efficiency, or substrate-use effectiveness. This physiological features of the microbial biomass powerfully pressure overall soil unrefined carbon (SOC) budgets and carbon sequestration in ecosystems (3). Since: nutrient ratios in microbial biomass differ over comparatively narrow ranges Y also contributes to regulation of nitrogen (and other nutrient) mineralization and immobilization in soils (3). Measurements of microbial growth efficiency in soil span a surprisingly wide range, from 0.14 to 0.77 (4, 6, 5). Despite the high variability of this integrative trait and its importance in influencing organic matter turnover and nutrient availability, we have limited understanding of how environmental variables influence growth efficiency (15, 3; and 5). The size and structure of the soil microbial population is a role of net primary making, plant carbon (C) portion, rhizosphere activity, and litter substrate superiority (11,10,7,and 9), and is controlled through complex communications with plants (12,13and 14). Changes in atmospheric CO2 concentration and nitrogen (N) deposition rates alter both the quality and quantity of above- and belowground plant litter inputs to soil (2, 8,14,), which in turn can affect belowground microbial society arrangement and function (4,15,and17). Considering the mechanisms controlling belowground C processes is useful in predicting future changes in soil C stores in response to climate and land-use change (17). Altering root and coarse woody debris (CWD) inputs to soil is one method to examine the feedbacks between plants, microbes, and soil organic matter (SOM) dynamics [18, 19]. In a Douglas-fir forest, 7 y of CWD additions and litter and root exclusion have produced significant changes in annual soil CO2 efflux (16, 11].

Governing equation

$$K\frac{\partial^2 c}{\partial t^2} = D\frac{\partial c}{\partial Z} - U\lambda\frac{\partial c}{\partial Z} \qquad (1)$$

Nomenclature

C = Citrobacter concentration $[ML^{-3}]$
λ = Saline concentration $[ML^{-3}]$
K = Permeability $[LT^{-1}]$
U = Velocity $[LT^{-1}]$
T = Time [T]
Z = Depth [L]

Let $C = T, Z$

$$KT^{11}Z = DTZ^1 - U\lambda TZ^1 \qquad (2)$$

$$K\frac{T^{11}}{T} = D\frac{Z^1}{Z} - U\lambda\frac{Z^1}{Z} \qquad (3)$$

$$K\frac{T^{11}}{T} = \theta^2 \qquad (4)$$

$$D\frac{Z^1}{Z} = \theta^2 \qquad (5)$$

$$-U\lambda\frac{Z^1}{Z} = \theta^2 \qquad (6)$$

$$[D - U\lambda]\frac{Z^1}{Z} = \theta^2 \qquad (7)$$

$$K\frac{dc}{dt} = \theta^2 \qquad (8)$$

$$K\frac{d^2c}{dt^2} = \theta^2 \qquad (9)$$

$$D\frac{dc}{dZ} = \theta^2 \qquad (10)$$

(11)

$$d^2Z = \left[\frac{\theta^2}{K}\right] = dZ \qquad (12)$$

$$\int d^2 = \int\frac{\theta^2}{K}dZ \qquad (13)$$

$$dZ = \frac{\theta^2}{K}Z + C_1 \qquad (14)$$

$$\int dZ - \int\frac{\theta^2}{K}Z\ dZ + C_1\int dZ \qquad (15)$$

$$Z = \frac{\theta^2}{K}\frac{Z^2}{2} + C_1 + C_2 \qquad (16)$$

$$Z = \frac{\theta^2}{K}\frac{Z^2}{2} + C_{1^2} + C_2 \tag{17}$$

$$\boxed{Z = \frac{\theta^2}{K} Z^2 + C_{1^2} + C_2} \tag{18}$$

$$\Rightarrow \frac{\theta^2}{2K} Z^2 + C_{1^2} + C_2 = 0$$

(19)

Auxiliary equation becomes

$$\frac{\theta^2}{2K} M_2 + C_2 M + C_2 = 0 \tag{20}$$

Applying quadratic expression, we have

$$M_{1^2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \tag{21}$$

$$M = \frac{-C_1\sqrt{C^2 - 4\frac{(\theta^2)}{2K}C_2}}{2\frac{\theta^2}{K}} \tag{22}$$

$$M_1 = \frac{-+C_1\sqrt{C^2 - 2C_2\frac{\theta^2}{K}}}{2\frac{\theta^2}{K}} \tag{23}$$

$$M_2 = \frac{-C - \sqrt{C_1^2 - 2C_2\frac{\theta^2}{K}}}{2\frac{\theta^2}{K}} \tag{24}$$

Assuming this discriminant is complex, therefore equation (23) and (24) can be written as:

$$C[T,Z] = F1\,Cos M_1 t + F2\,Sin M_2 Z \tag{25}$$

But if But if $t = \frac{d}{v}$ and $Z = v \cdot t$

The expressed model can be written as

$$C[T,Z] = F1\,Cos M_1 \frac{d}{v} + F2\,Sin M_2 V \cdot t \tag{26}$$

Material and Method

Column experiments were also performed using soil samples from several borehole locations, the soil samples were collected at intervals of three metres each (3m). A Citrobacter solute was introduced at the top of the column and effluents from the lower end of the column were collected and analyzed for Citrobacter. The effluents at the down of the column were collected at different depth and days for thorough analysis. This experiment was performed to compare with the theoretical values for model validation.

Results and Discussion

Results and discussion are presented in tables including graphical representation of Citrobacter concentration.

Table 4.1: Theoretical values of Citrobacter at Different Depth

Depth [m]	Theoretical Values Conc.
3	1.45E-04
6	2.89E-04
9	4.26E-04
12	5.77E-04
15	7.23E-04
18	8.65E-04
21	9.88E-04
24	1.24E-04
27	1.34E-05
30	1.52E-05

Table 4.2: Theoretical values of Citrobacter at Different Time

Time per day	Theoretical Values Conc.
10	1.45E-04
20	2.89E-04
30	4.26E-04
40	5.77E-04
50	7.23E-04
60	8.65E-04
70	9.88E-04
80	1.24E-04
90	1.34E-05
100	1.52E-05

Table: 4.3 Theoretical and Measured values of Citrobacter Concentration at Different depth

Depth [m]	Theoretical Values Conc.	Measured Values
3	1.45E-04	1.62E-04
6	2.89E-04	3.22E-04
9	4.26E-04	4.72E-04
12	5.77E-04	6.22E-04
15	7.23E-04	7.57E-04
18	8.65E-04	9.32E-04
21	9.88E-04	1.25E-05
24	1.24E-05	1.32E-05
27	1.34E-05	1.39E-06
30	1.52E-05	1.48E-06

Table: 4.4 Theoretical and Measured values of Citrobacter Concentration at Different Time

Time per day	Theoretical Values Conc.	Measured Values
10	1.45E-04	1.32E-04
20	2.89E-04	2.22E-04
30	4.26E-04	3.22E-04
40	5.77E-04	4.12E-04
50	7.23E-04	5.32E-04
60	8.65E-04	6.32E-04
70	9.88E-04	7.42E-04
80	1.24E-05	8.12E-04
90	1.34E-05	9.12E-05
100	1.52E-05	1.20E-06

Table 4.5: Theoretical vales of Citrobacter at Different Depth

Depth [m]	Theoretical Values Conc.
3	8.39E-03
6	0.023
9	0.031
12	0.043
15	0.051
18	0.066
21	0.078
24	0.084
27	0.091
30	0.098

Table 4.6: Theoretical vales of Citrobacter at Different Depth

Time per day	Theoretical Values Conc.
10	8.39E-03
20	0.023
30	0.031
40	0.043
50	0.051
60	0.066
70	0.078
80	0.084
90	0.091
100	0.098

Table: 4.7 Theoretical and Measured values of Citrobacter Concentration at Different Time

Depth [m]	Theoretical Values Conc.	Measured Values Conc.
3	8.39E-03	7.00E-03
6	0.023	0.019
9	0.031	0.024
12	0.043	0.051
15	0.051	0.066
18	0.066	0.072
21	0.078	0.081
24	0.084	0.087
27	0.091	0.094
30	0.098	0.099

Table: 4.8 Theoretical and Measured values of Citrobacter Concentration at Different Time

Time per day	Theoretical Values Conc.	Measured Values Conc.
10	8.39E-03	7.88E-03
20	0.016	1.85E-02
30	0.025	2.33E-02
40	0.033	3.17E-02
50	0.041	3.94E-02
60	0.05	5.11E-02
70	0.058	5.74E-02
80	0.067	6.67E-02
90	0.076	7.57E-02
100	0.083	7.96E-02

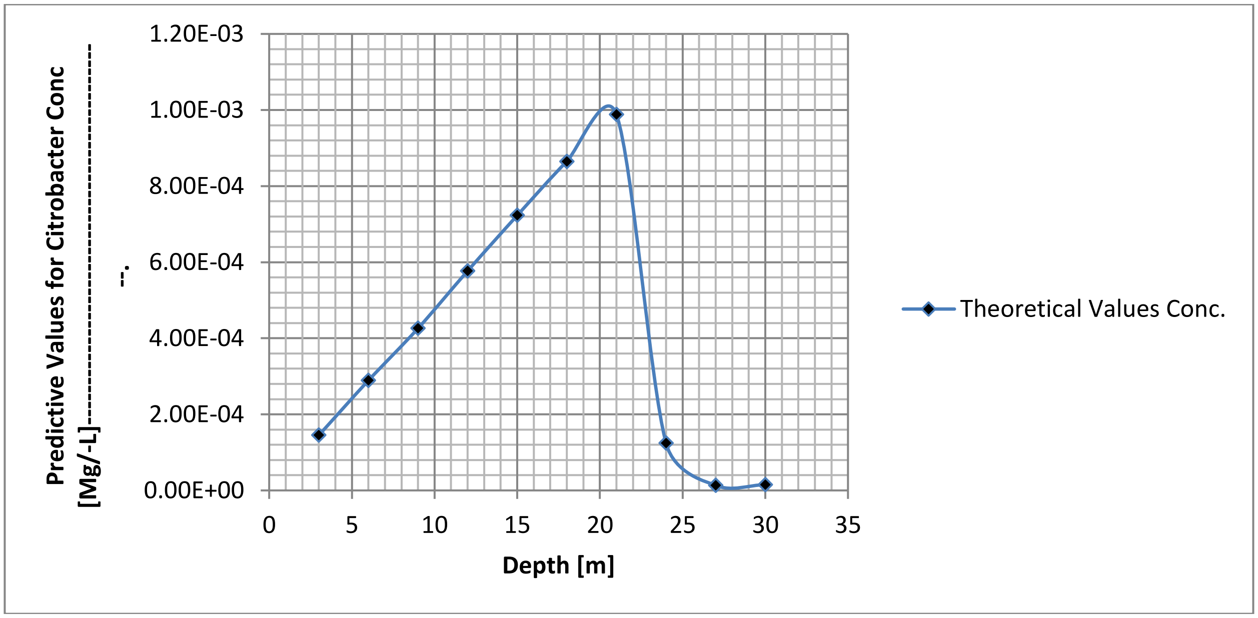

Figure 4.1: Theoretical values of Citrobacter at Different Depth

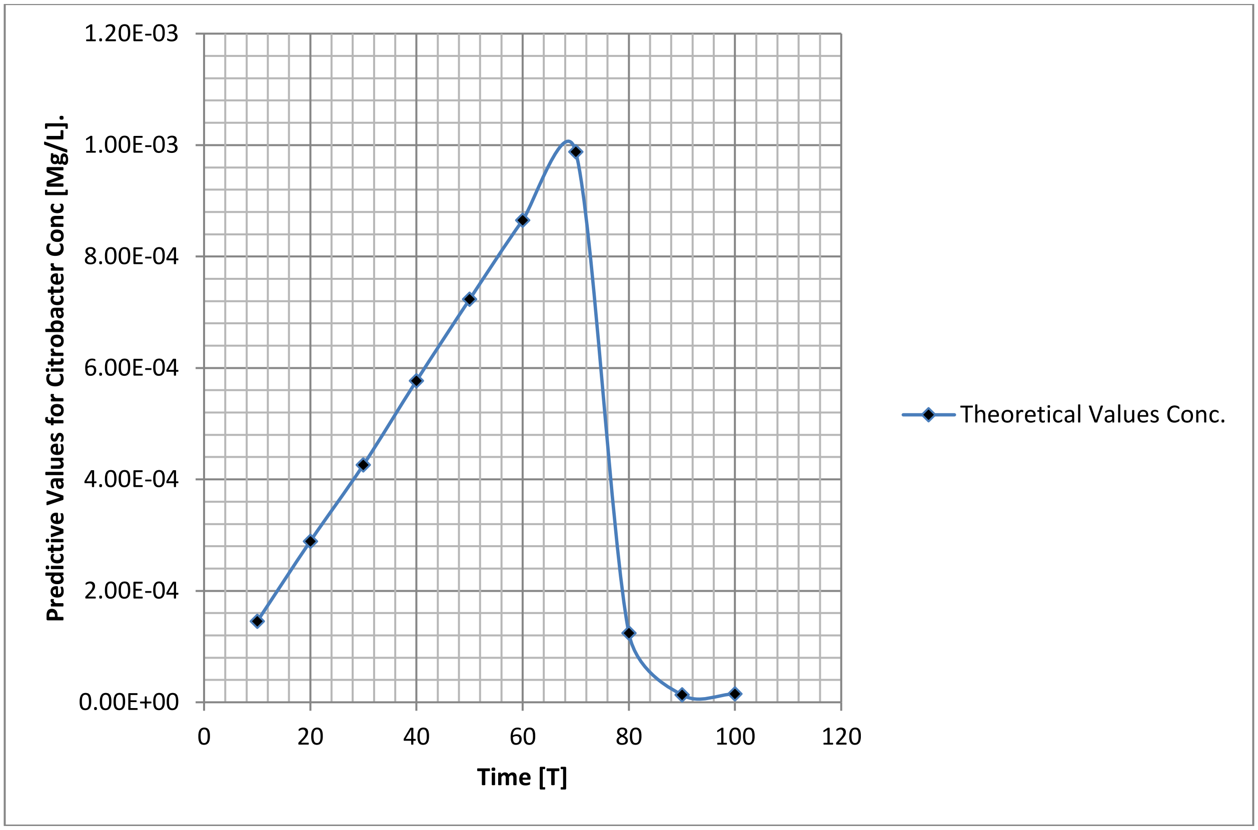

Figure 4.2: Theoretical values of Citrobacter at Different Time

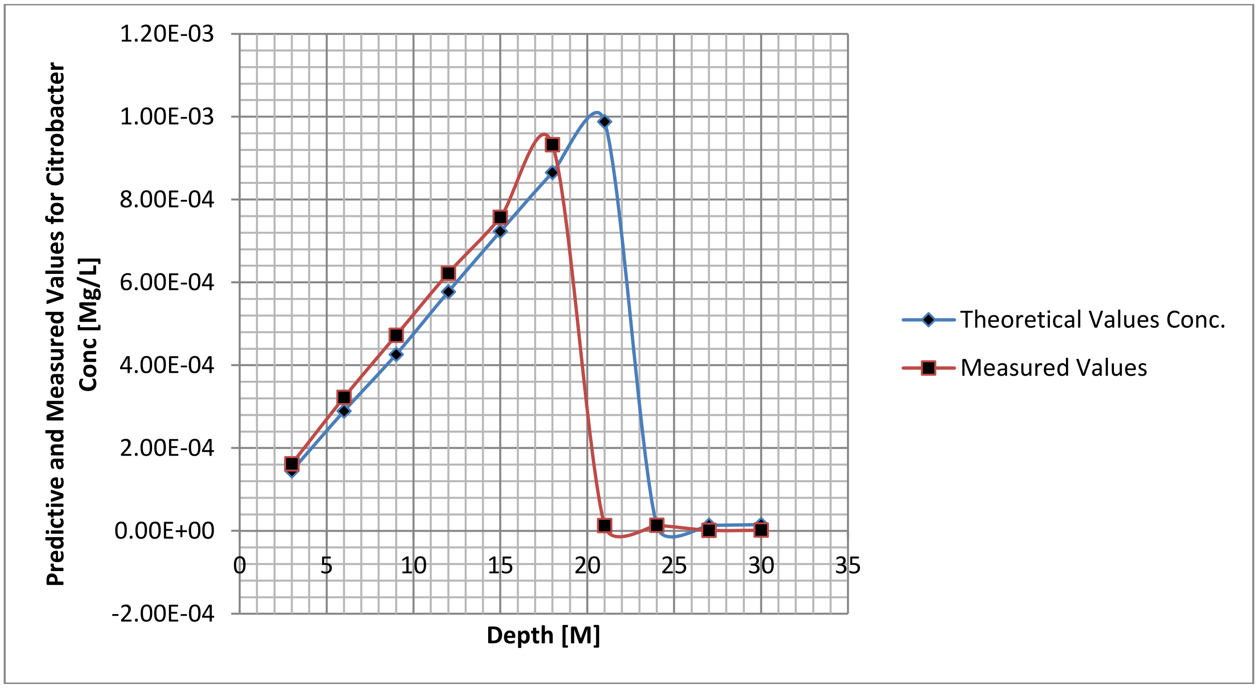

Figure: 4.3 Theoretical and Measured values of Citrobacter Concentration at Different Depth

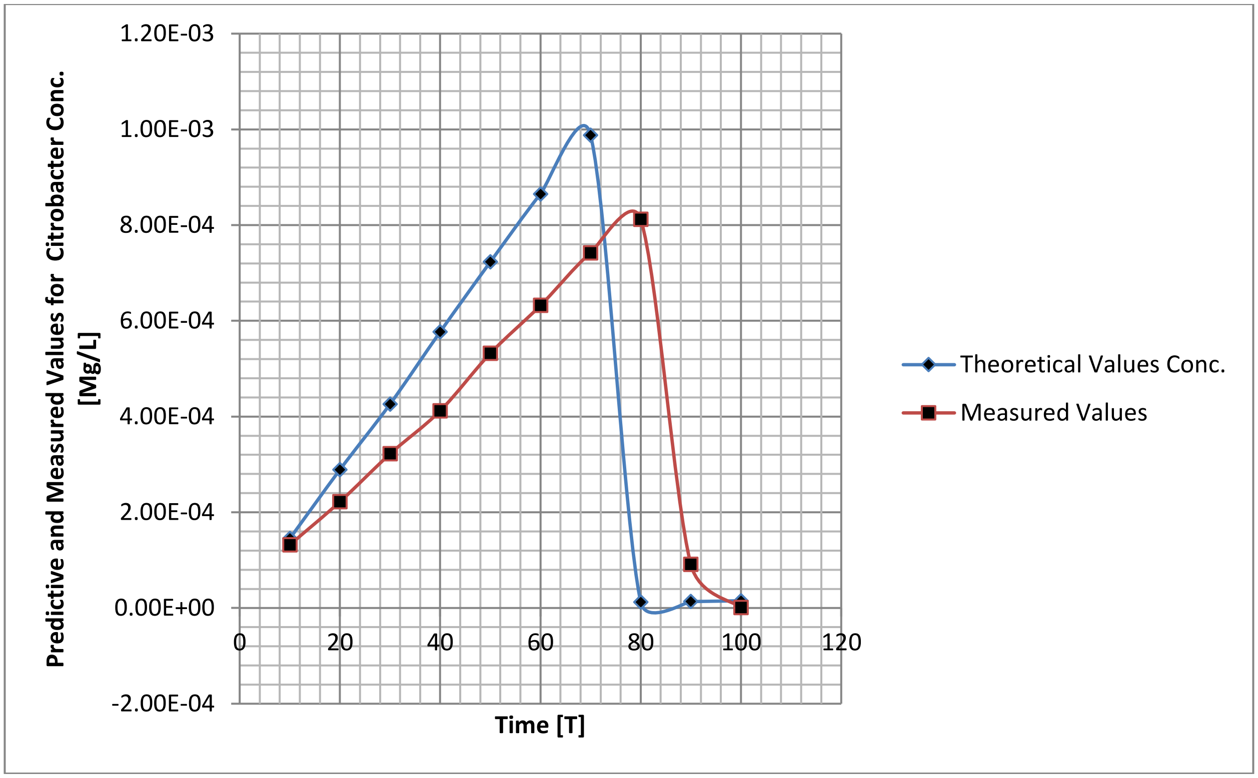

Figure: 4.4 Theoretical and Measured values of Citrobacter Concentration at Different Time

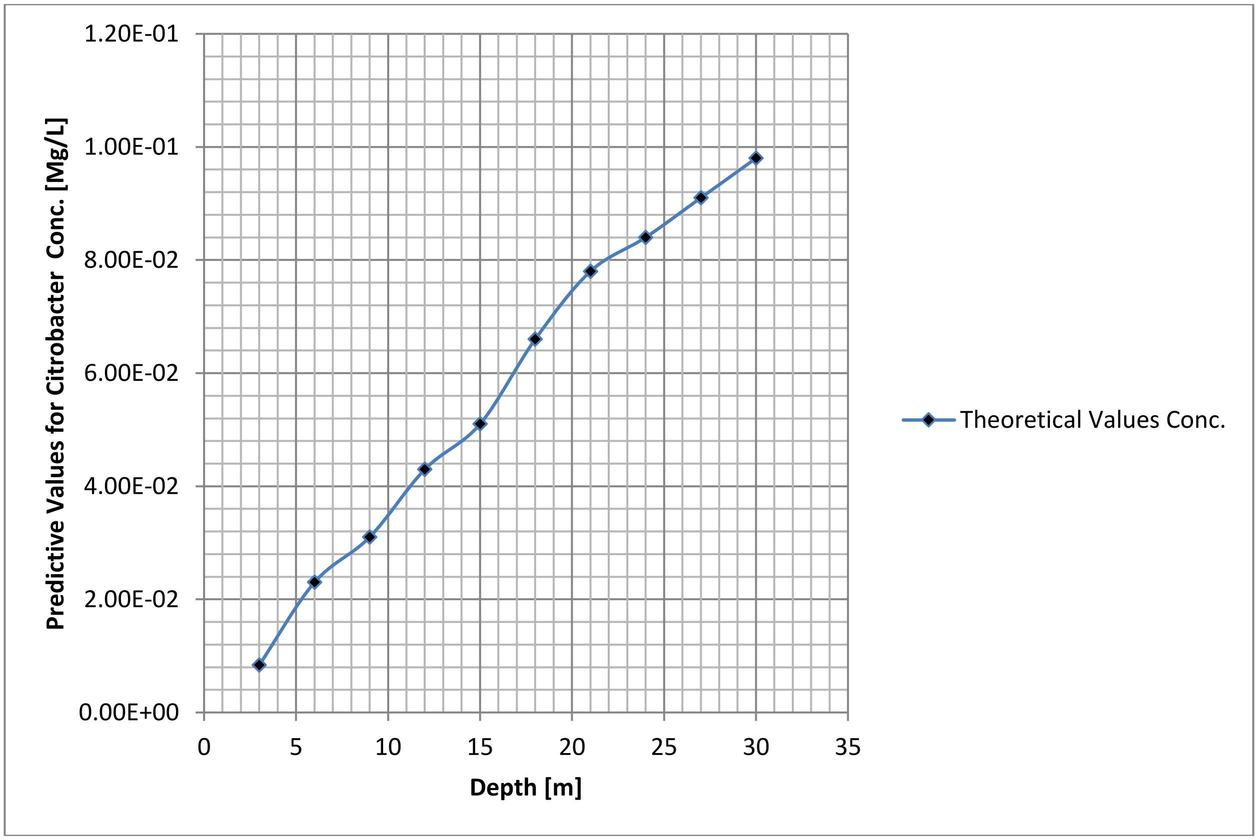

Figure 4.5: Theoretical values of Citrobacter at Different Depth

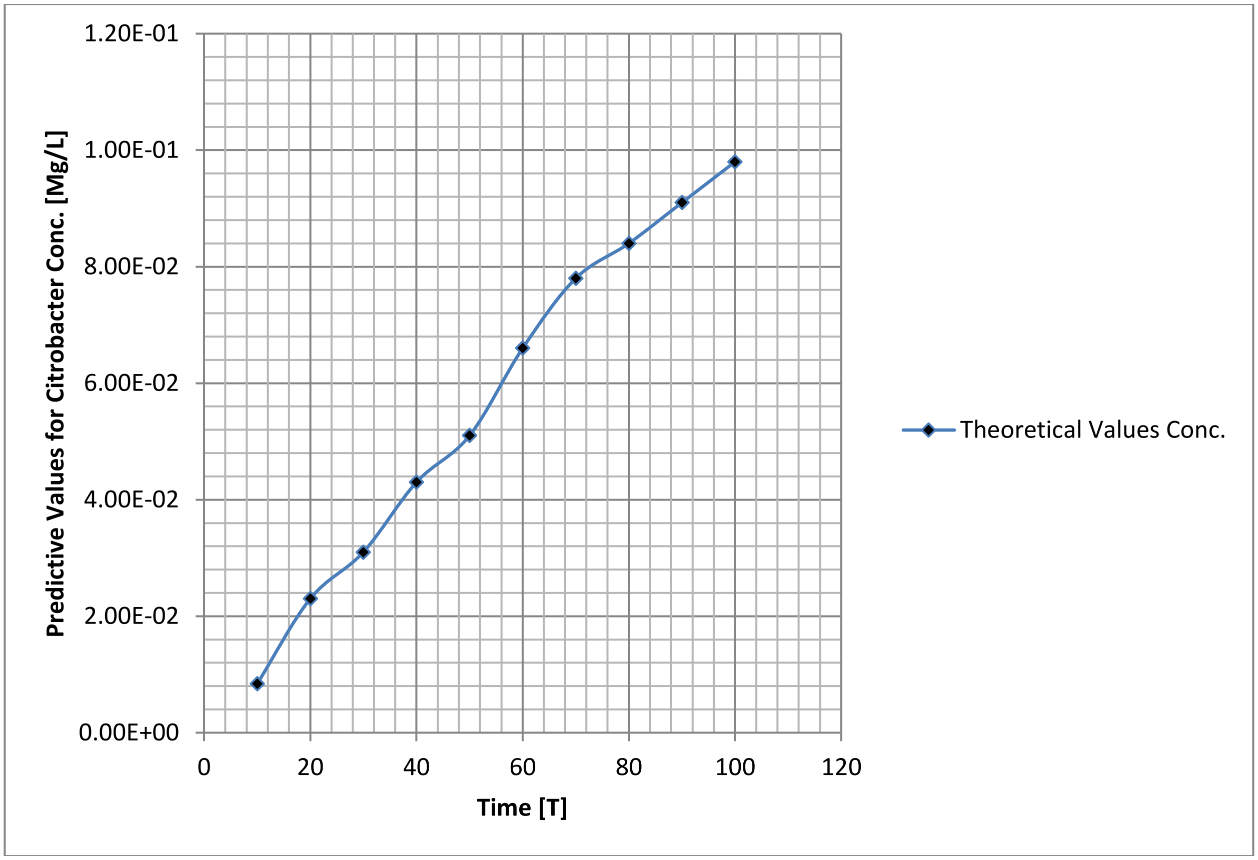

Figure 4.6: Theoretical vales of Citrobacter at Different Time

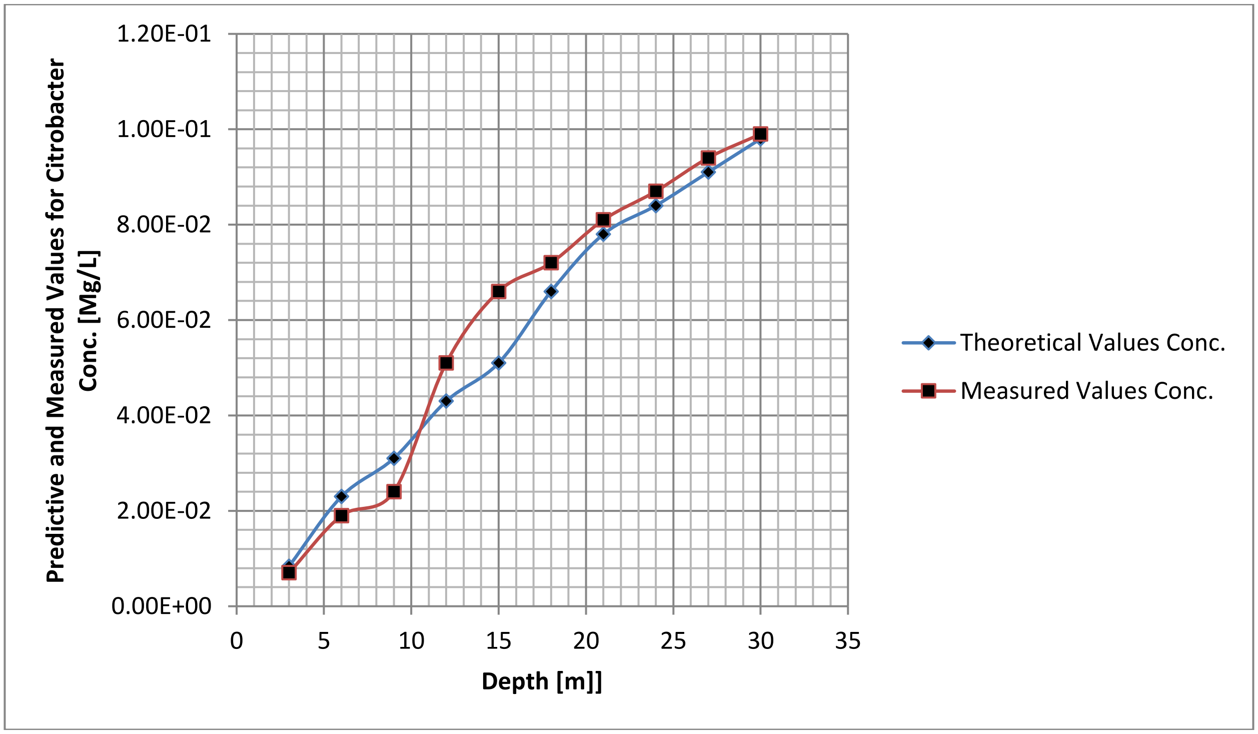

Figure: 4.7 Theoretical and Measured values of Citrobacter Concentration at Different Depth

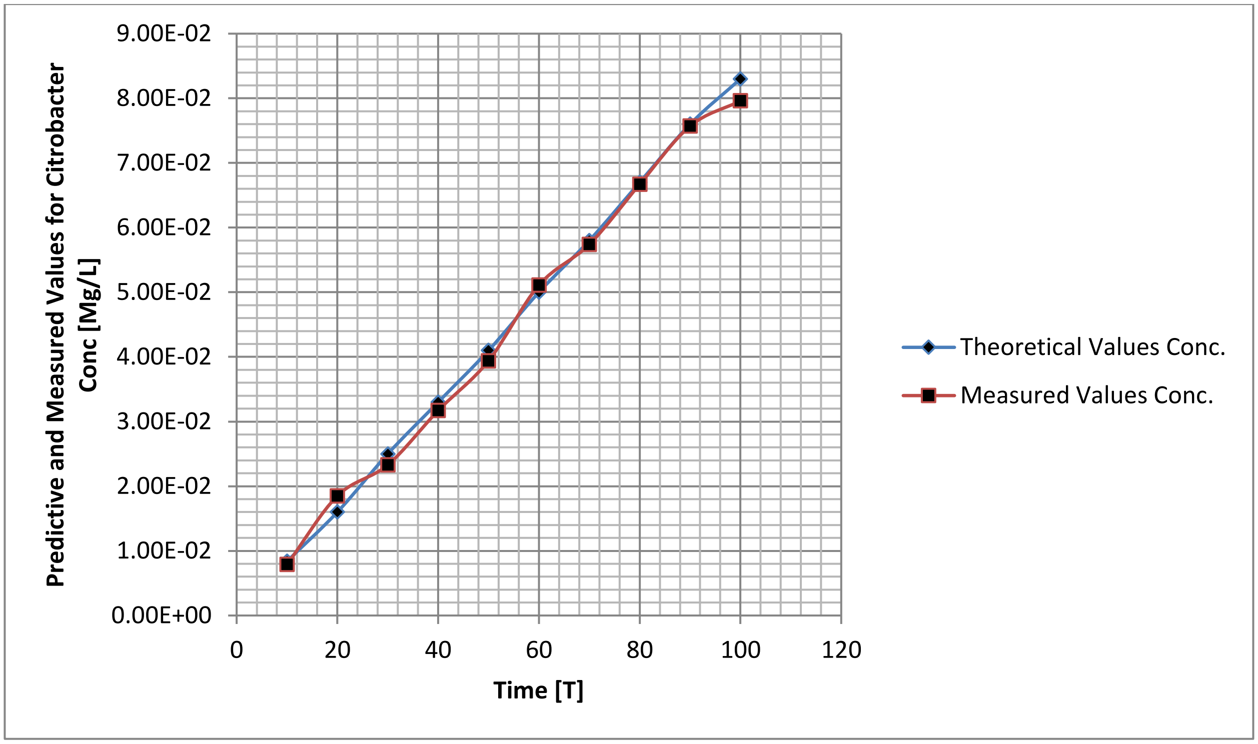

Figure: 4.8 Theoretical and Measured values of Citrobacter Concentration at Different Time

The expression from the graphical representation between figures one to four shows the transport level including the behaviour of the Citrobacter in the study location. The concentration developed are in exponential phase from three to twenty one metres at the period of seventy days and suddenly observed rapid degradation down to the lowest at thirty metres at the period of hundred days. The comparison between the theoretical and measure for depth and time of transport developed faviourable fits expressing the validation of the system. These implies that the condition of the microbial transport process experiences due the fluctuation deposition of microelement in these formations, this were observed to reflect on the growth or concentration rate at different strata of the formation, the deposition of the Citrobacter in the study area were found from the developed model to be influenced by predominant deposition of one of the formation characteristics, the formation parameters pressure the deposition of the Citrobacter transport and concentration under the influences porosity, this were discovered to be the predominant in the study location. While figure five to eight express exponential phase of deposition in the formation with slight vacillation base on porosity variation between intercedes of the formation. The behaviour of Citrobacter definitely depend on the deposition of the structural setting of the formation, the pressure of deltaic condition has also expressed it influences on the transport and depositional level of the Citrobacter, the predictive and measured values of the stated figures express faviourable fits, the migration of Citrobacter has been express from the developed model through the simulation values, the study in this condition were able to express insignificant effect of saline deposition on the migration of the Citrobacter at coastal environments, the study has developed a base line that will be applied in monitoring and evaluation of Citrobacter thus determined the pressure from porous medium variations effect including its behaviour in coastal location.

Conclusion

Citrobacter were found in saline environments, the deposition of this microbes were assessed to monitor its migration process to determined the possibility effect of saline to phreatic beds, monitoring this contaminant transport were done through the application of mathematical modeling techniques, the developed modeling generated theoretical values that express the fluctuation and exponential transport process of Citrobacter in saline environment, the study observed the condition of it migration process and found that saline could not influences the behaviour of the Citrobacter, the study were able to express the rate of migration and other influences that pressured the behaviour of the microbes in the study area. Such condition were able to influences the concentration process of Citrobacter in coastal environments, there is no doubt that the process were necessary to confirm it rates of concentration thus observed whether saline deposition inhibited it migration process, furthermore, the study has express the rate of health implication this pollutant sources has cause to the human settlers though the concentration rates in the study area. The study definitely confirm the rate of concentration between the phreatic beds thus area the concentration were observed signification compared to WHO standard on microbial deposition on phreatic beds, experts will ensure that this approach will be applied proactively to eradicate Citrobacter pollution in the study environment.

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