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"CARBON DERIVED FROM PHOENIX DACTYLIFERA (DATE PLAM) SEEDS THAT HAS BEEN ACTIVATED IN COMPARATIVE ADSORPTION STUDIES OF FLUORIDE"

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ABSTRACT: This work describes the elimination of fluoride after a artificial model by adsorption on physical activated carbon made from Phoenix Dactylifera seeds and Magnifera Indica (Mango) seeds at 32°C. Batch studies were accepted out to regulate the best time, dosage, pH, sorption kinetics, and sorption equilibrium for Fluoride removal on physically activated carbon. The optimum contact duration, adsorbent dose, and pH for carbon were 50 minutes, 140 mg, and 7.50, and 40 mins, 200 mg, and 7.50, with fluoride elimination effectiveness of 77.5 percent, 76.5 percent, and 45 percent, 58 percent, and 84 percent, respectively. Isotherms of Langmuir, Freundlich, and Temkin are well followed.

KEYWORDS: Fluoride, Activated carbon, Kinetics, Adsorption isotherms, Contact time, Dosage, pH, Phoenix Dactylifera seeds, Magnifera Indica (Mango) seeds.

1. INTRODUCTION

Water is life, but we are still unable to provide everyone with safe drinking water that is both accessible and inexpensive. Water is an essential component of life for all living things. Though, only a trivial percentage of the population has admittance to potable consumption water anymore. Others drink polluted water to varying degrees. The topic of providing clean drinking water is causing a lot of anxiety round the world, especially in emerging and poor countries. Because India is a developing country with a large population living in villages with limited infrastructure, a high rate of illiteracy, and a deficiency of consciousness of hygiene, the idea of harmless drinking water takes on more importance However, the majority of the rustic population relies on contaminated pulverized water for consumption, which is polluted with a variability of salts and minerals. One of them is an overabundance of fluoride in the water, which has a negative impression on people's health. Fluoride is a hazardous substance that is more poisonous than lead but less poisonous than arsenic, and it is an acquisitive poison. Incessant use of polluted water causes dental and skeletal fluorosis, as well as a variety of other health problems such as gastrointestinal issues. Because "Fluorosis" is an incurable condition, the only way to solve the problem is to prevent it. As a result, investigations on the defluoridation of water utilising a range of adsorbents have become increasingly important in recent years. Defluoridation can be accomplished using a variety of ways, including reverse osmosis, electrodialysis, and ion conversation. NEERI's Nalgonda defluoridation process has recently gained popularity, however it has its own set of limitations. Defluoridation activity is also tested with a variety of adsorbents. Defluoridation capacity of activated alumina is said to be high. However, the majority of these strategies and methodologies have been calculated to be costly.

Literature Review:

Graphite (M Karthikeyan & K P Elango*,2008), Gulmohar fruit shell (Pallavi Vijyakumar & S.R.Mise,2008-09), Rice Husk (Waheed S. Deshmukh,et al,2009), Cynodon Dactylon (G. Alagumuthu*, et al,2010), Phyllanthus Emblica (Veeraputhiran V (Monal Dutta, et al,2012),possotia(vitex negundo) leaf by (pranjal saikia et al,2017), Fired clay pots by (G.P.Kof et al, 2017), commercial and natural adsorption by (Das Kumar et al 2011), mango seeds by (Salwa A Ahmed et al, 2015) have been cast-off as adsorbents. The ability of activated carbon made from a variety of rare materials to remove fluoride from drinking water is impressive. There haven't been any reports of defluoridation using Phoenix Dactylifera (Date Plam) seeds.

As a result, the goal of this research is to see if carbon made from Phoenix Dactylifera (Date Plam) seeds and Magnifera Indica (Mango) seeds can be utilised as an adsorbent to remove fluorides from drinking water.

2. MATERIALS AND METHODS

2.1 Materials:

The fruit of Phoenix Dactylifera (Date Plam) seeds and Magnifera Indica (Mango) seeds were utilised to make carbons. Physical properties of carbon, such as Moisture content, decolorizing power, pH, surface area, bulk density, and specific gravity are all important factors to consider.re all important factors to consider., were measured and are listed in table 1 below.

2.2 Characteristics of Activated Carbons:

It is necessary to understand some of the characteristics of Phoenix dactylifera (Date Palm) seed and Magnifera Indica (Mango)Seeds carbon before using it as an adsorbent. These characteristics include Moisture content, decolorizing power, pH, surface area, bulk density, and specific gravity are all important factors to consider.that have been manufactured are all factors to consider. Table 1 displays the results.

Table.1 Appearances of Organized Activated Carbons

SL.NO	Characteristics	Physical Activated Carbon	
		Date Palm Seeds	Mango Seeds
1	Moisture content (%)	4.00	6.76
2	Ash content (%)	11.77	15.20
3	Decolorizing power (mg/g)	3.00	4.50
4	Surface area (m^2/g)	503.31	580.64
5	pH	9.50	7.2
6	Specific gravity	1.218	1.218
7	Bulk Mass (g/cm^3)	0.45	0.262

The examination has stayed approved out as apiece the “Standard Methods”, 20^{th} edition.

2.3 Methods:

2.3.1 Grounding of Physical Activated carbon:

The seeds of Phoenix dactylifera (Date Palm) and Magnifera Indica (Mango) were prepared and cracked into bits before being rinsed in distilled water 8 to 9 times. The powder was then oven dried for 24 hours at 105°C. The oven dried residue was compacted in three layers in a small container, keeping no air space between each layer to avoid powder loss in weightiness; otherwise, the material will burn instantly, leaving just the ash. The little container was then placed inside a larger container, with the lid of the larger container snugly fitted, such that sand completely encircled the small container. The arrangement was then placed in a muffle furnace and fiery at a constant degree until it reached 800°C. The furnace was allowable to calm for roughly 10 hours after reaching the 800°C temperature, and then the ampoule was removed. The activated carbon was then sieved to a size of 300 microns, wrapped in polythene gears, and kept in a dessicator.

2.4 Purpose of optimal contact time:

The contact period has a significant impact on adsorption. To investigate the effect of contact period, 100mL of 5mg/L fluoride resolution was assorted with 100mg of activated carbon and swirled at various contact times ranging from 10 minutes to 24 hours (10mins, 20mins, 30mins up to 120mins). The fluoride concentration in the filtrate was then determined using a UV-visible spectrophotometer.

2.5 Resolve of optimal dosage of adsorbent:

To establish the best amount of activated carbon from Phoenix dactylifera (Date Palm) seed and Magnifera Indica (Mango) seeds, it was put to a conical flask holding a known attentiveness of fluoride solution (5 mg/L in 100mL) at several dosages ranging from (20mg, 40mg, 60mg up to 180mg). The filtrate was tested for residual fluoride content using a spectrophotometer after the resolution in the conical flasks was stirred for optimal interaction time.

2.6 Resolve of optimum pH on Fluoride:

The pH at which adsorption occurs has a significant impact on the amount of adsorption that occurs. Equilibrium adsorption studies at various beginning pH values, reaching from 2.0 to 9.0, were used to investigate the effect of pH on fluoride adsorption. 0.1N H_2SO_4 or 0.1N NaOH were used to alter the pH of the solution. The activated carbon from Phoenix dactylifera (Date Palm) seeds and Magnifera Indica (Mango) seeds were combined and agitated for an optimal contact period, after which the rest was tested for remaining fluoride content. The pH at which supreme fluoride elimination occurs is referred to as the optimal pH.

3. RESULTS AND DISCUSSIONS

3.1 The efficiency of elimination of Fluoride is calculated in terms of:

3.1.1 Consequence of contact time.

3.1.2 Consequence of dosage.

3.1.3 Consequence of pH.

3.2 Sorption Kinetics

3.3 Sorption Equilibrium

3.1.1. Consequence of Contact Time:

The adsorption method is mostly influenced by contact time Figure 1 depicts the influence of contact time on the elimination of fluoride from a synthetic sample. It has been discovered that the amount of Fluoride adsorption grows with period and reaches equilibrium at a specific time. As a result, Table-2 lists the best contact time for all prepared carbons.

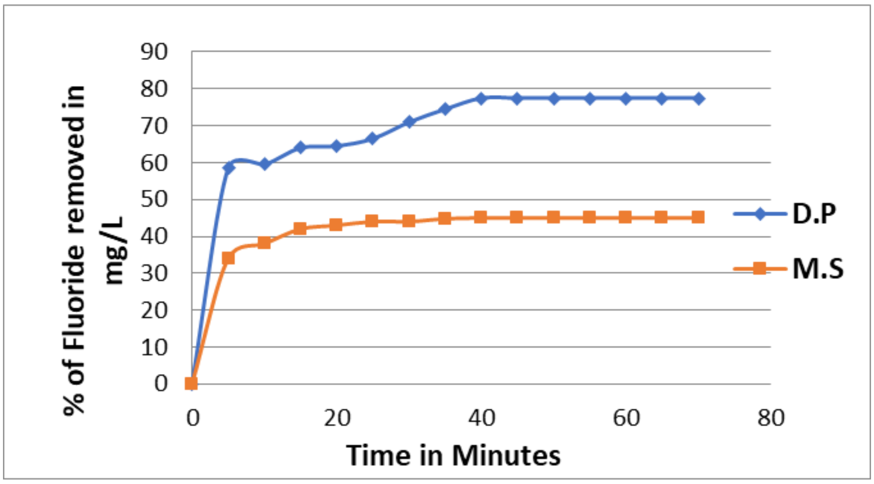

Fig.1. Fluoride elimination by Physically Activated Carbon is affected by contact time.

3.1.2. Effect of Adsorbent Dosage:

The consequence of adsorbent dosage is investigated, and a graph of Fluoride removal percentage vs dosage is presented in Figure 2. As the carbon dosage rises, the amount of remaining fluoride reduces dramatically and reaches equilibrium, as seen in the graph. The dosage that achieves maximum removal is referred to as the optimum dosage. As a result, Table-2 lists the optimum dosages for every prepared carbon.

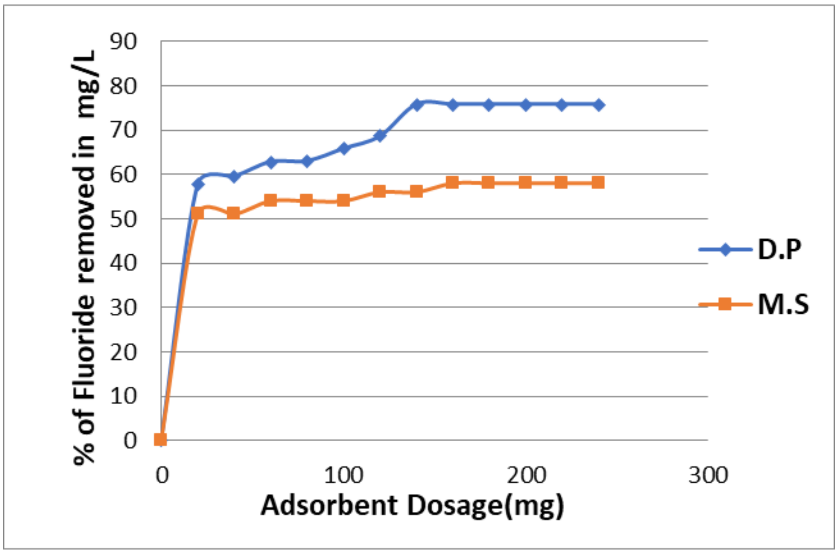

Fig.2. Fluoride elimination by Physically Activated Carbon as a purpose of contact dosage

3.1.3. Effect of pH on Fluoride Removal :

The pH at which adsorption occurs has a significant impact on the amount of adsorption that occurs. The level of adsorption exclusion effiencies of Fluoride by produced activated carbon was impacted by the pH of the solution at dissimilar pH values, as revealed in Fig 3 and Table-2.

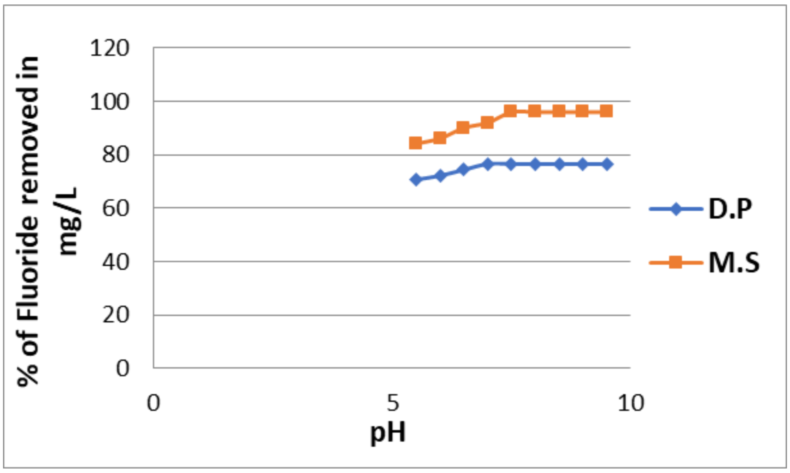

Fig.3., The effect of pH on the elimination of fluoride by Physically Activated Carbon

Table.2: For prepared carbons, the best time, dosage, and pH are

SL.NO	Kind of carbon (Phyically Activated Carbons)	Optimal time (min)	Optimal dosage in (mg)	Optimal pH
1	Date Palm seeds	50	140	7.00
2	Mango seeds	40	200	7.50

3.2. Sorption Kinetics:

At room temperature, the kinetics of fluoride removal were studied at varied time intervals of adsorption. Table 3 shows the model standards of the response rate constant for various carbons, with the resulting plots assumed in Figure 4. Table 3 displays the calculated and graphical standards of 'K' for prepared carbon. The first order reaction was tested using batch kinetic data for fluoride adsorption. The first order reaction's rate equation is provided as levelspiel.

L_n Ca / Co = K*T

i.e., 2.303 $\log_{10}$ a / (a – x) = K * t i.e., $\log_{10} a / (a–x) = (k / 2.303)\ t$

i.e., $k = 2.303 / t \times \log_{10} a / (a –x)$

Where a = initial attentiveness of the fluoride

x = amount of fluoride adsorbed at any time‘t’

a –x = residual quantity of fluoride

K = rate continuous

Equation (5) is of the sort Y = mx

Where,

$Y = \log_{10} a / (a –x)$ and

x = t,

m = k / 2.303

Substituting the standards in equation (5) we get

y = mx

As a result, a straight streak graph with slope = k / 2.303 is produced. It can be seen from the graphical and computed "K" values that fluoride adsorption follows first order rate equations. As demonstrated in Fig 4 and Table 3, the rate continual for each carbon becomes constant, and "K" values increase as the Impregnation ratio increases, and graphical values are somewhat lower than calculated values for physical activated carbons.

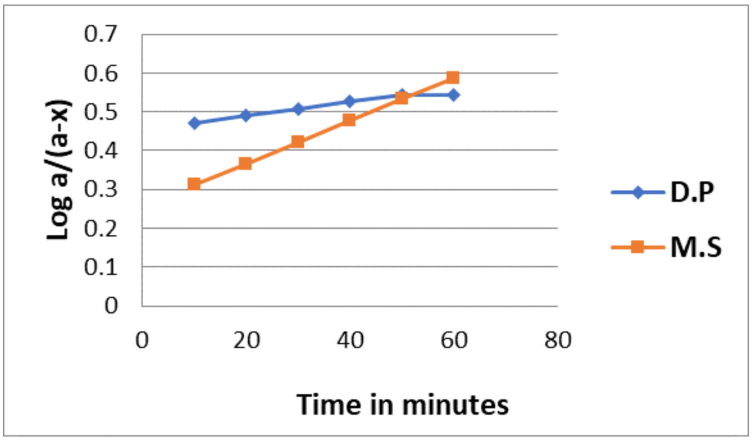

Fig.4., Plot of the Physically Activated Carbon Reaction Rate Constant

3.2.1. Pore Diffusion:

Further, the proportion of pore diffusion can be determined by,

$C / C_0 = K_P \times t^{½}$

Where C = Concentration of sorbate at any period “t” (hr) in mg/L

C_0 = Initial attentiveness of sorbate in mg/L.

t = time occupied for sorption

K_P = amount of pore diffusion

A straight line chart of C / C0 Vs t1/2 aimed at fluoride is given. The C/Co and t1/2 model values are shown. For prepared carbon, the computed and graphical values of KP are shown. As demonstrated in Fig 5 and Table-3, the graphical values of KP values are bigger than the theoretical values. It demonstrates that pore diffusion reduces with time, resulting in an increase in adsorption. Data on pore diffusion confirms the rise in adsorption with time.

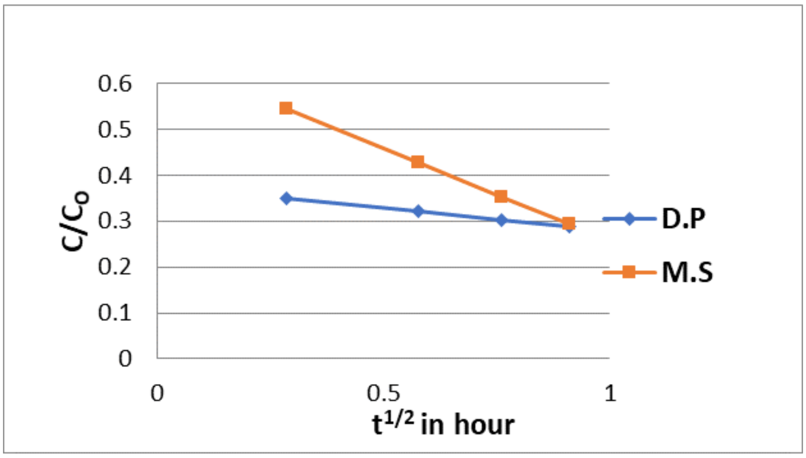

Fig.5., Plot for Physically Activated Carbon by Webber and Morris

TABLE.3: SORPTION KINETICS

Sl.No	Carbons (Physically AC)	K values	K values	Kp values from calculation	Kp values from graph
1	Date palm seeds	0.0647	0.03	0.0041	0.0127
2	Mango seeds	0.323	0.367	0.301	0.406

3.3. Sorption Isotherm Model:

Sorption equilibrium isotherms can be used to calculate the amount of sorbate necessary to sorb a specified amount of sorbate from solution. Freundlich, Langmuir, and Temkin isotherms are the most commonly used equations for presenting adsorption data. For all three isotherms, the sorption equilibrium data is filled.

3.3.1 Freundlich Isotherm

The lined form of the Freundlich isotherm is

$$\log_{10} \frac{X}{M} = \log_{10} K + 1 / n \log_{10} C$$

Where, X/M = At equilibrium, the total amount of sorbate adsorbed per unit weight of adsorbent is.

X = (mg / L) Total adsorbate eliminated

M = The adsorbent's mass or weight.

C = Adsorbate concentration in solution at equilibrium

K = sorption capacity or an empirical constant linked.

n = A sorption intensity-related empirical constant

The equation is of the type y = c + m x.

Where, c = $\log_{10} K$

Y = $\log_{10} X / M$, X = $\log_{10} C$ and m = 1/n

Knowing the slope and intercept "1/n" and "K," the conspiracy of log10 X/M vs log10 C yields a conventional line through slope 1/n and intercept = log10 K. As illustrated in Fig 6 and Table-4, experimental data are frequently presented in this method as a handy way of detecting if materials are removed from solution by adsorption and calculating the constants "K" and "n."

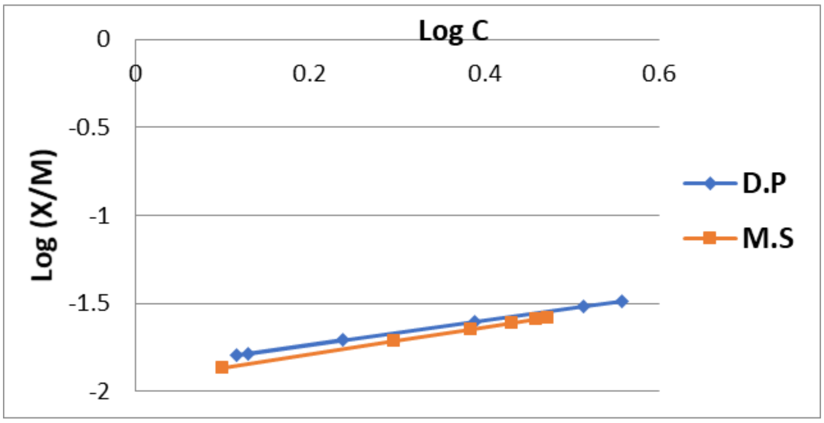

Fig.6., Webber and Morris' Plot for Physically Activated Carbon

3.3.2 Langmuir's Isotherm

The Langmuir isotherm is castoff to represent single-layer adsorption, and its linear form is:

X/M = abc / (a + bc)

C / (X/M) = 1/ab + c / a …… Eqn

Where X/M = Amount of adsorbate adsorbed per part weight of adsorbent.

C= Equilibrium attentiveness of adsorbent in solution after adsorption or saturated concentration.

'a' and 'b' are emperical constants.

The equation is of the kind y = c+mx, where c = 1/ab and m=1/a, and x = c yields a straight-line graph. The intercept and slope are used to derive the value of the constants 1/b and 1/ab. 1 / ab = intercept; 1/a = slope 1/b X slope Equals intercept; b = slope / intercept

Table-4 displays the model data that was calculated. Figure 7 and Table 4 show the linearised Langmuir isotherm (C / X/M against C) plotted for several adsorbents.

The slope and intercept of the above graphs are used to evaluate 'a' and 'b.' Least square analysis can be used to verify this, and graphical values are shown. On the base of the findings, the following equations for various carbons are presented.

Webber defines the main properties of the Langmuir isotherm in terms of a dimensionless continual distinct factor or symmetry restriction,

R = 1 / [(1 + a) Co]

Where a = Langmuir constant and

C_0= Initial solute concentration (mg/L)

From the overhead equivalence Webber has agreed limit indicating the type of the line as follows:

Values of R	Type of Isotherm
R > 1	unfavorable
R = 1	Linear
0 < R < 1	Favorable
R = 0	Irreversible

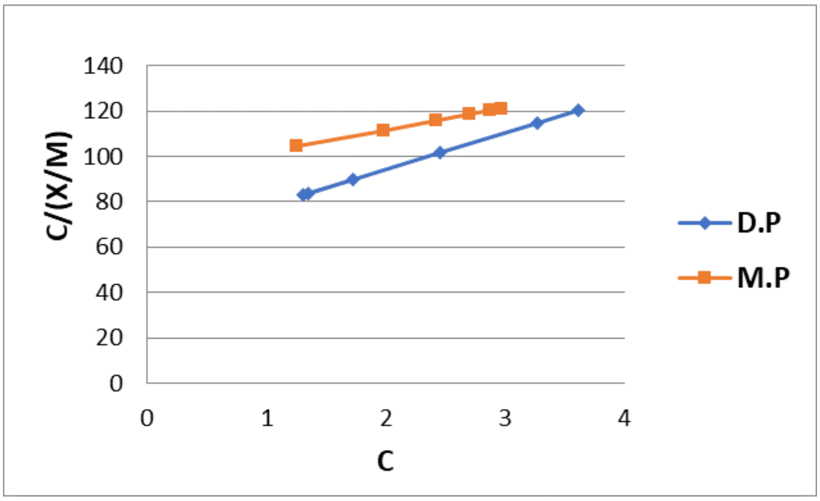

Fig.7., The Langmuir Isotherm for Physically Activated Carbon is plotted on a graph.

3.3.3 TEMKIN ISOTHERM:

The chemical adsorption of an adsorbate on the adsorbent is described by the simple form of an adsorption isotherm model, which is written as

X = a + b ln C

Where, C = Adsorbate concentration in solution at equilibrium (mg/L).

X = Per unit amount of metal adsorbed the adsorbent's weight (mg/gm).

a = Per unit amount of metal adsorbed the adsorbent's weight.

b = An empirical constant that is proportional to the amount of adsorption..

The vigor of adsorption is a lined function of superficial coverage in the Temkin isotherm equation. Only an middle range of ion concentrations is covered by the Temkin isotherm.

The conspiracy of ln C vs X yields a conventional line with slope and intercept; given the intercept and slope, the constants 'a' and 'b' are derived, as shown in Fig 8 and Table-4, respectively.

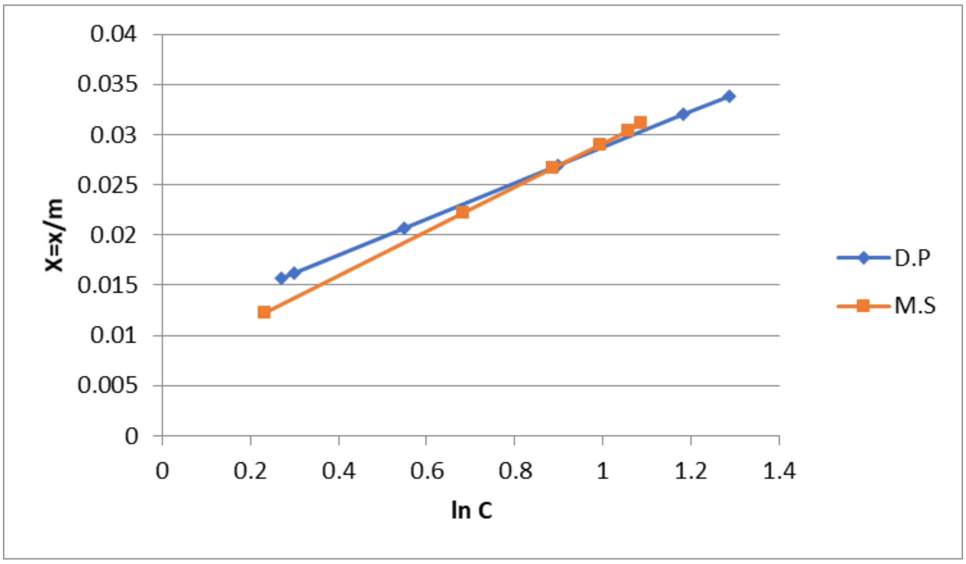

Fig.8., For Physically Activated Carbon, the Temkin Isotherm is plotted.

TABLE.4: SORPTION ISOTHERM MODELS

SL.NO	Type of Carbons (Physically Activated)	Freundlich Isotherm		Langmuir Isotherm			Temkin Isotherm	
		Const '1/n'	Const 'k'	Const 'a'	Const 'b'	'R'	Const 'a'	Const 'b'
1	Date Palm Seeds	0.6952	0.0133	0.0654	0.2367	0.208	0.0109	0.0178
2	Mango Seeds	0.7657	0.0113	0.1023	0.106	0.181	0.0071	0.0219

4. CONCLUSIONS

The following conclusions were drawn built on the experimental study:

1. Physical activated carbon has an optimum contact period of 50 minutes and 40 minutes, with removal effectiveness of 77.5 percent and 45 percent, respectively.
2. The results of an experiment on adsorbent dose optimization show that increasing the quantity of adsorbent supplied surges fluoride elimination from the solution. Physical activated carbon dosages of 140 mg and 200 mg were shown to be optimal, with elimination efficiencies of 75.8% and 58 percent, respectively.
3. Fluoride adsorption is primarily pH dependant. With a lower pH value, the adsorbent's removal effectiveness improves. For physical activated carbons, maximal adsorption occurred around pH 7.00 and 7.50, with removal effectiveness of 76.5 percent and 84 percent, respectively.
4. The rate of fluoride adsorption follows a first order rate equation. For pore diffusion, it also follows the Webber and Morris equation.
5. The results of the isotherm models that follow the Temkin, Langmuir, and Freundlich isotherms show that adsorption is favourable.

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