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A Study of Adsorption Dynamics of Biologically Active Plants

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Abstract: Alstonia scholaris is a biologically active and important Devil tree. The medicinal importance pharmacology importance in particulars antiulcer activity of Alstonic scholaris in albino rats were Analyzed and reported. The juice of Alstona scholaris to rats show a remarkable record with respect to ranitidine tablet (to cure ulcer). This result initiate the author to study chemo mimetic nature of plant material for the removal of heavy metal in synthetic solution also extended studies with modified Alstonia scholaris and Wrichitia Tinctoria. An adsorption of 96% in all the cases was observed. A linear correlation with R^2 value of 0.977 was calculated from the linear plot of optical densities of Alstonia Scholaris and modified Alstonia Scholaris similar trend in adsorption was also noted. In the case of Wrightia Tinctoria instead of modified Alstonia Scholaris

I. INTRODUCTION

Literature survey has revealed the availability of several lowcost adsorbents materials, including straw-dust, cellulose, xanthate, straw, peat mass, wood, hard saw dust, sagaum tectona grandis, agricultural wastes, neem leaves, saw dust, barley straw, groundnut husk carbon, bicarbonate treated coconut husk, sediments, sand, iron, soil, alumina pillared clay (lv) oxide,. Aluminium oxide, fly ash, activated sludge, Portland cement clinker powder and discarded tire rubber.

The chemical nature of the surface of the adsorbent materials has relatively less significance. This factor is considered only secondary to the magnitude of the surface of the particles of adsorbent material. Reasons for the selection of an absorbent material vary. However, frequently refereed reason are the unusual surface properties of the absorbent material and economics of its application. The adsorbent materials is so chosen that can be regenerated effectively. This make its application quite economical.

A. Freundlich Adsorption Isotherm

Solid surfaces can act as absorbents for the removal of dissolved substances from a solution, for instance, activated carbon can be used as an absorbent for the removal of acetic acid from its aqueous solution and also forthe removal of ammonia from its aqueous solution. The phenomenon of adsorption of a solution is similar to that of gases and subjected to the same principles and factors applicable to adsorption of gases. Some adsorbents are specifically more effective in attracting certain substances to the extent of absorption, while an increase in surface area operates directly to it.

Adsorption of solutes, like that of gases, involves the establishment of an equilibrium between the amount adsorbed on the surface and the concentration of the substances in solution. The variation of the extent of adsorption with concentration of the solute is usually represented

$$Y= K(C_{cq})^{1/n}$$

Y = mass of the substance adsorbed per unit Mass f the absorbent. Ccq = concentration of the substance at equilibrium

K and n = empirical constants.

Taking log, we get,

$$\text{Log } y = \log k \ +1/n \log C_{eq}$$
$$= 1/n \log C_{eq} + \log k$$

The pot of log y versus log Ceq gives a straight line, the slope of it equals to i/n and the intercept to k.

B. Weber – Morris Equation

Weber and Morris have suggested a relation between the amount of the adsorbate absorbed and the contact-time. It has been stated that the amount of the absorbable is almost directly proportional to the square root of contact-time, provided the adsorption process involves intraparticle diffusion as the rate determining step.

The weber –Morris equation is given as:

$$Q = \frac{X}{M} \text{ Kidt } 0.5$$

Where,
Q = a mount of the adorbate adsorbed per unit weight of the adsorbent, mg g^{-1}.
X = amount of the adsorbate adsorbed, mg dm^{-3}
T = contact –times, s and
K_{id}= the rate constant for intraparticle diffusion, mg g-1 $min^{0.5}$

C. Correlation Analysis

It any scientific, study, experimentation is a common feature. The results of an experiment are recorded and these records are useful in deriving conclusions. To arrive at these conclusions. Representation, interpretation and creational analysis of the data are reburied. Correlation brings out the intensity of association exiting between a pair of variables and it reveals the direction of movement of each pair. A positive association and a negative association indicate parallel movement and diametrically opposite movement respectively.

The term correlation analysis refers to the analysis of the total volume of results with empirical correlations in after to correlate one body of results with another so as to reveal the fundamental factors underlying reactivity.

System with the same linear free energy relationship is similar provided that there exists some simple and constant reaction mechanism. It is to be noted that to correlated equilibrium constants in a reaction series, the product must have similar structures throughout that series.

After finding out the direction of movement of a pair of variables, it is of interest of find cause and effect relations among the how the rare of change of a depended variable is affected by a change in the cause variables. The relations are of different types. If the rate of change of a dependent variable is assued constant throughout the course of the experiment the following liner relation is applied.

$$Y = b_0+b_1x$$

Where,
X = is the cause
Y is the effect
B, is the slop.

And b_o is a constant.

But reality, a constant increase or decrease cannot be expected between tow variables. A reaction, normally shows a slight jolts in the beginning and after stabilization, it may increases at an increasing rate, increase at a decreasing rate, decrease at an increasing rate, decreasing rate. To accommodate this phenomenon, the fit is expected to have a second derivative. This is possible only if the power of the independent variable is at least two. This suggests the use of quadratic equation and its general from is given below.

$$Y = b_o+b_1X + b_2 X^2$$

D. Wrightia Tinctoria

The leaves are acrid, Themogenic, anodysne and hypotensive and are very useful in adontagia, vitiated conditions of vata and hypertension. The eds are bitter, astringent, acrid, carminative constipating depurative, anathematic and februfuge. They are use full in vitiated conditions of Pitta and kapha, dyspepsia etc.

Its pungent fresh leaves quickly relieve toothaches. Leaves, quickly relieve toothaches. Leaves, flowers and fruits are source of a kind of indigo called pala –indigo. White, close grained wood looks like ivory and is much fever diarrhea, roundworm and colic

E. Alstonia Scholaris

The Ayurveda herb. Alstonia scholaris leaves are arranged in group of seven as called by the name. saptaparana and its Latin name is Alstonia scholaris it is a large every green tree, found in Bengal south India and an western coastal area. The physical appearance of upper surface of the leaves is green in colour and the cover grash white either cutting the bask or leaves oozes white milky fluid this is used largely in Ayurveda medicine an litter and as an astringe hard or skin disorder crticarin and for upper purification process of Panjakarama.

II. EXPERIMENTAL METHODS

A. Doubly Distilled Water

Distill water and alkaline potassium permanganate were taken in an all glass Pyrex apparatus then distilled.

B. Glassware Cleaning

Glassware's were cleaned using soap soln. Then washed with tap water soaked with 10% $HN0_3$ over period of two days. These glassware's were cleaned again with tap water and rinsed with doubly distilled water.

C. Materials

Diphenyl Carbazide, $K_2Cr_2O_7$,ethanol, glacial acetic acid, conc H_2S_{O4} of merck Quality were purchased purified. Medicinal plants of *Alstonia scholaris* modified *Alstonia Scholaris* and *Wrightia tinctoria* were collected and purified used for highest purity.

D. Apparatus Required

1) Colorimeter
2) pH meter
3) Digital balance
4) Hot air oven

III. PREPARATION OF STOCK SOLUTION

Synthetic solution of $K_2Cr_2O_7$ was prepared by weighing accurately 0.1g taken in a 1000ml of standard flask and made up to mark with distilled water.

1) *Diphenyl Carbazide Solution:* A solution of 1.5 – diphenyl carbazide (1.00g), glac. acetic acid (50mL) and ethylalcohol (450mL) was mixed well and taken in brown in color reagent bottles.
2) *Cow Dung:* Cow dung was collected. Cleaned with tap water about four times till to get the maximum dusts were removed, filter it. Then dried of shadow drying over a period of a month, powdered and kept the material in a brown bottle for use.
3) *Preparation of Adsorbent A: Alstonia scholaris* leaves were collected from a well grown tree. In these healthier leaves were separated out wash with tap water, distilled water and then partly dried. Then, cut into small pieces continue drying over a period of 168 hrs. The resulting powdered over a period of 19hrs. The resulting dried material is kept in desicator and use.
4) *Modified Adsorbent B:* The modified adsorbent B was prepared by the equal (w/w) mixture of adsorbent A and dried cow dung.
5) *Preparation of Adsorbent C: Wrightia tinctoria* leaves were collected from a well grown tree. In these healthier leaves are separated out wash with tap water, distilled water and then partly dried cut into small pieces continuing drying over a period of 168 hrs powdered over a period of 19hrs. The resulting dried material is kept in desiccator and use.
6) *Estimation of Cr^{6+}:* Hexavalent chromium reacts with 1,5 diphenyl carbazide in the acid medium produces a reddish – violet colored complex. The intensity of the complex observed in colorimeter. A series potassium dichromate solution containing 50,100,150 X 200 X $10^{-6}dm^3$ of cr6+ soln. were prepared by diluting the stock solutions. One mL of diphenyl carbazide reagent was added to the solution. The color intensity was measured after 10mts of time interval at 540nm

IV. RESULTS AND DISCUSSION

The maximum absorption of synthetic solution and along with indicator are noted as $50x10^{-6}$ g/dm(table -1) keeping concentration of synthetic solution as same throughout the experiments (tables 2 to 17), change in volume and change in pH. The optical densities are measured with no change in time duration and adsorbent concentration.

The adsorptive power changes in certain cases with the change in physical observed. The result reflects remarkable adsorption of 96% at pH-3.0 using Alstonia scholaris, the same (96%) is noted in the case of modified alstonia scholaris and wrightia tinctoria.

The values are plotted against optical density using SPSS 10.00 software among the possible eleven forms of equation namely linear, logarithmic, inverse, quadratic, and cubic, poser compound, and logistic growth and exponential. The correlation study we have been utilizing linear functional relationship between two variables, which indirectly assume constant rate of the reaction with in the period of investigation which may increase (or) decrease. The mathematical form of the best fitted equation is

$$Y= b_o+ b_1x$$

Using this equation the concentration of adsorbate in the system are measured in tables (2) optical density of alstonia scholaris and optical density of modified alstonia scholaris shows a good linearity of R= 0.977 but after removing OD corresponding to 50ml (tables 17) also produces an excellent linearity.
Our main aim in this system is to observe the chemo mimetic nature of the medicinal plants.

Table – 1
Absorbance of Adsorbate Concentration

S.No	Concentration,10^{-6}	Optical Density
1	10	3.57
2	20	4.0
3	30	4.54
4	40	5.0
5	50	6.2
6	60	8.5
7	70	11.0
8	80	14.2
9	90	20.0

MODEL: MOD_5.
Independent: VAR00001 Dependent Mth Rsq d.f. F Sigf b0 b1 VAR00002 LIN .977 7 291.49 .000 1.5464 .1535

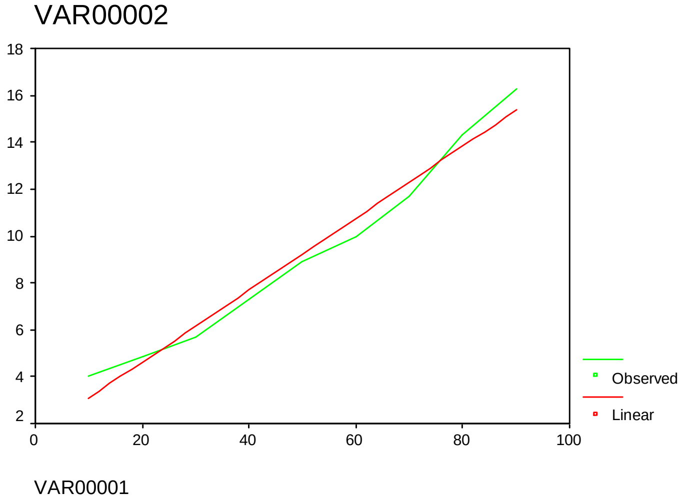

Fig. 1

Table – 2
Absorbance of Adsorbate at pH of 0.5
Adsorbent : A (500mg)Conc 0.5 X 10^{-6}g/lit Time : 2hrs

S.No	Volume, ml	Optical Density
1	50	7.14
2	100	6.66
3	150	5.88
4	200	5.26

MODEL: MOD_6.
Independent: VAR00004
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00005 LIN .993 2 266.26 .004 7.8400 -.0128

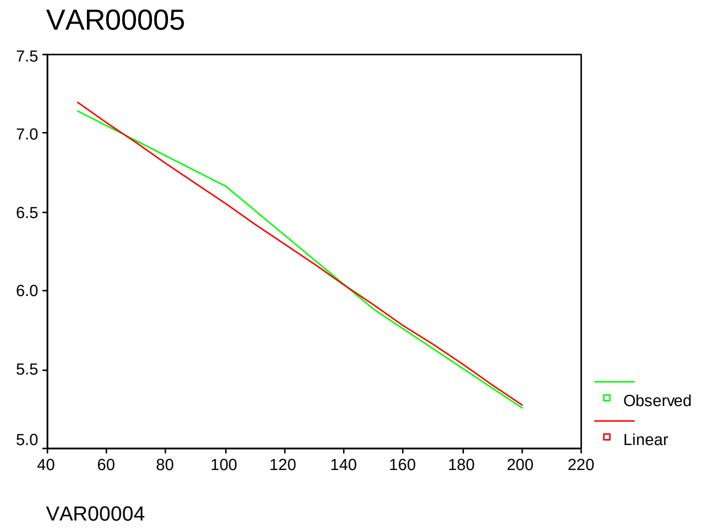

Fig. 2

Table – 3
Absorbance of Adsorbate at pH of 1.0
Adsorbent : A (500mg)Conc 1.0 X 10^{-6}g/lit Time : 2hrs

S.No	Volume, ml	Optical Density
1	50	10.0
2	100	8.2
3	150	7.0
4	200	6.25

MODEL: MOD_7.
Independent: VAR00006
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00007 LIN .966 2 56.01 .017 10.9750 -.0249

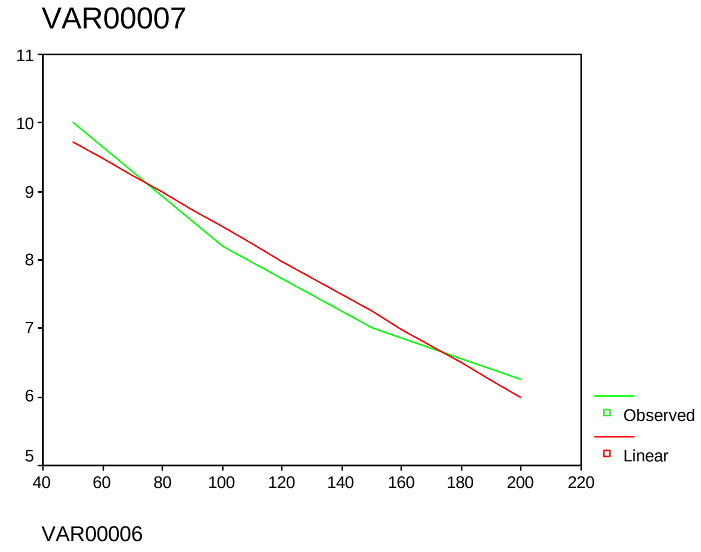

Fig 3

Table – 4

Absorbance of Adsorbate at pH of 2.0

Adsorbent : A (500mg)Conc. 2.0 X 10^{-6} g/lit Time: 2hrs

S.No	Volume, ml	Optical Density
1	50	4.54
2	100	2.94
3	150	2.0
4	200	1.61

```
MODEL:  MOD_9.
Independent:  VAR00010
Dependent Mth   Rsq  d.f.      F  Sigf      b0      b1
VAR00011 LIN  .930     2   26.41  .036  5.2100  -.0195
```

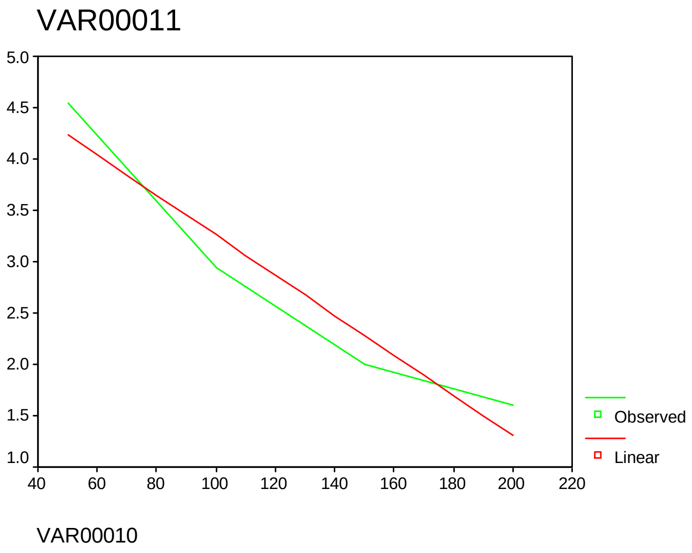

Fig – 4

Table – 5

Absorbance of Adsorbate at pH of 3.0

Adsorbent : A (500mg)Conc. 3.0 X 10^{-6} g/lit Time: 2hrs

S.No	Volume,ml	Optical Density
1	50	1.21
2	100	1.66
3	150	2.85
4	200	3.84

```
MODEL:  MOD_12.
Independent:  VAR00014
Dependent Mth   Rsq  d.f.      F  Sigf      b0      b1
VAR00015 LIN  .972     2   70.42  .014   .1200   .0182
```

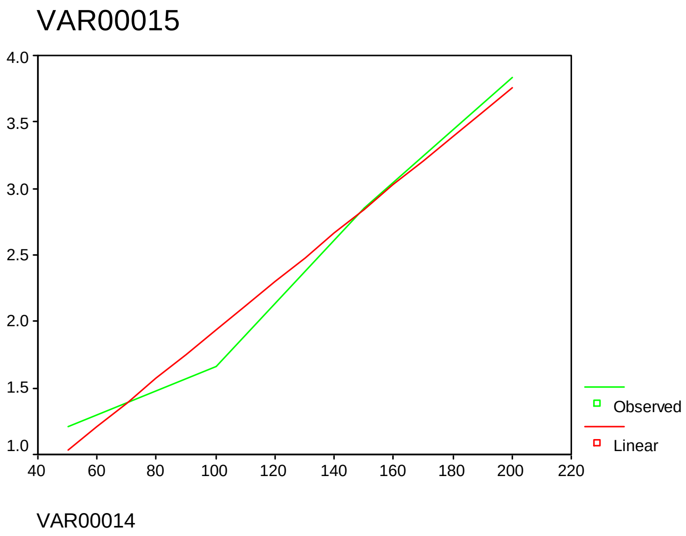

Fig – 5

Table – 6
pH Variation of Concentration of 50 X 10^{-6} g/lit
Adsorbent: A (500mg) Time: 2hrs

S.No	pH	Optical Density
1	1.0	10.0
2	1.5	50.0
3	2.0	4.54
4	2.5	1.03
5	3.0	1.11

MODEL: MOD_23.
Independent: VAR00028
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00029 LIN .257 3 1.04 .383 40.0360 -13.350

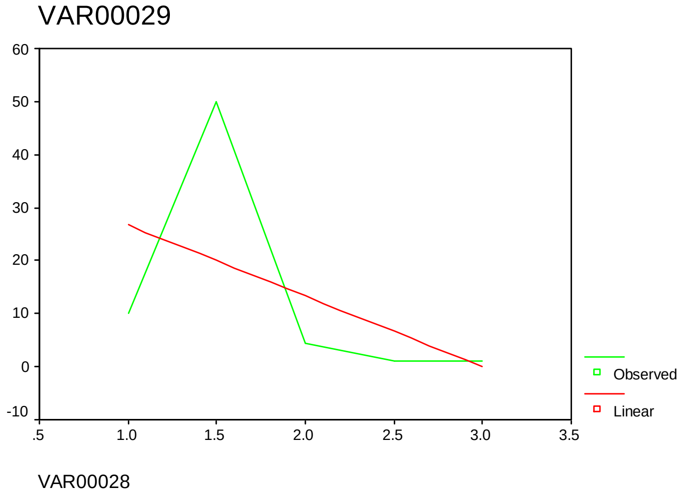

Fig. 6

Table – 7
pH Variation of Concentration of 100 X 10^{-6} g/lit
Adsorbent : A (500mg) Time : 2hrs

S.No	pH	Optical Density
1	1.0	7.69
2	1.5	14.28
3	2.0	2.9
4	2.5	1.8
5	3.0	1.6

MODEL: MOD_24.
Independent: VAR00028
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00029 LIN .257 3 1.04 .383 40.0360 -13.350

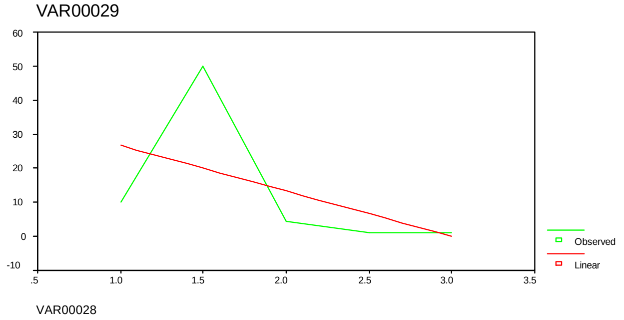

Fig. 7

Table – 8
pH Variation of Concentration of 200 X 10^{-6} g/lit
Adsorbent: A (500mg) Time : 2hrs

S.No	pH	Optical Density
1	1.0	6.25
2	1.5	5.88
3	2.0	1.61
4	2.5	1.09
5	3.0	3.84

Table – 9
Absorbance of Adsorbate of pH = 1.0
Adsorbent : B (500mg)
Conc 1.0 X 10^{-6} g/lit Time : 2hrs

S.No	Volume, ml	Optical Density
1	50	6.25
2	100	5.0
3	150	1.4
4	200	1.3

MODEL: MOD_14.
Independent: VAR00016
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00017 LIN .895 2 17.04 .054 8.0600 -.0362

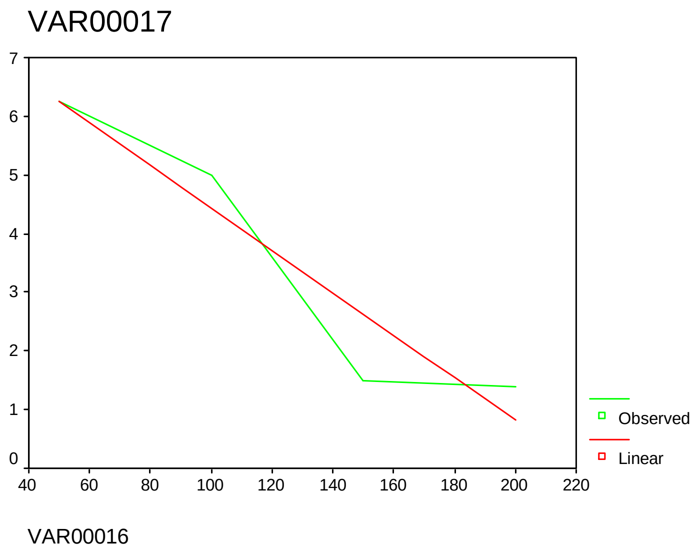

Fig. 9

Table – 10
Absorbance of Adsorbate of pH = 2.0
Adsorbent : B (500mg)
Conc 2.0 X 10^{-6}g/lit Time : 2hrs

S.No	Volume, ml	Optical Density
1	50	1.61
2	100	2.61
3	150	6.66
4	200	50.0

```
MODEL:  MOD_16.
Independent:  VAR00020
Dependent Mth   Rsq  d.f.      F  Sigf      b0      b1
VAR00021 LIN  .651     2   3.73  .193   .4150   .0283
```

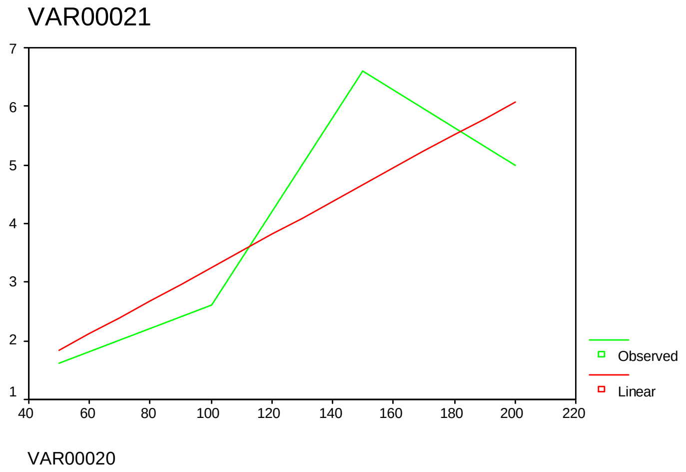

Fig 10

Table – 11
Absorbance of Adsorbate of pH = 3.0
Adsorbent : B (500mg)Conc 3.0 X 10^{-6}g/lit   Time: 2hrs

S.No	Volume, ml	Optical Density
1	50	0.48
2	100	0.64
3	150	0.91
4	200	2.43

```
MODEL:  MOD_18.
Independent:  VAR00024
Dependent Mth   Rsq  d.f.      F  Sigf      b0      b1
VAR00025 LIN  .780    2   7.10  .117  -.4150   .0122
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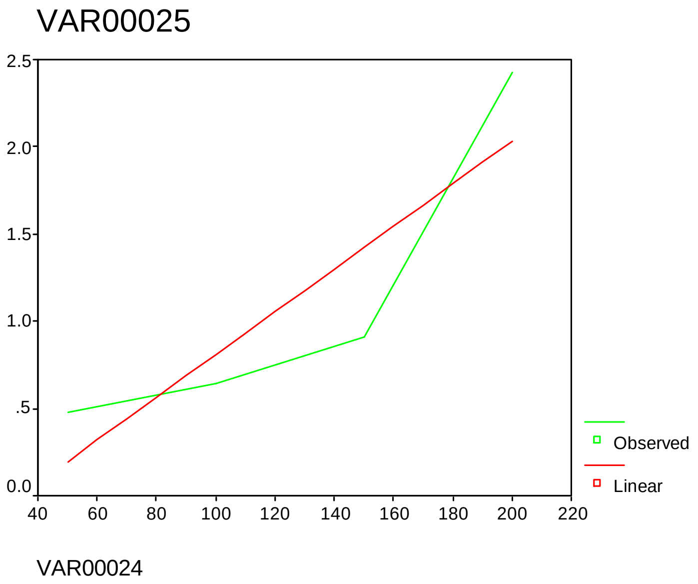

Fig. 11

Table – 12
Absorbance of Adsorbate of pH = 3.0
Adsorbent : C (500mg)Conc 1.0 X 10^{-6o}g/lit Time : 2hrs

S.No	Volume, ml	Optical Density
1	50	25.0
2	100	2.22
3	150	1.67
4	200	1.11

```
MODEL:  MOD_20.
Independent:  VAR00026
Dependent Mth   Rsq  d.f.      F  Sigf      b0      b1
VAR00027 LIN  .981    2  104.91  .009  3.0550  -.0096
```

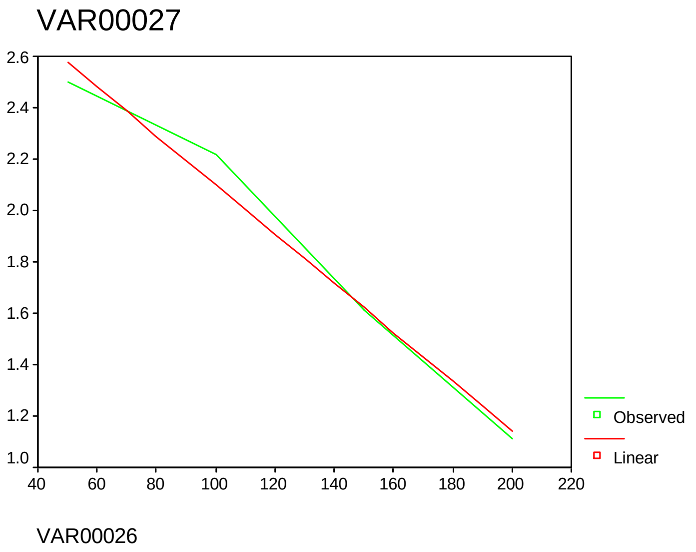

Fig. 12

Table – 13
pH Variation of Concentration of 50 X 10^{-6} g. lit
Adsorbent: B (500mg) Time: 2hrs

S.No	pH	Optical Density
1	1	6.25
2	1.5	0.93
3	2.0	1.61
4	2.5	0.51
5	3.0	0.48

Table – 14
pH Variation of Concentration 100 X 10^{-6} g. lit
Adsorbent : B (500mg) Time : 2hrs

S.No	pH	Optical Density
1	1	0.05
2	1.5	1.04
3	2.0	2.61
4	2.5	0.72
5	3.0	0.64

Table – 15
pH Variation of Concentration 200 X 10^{-6} g. lit
Adsorbent : B (500mg) Time : 2hrs

S.No	pH	Optical Density
1	1	1.38
2	1.5	3.47
3	2.0	5.0
4	2.5	3.3
5	3.0	2.4

Table – 16
Correlation table
Absorbent : A &B

S.No	pH	Optical Density
1	1.24	0.48
2	1.66	0.64
3	2.85	0.91
4	3.84	2.43

MODEL: MOD_28.
Independent: VAR00035
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00036 LIN .831 2 9.86 .088 -.5247 .6861

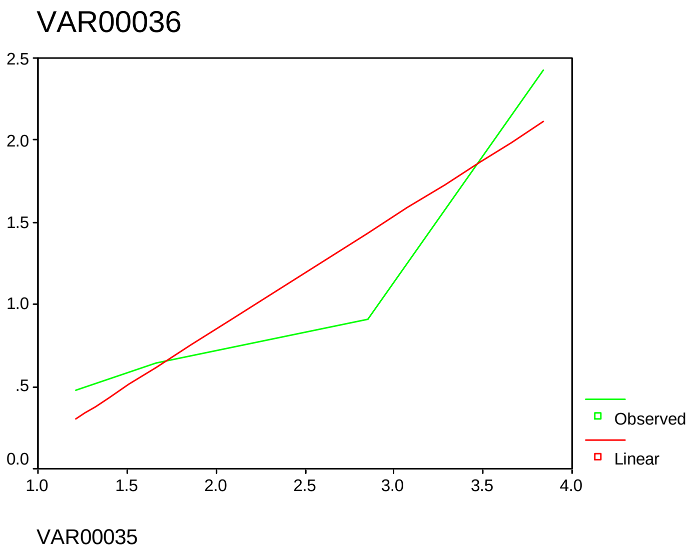

Fig. 16

Table – 17
Correlation Table
Absorbent : A &C

S.No	Optical Density	Optical Density
1	1.24	25.0
2	1.66	2.22
3	2.85	1.61
4	3.84	1.11

MODEL: MOD_29.
Independent: VAR00037
Dependent Mth Rsq d.f. F Sigf b0 b1
VAR00038 LIN 1.000 1 55778.7 .003 3.0642 -.5093

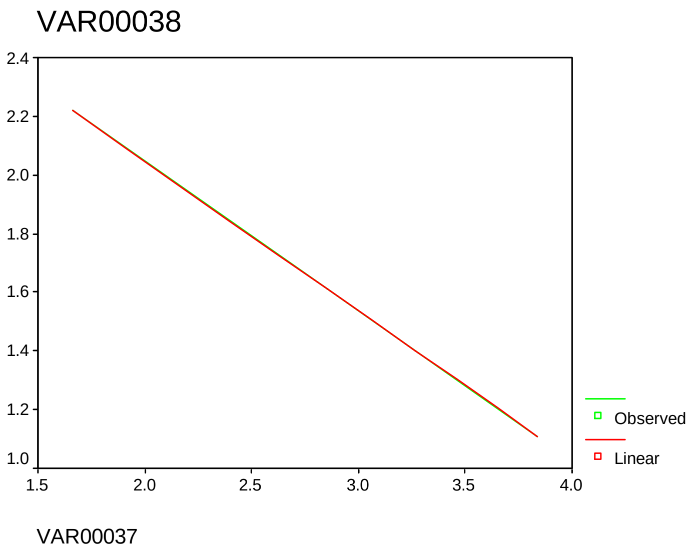

Fig. 17

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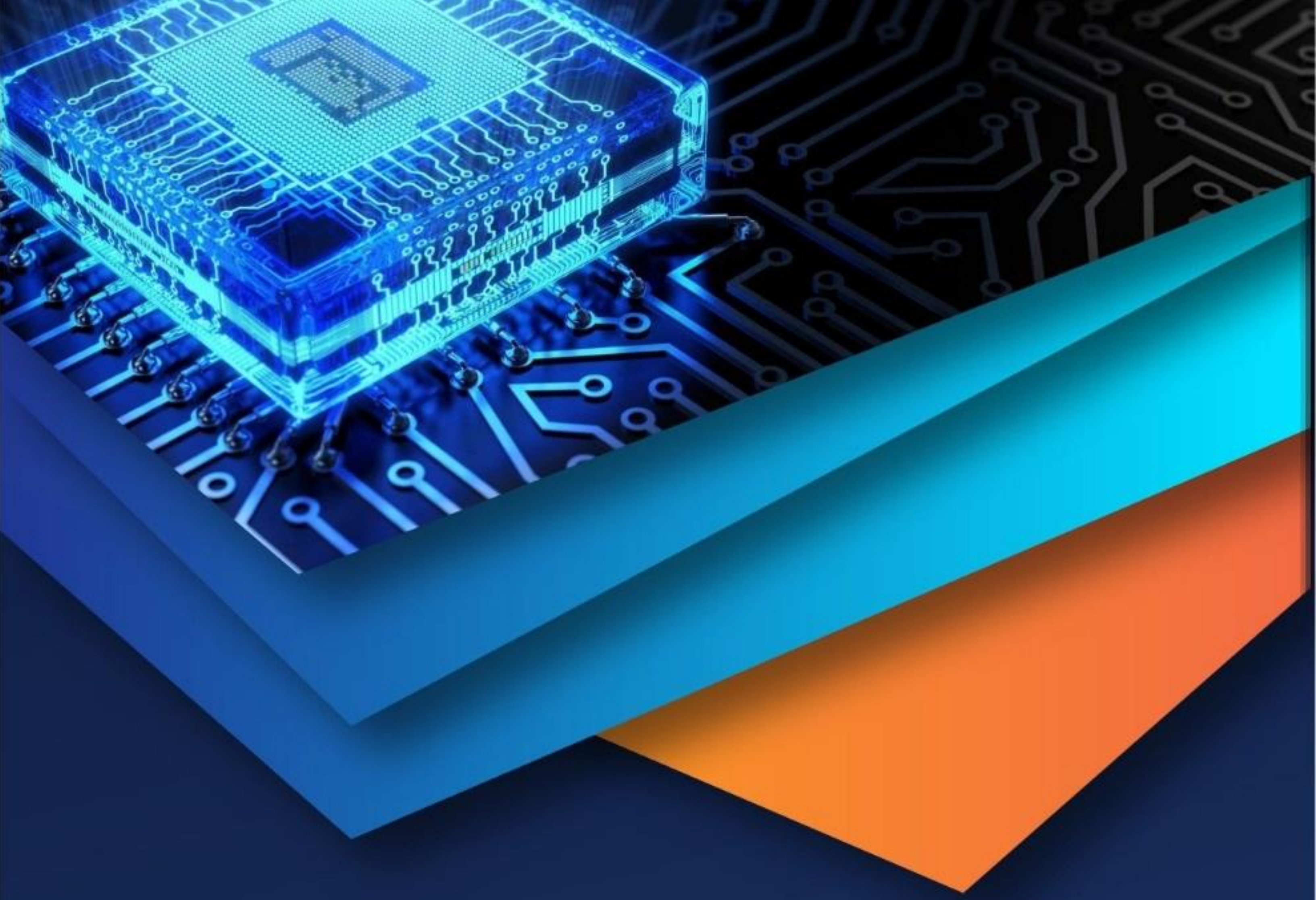

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