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Preparation And Characterization Of Activated Carbon Prepared From Polyathia Longifolia Seed Waste Through Various Activation Processes

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ABSTRACT

The Preparation of Activated carbon from polyalthialongifolia seed by various chemical processes shows excellent improvement in the surface characteristics. Surface morphology also plays a significant role in the adsorption Properties along with surface functional groups. The morphology of the resulting sample was studied by scanning electron microscopy and the surface functional group was investigated by infrared spectroscopy techniques, physico-chemical characteristics such as bulk density, moisture content, ash content, matter soluble in water, soluble in acid, P^H iodine number, conductivity, porosity, yield percentage and surface area have been carried out to assess the suitability of the carbon as adsorbent, results of this investigation indicate that the activated carbon prepared using polyalthialongifolia by H_2O impregnation process followed by activation at 110^oC and yield activated carbon with the highest surface area and more developed micro, meso, macro porosity. The Prepared Activated carbon is used to remove methylene blue dye.

Keywords : Polyalthialongifolia, Activated carbon; Methylene Blue, carbonization, SEM,XRD,IR.

INTRODUCTION

Water is very essential for our day to day life activities. It can be used for drinking, domestic, agricultural, and industrial purposes. Contamination of the water bodies from a cosmetics, pharmaceutical and food industries possess serious environmental problems due to the persistent and recalcitrant nature of the dyes. In addition, some dyes are either toxic or mutagenic and carcinogenic [1]. The conventional methods for treating dyes containing wastewaters are coagulation and flocculation [2], oxidation or ozonation [3],[4] member separation [5] and activated carbon adsorption [6]. These methods are costly and cannot be used effectively to treat the wide range of dyes wastewaters when compared with adsorption processes. The present investigation is an attempt to remove methylene blue dye by adsorption process.

Adsorption is an important technique in separation and purification process. The objective of this study is to prepare activated carbon from polyalthia longifolia seed by chemical activation with potassium hydroxide. Large availability of this material around our city attracted as to utilize it as potential adsorbent for the removal of aqueous organic dyes varying with process factors including initial dye concentration, contact time, initial $_PH$, adsorbent dose and temperature.

EXPERIMENTAL TECHNIQUES

ADSORBENT PREPARATION

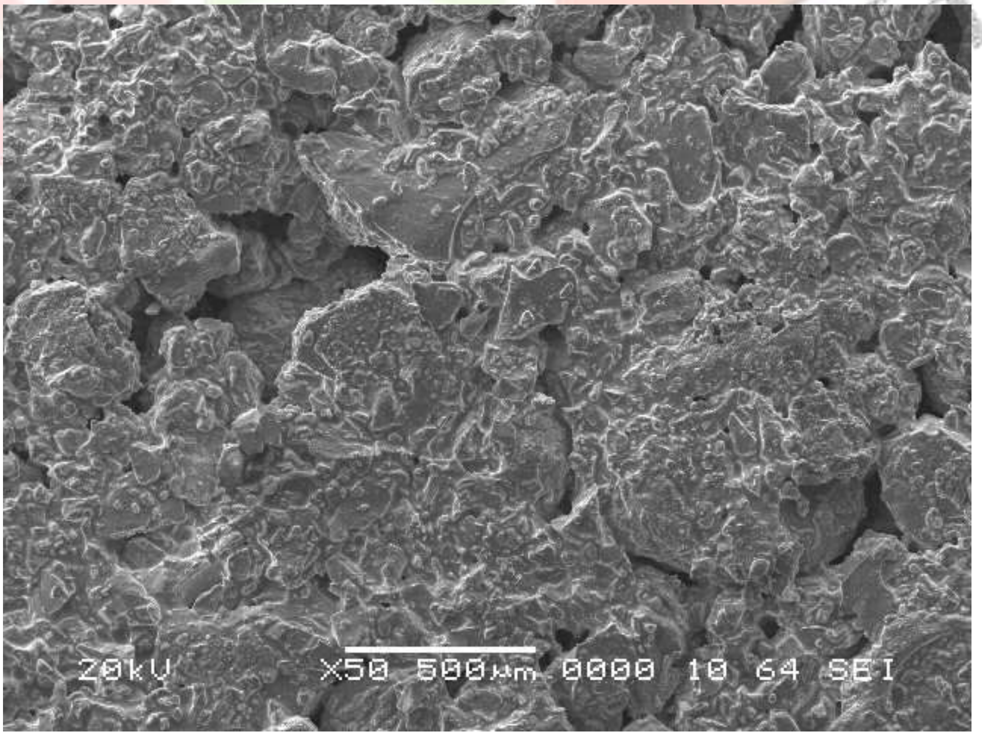
Polyalthia longifolia seeds used in the study was collected from local fields. The collected seeds were extensively washed with tap water to remove soil and dust, spraying with distilled water then dried, charred with required quantity of water(H_2O) for 3 weeks. Then the resultant carbon is washed with excess quantity of distilled water and dried at $110^{o}C$ for 1 hour and stored in air tight container for further studies. Finally it is ground screened through a mesh sieve and collected [7].

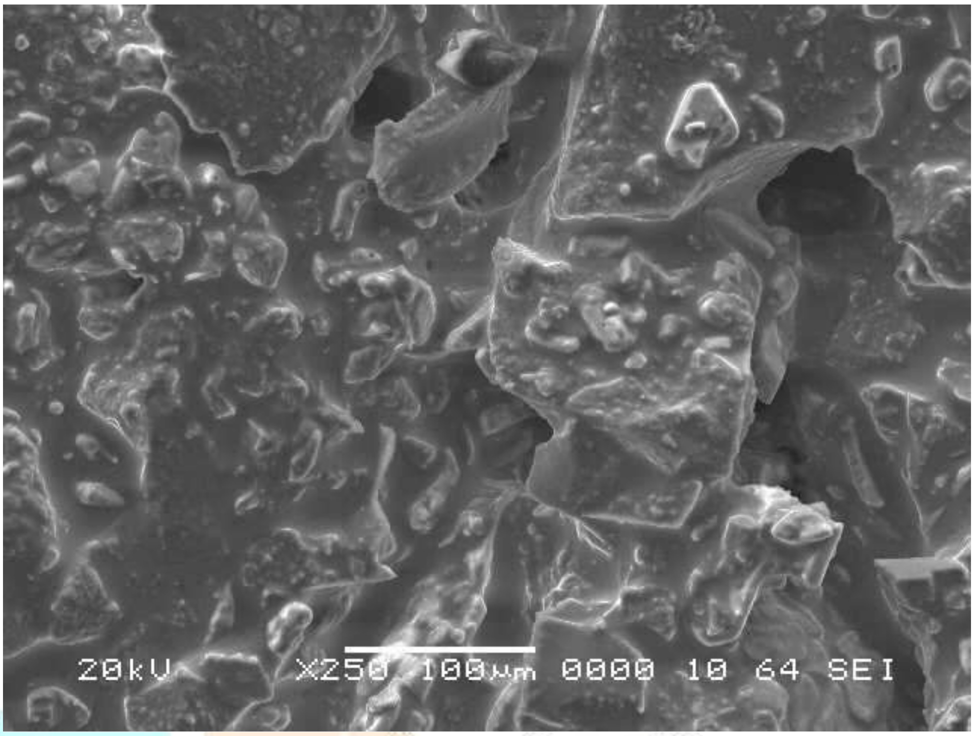
PREPARATION OF ADSORBATE

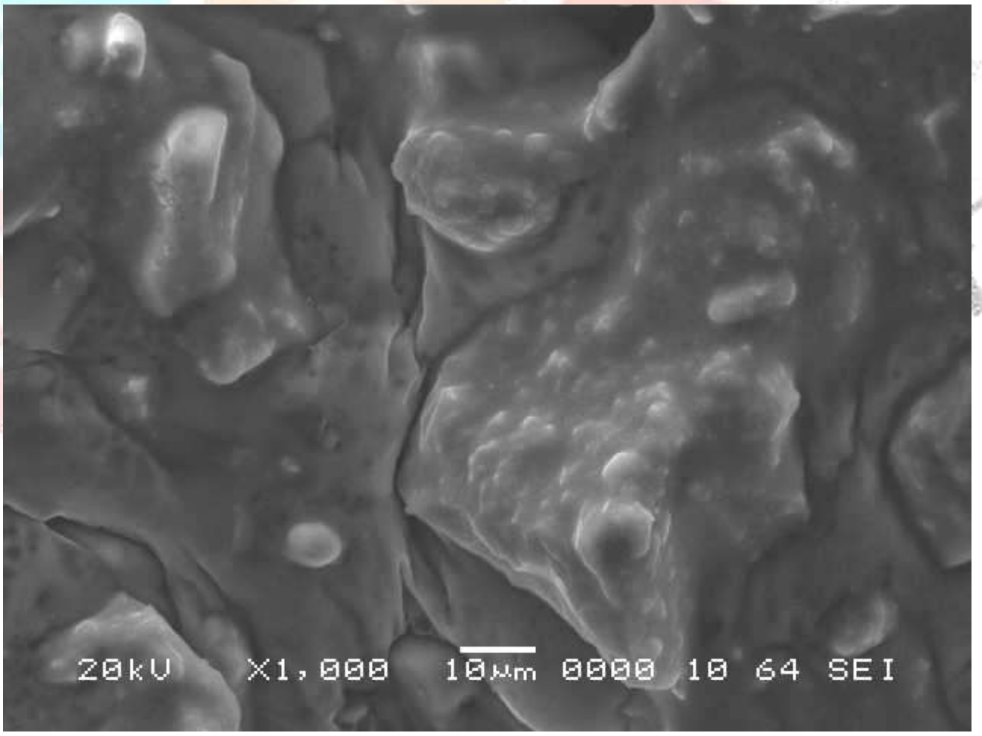
The dye (methylene blue) in commercial purity, was used without further purification. The dye stock solutions were prepared by dissolving 1g of accurately weighed dye in distilled water to the concentration of 1000mg\L. The experimental solutions were obtained by diluting the dye stock solutions in accurate proportions to different initial concentrations [8].

SEM analysis:

Scanning Electron Microscopy (SEM) has been a primary tool for characterizing the surface morphology and fundamental physical properties of the adsorbent surface. It is useful for determining the particle size, porosity and appropriate size distribution of the adsorbent. Scanning Electron Microscophs of raw PAL are shown in figure. It is clear that PAL has considerable numbers of pores where, there is a good possibility for dyes to be trapped and adsorbed into these pores. The SEM of PAL samples show very distinguished dark spores which can be taken as a sign for effective adsorption of dyes molecules in the cavities and pores of this adsorbent.





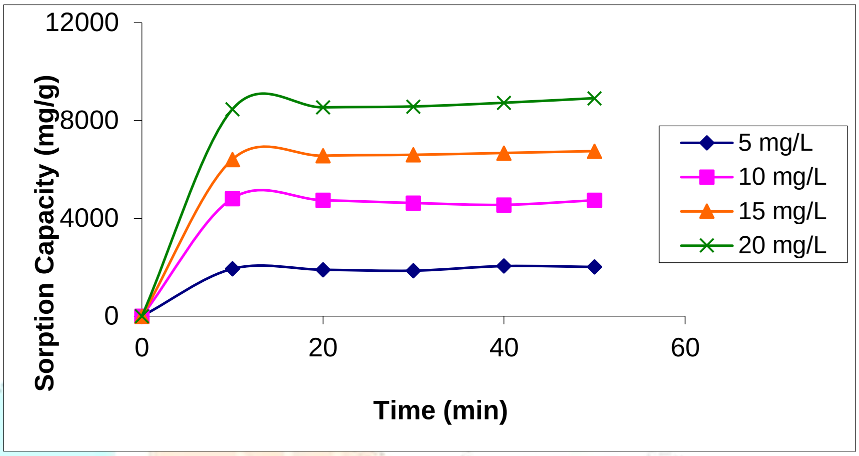


ISOTHERM MODELS

Sorption isotherms define the equilibrium relationship between sorbent and sorbate. In other words, how the sorbed molecules interact with sorbents when the sorption process approaches to an equilibrium state can be described by sorption isotherms [9]. Sorption isotherms also ensure many fundamental physicochemical data to estimate the applicability of sorption processes. Sorption isotherms are characterized by certain constants which values express the surface properties and affinity of the sorbent and can also used to find the sorptive capacity of a mass [10]. Different isotherm models are available, and three of them are selected in this study: Langmuir, Freundlich and Tempkin models, due to their simplicity and reliability.

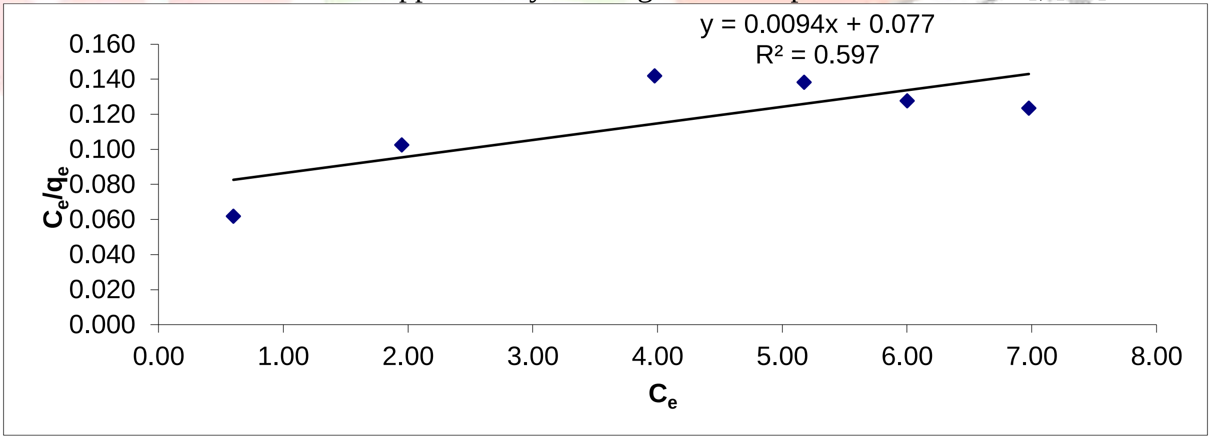
EFFECT OF AGITATION TIME INITIAL DYE CONCENTRATION

The initial concentration of methylene blue solution was varied from 5,10,15 and 20 mg/Land batch experiments were carried out with 100 mg of the adsorbent at 30°C and at pH 7.0. An decreased percentage removal of methylene blue from 20% to 90% observed with 100 mg of the adsorbent in agitation time of 50 minutes and results are shown in figure. In order to establish equilibration time for maximum uptake and to know the kinectics of adsorption process, the afsorption of methylene blue on adsorbent was studied as a function of contact time. It was found that time of equilibrium as well as time required to achieve a definite fraction of equilibrium adsorption is dependent of initial concentration.



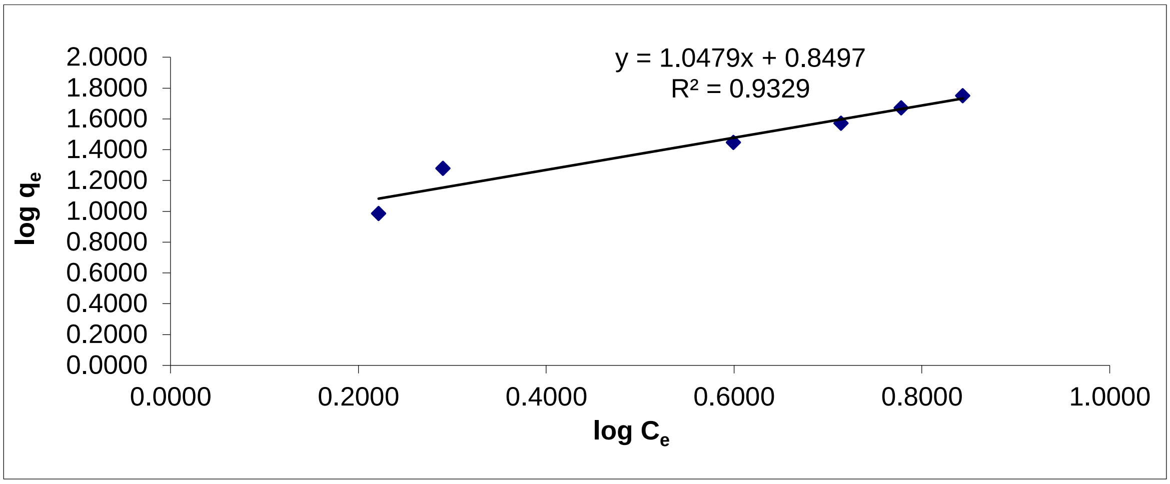
LANGMUIR ADSORPTON ISOTHERM

Adsorption isotherm obtained by fixing adsorbent dosage of 100 mg and 120 minutes of agitation time is shown in figure. The adsorption capacity Q^o values found to be comparable with commercial activated carbon. The values of R_L obtained in this study indicate the applicability of Langmuir adsorption isotherm. The calculated value R^2 confirm the applicability of Langmuir adsorption isotherm [12], [13].



FREUNDLICH ADSORPTION ISOTHERM

Freundlich plot for the adsorption of methylene blue on to PALS activated carbon is given in the figure. The applicability of Freundlich isotherms to the sorption of the dye polyalthia longifolia seed and implied both monolayer adsorption and heterogeneous conditions exist under the experimental conditions used. Several researchers have reported similar results in their studies[14].

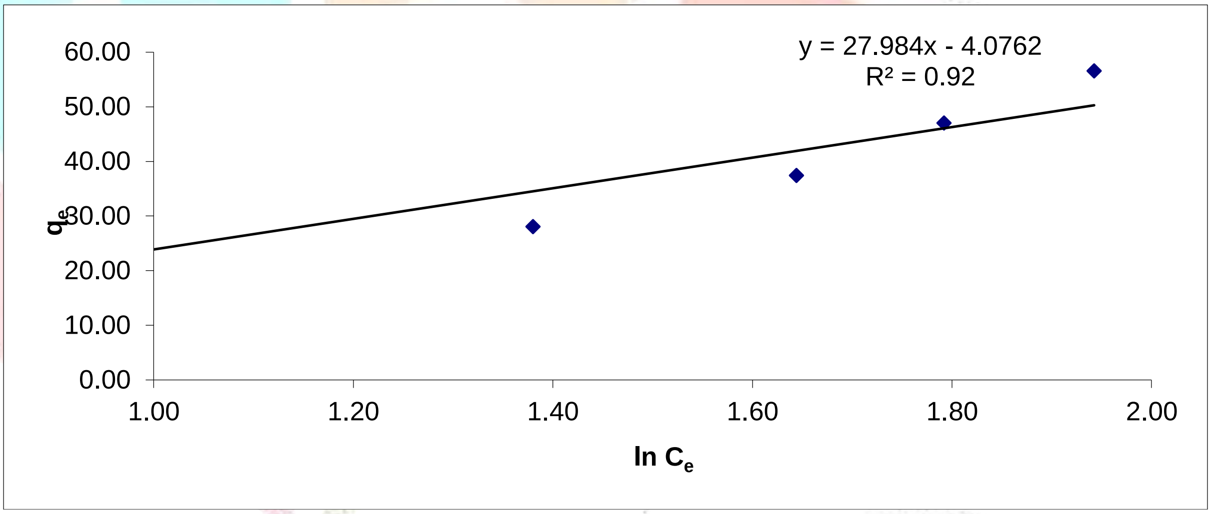


TEMKIN ISOTHERM

The linear form of the TEMKIN ISOTHERM can be expressed as,

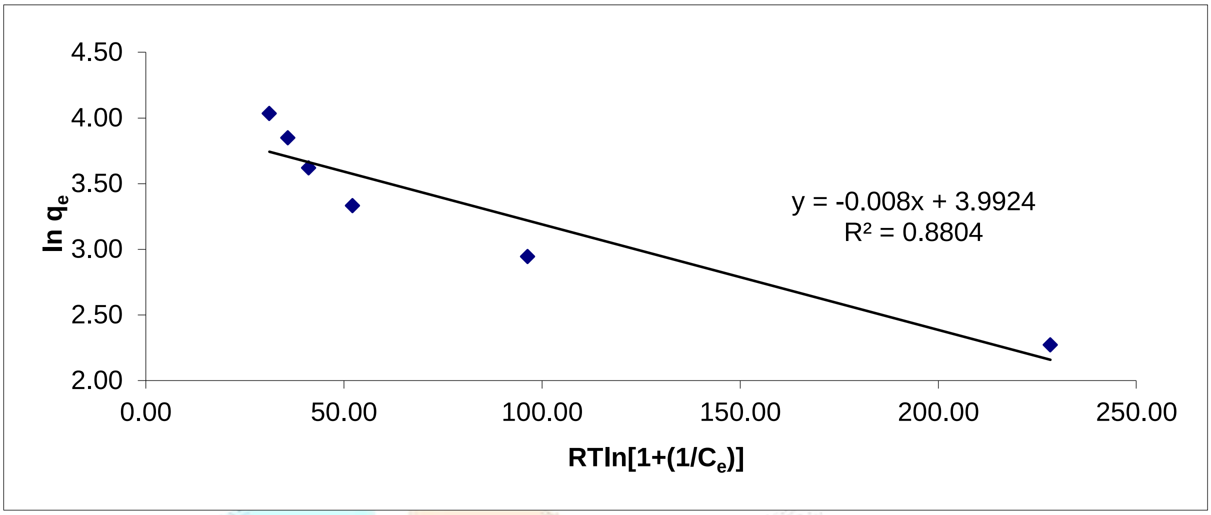
q_e= B lnA + B lnCe

where, Ce= concentration of the dye at equilibrium (mg/L), q_e= amount of dye adsorbed at equilibrium (mg/g) and A plot of q_e vs lnC_e is used to determine the constants A,B [15].



DUBININ-RADUSHKEVICH ISOTHERM (D-R)

The D-R isotherm equation is more general than Langmuir isotherm because it does not assume a homogeneous surface or constant sorption potential. It was applied to distingush between the physical and chemical adsorption of dyes [16].



EXPERIMENTAL TECHNIQUE

pH AND CONDUCTIVITY

1 g of the carbon in 200 ml of distilled water was equilibrated by agitating at 165 rpm for 1 hr and filter using whatmann filter paper. The supernatant solution was analysed for pH and conductivity using pH meter and conductivity meter respectively.

pH carbon = 2.69

MOISTURE CONTENT

1 g of carbon was placed in a china dish and heated in oven at 110 0C for 1 hr, after heating, the china dish was cooled in a desiccator and then weighted. Heating, cooling and weighing was repeated at 30 min intervals until the difference between the two consecutive weighting was less than 1 mg. the loss in weight gives the moisture content.

Moisture content (%) by mass = $\frac{M-X}{M} x\ 100$

Where

M= Mass of the material taken for test (g)

X = Mass of the material after drying (g).

Moisture content carbon = 42.8944

ASH CONTENT

About 1 g of carbon was weighed accurately in a silica crucible and placed in an electric furnace at 180 ^{O}C about 1 hr . The crucible was removed from the electric furnance , after heating the crucible was cooled in a dessicator and then weighted. The process of heating and cooling was repeated until the difference between two consecutive weighing was less than 1 mg.

Ash (on dry basis) % by mass = $\frac{M1}{M2-X}\ x\ 100$

Where

M1 2 mass of the ash (g)

M2 = Mass of the material taken for test(g)

X = Percent moisture content present in the material taken for test.

ASH content carbon = 36.860

MATTER SOLUBLE IN WATER

5g of the carbon and material of known moisture content was weighed accurately and transferred to a I lit beaker. About 300 ml of distilled water was added and heated to boiling with continuous stirring. Stirring was continued for 5 min after the flame was removed. The material was then allowed to settle. The supernatant was filtrate through crucible fitted with an asbestos mat. The procedure was repeated thrice with the residue in the beaker using 300 ml of water each time .the combined liquid was concentrated to less than 100 ml over a water bath, cooled and made upto 100 ml mark in a volumetric flask. Exactly 50 ml of the concentrate was transferred to china dish and evaporated to almost dryness on boiling water bath and finally dried in an electric oven , maintained at 100 ± 5 ^{0}C cooled in a dessicator and weighed. The procedure of drying and weighing was repeated at 30 min intervals, until the difference between the two consecutive was less than 5 gm.

Matter soluble in water (%) = $\frac{M1}{M2-X}\ x\ 100$

M1 = Mass of the residue (g)

M2 = Mass of the material taken for test (g)

X = Percent of moisture present in the material.

Carbon =1.4183

MATTER SOLUBLE IN ACID

5g of the carbon material of known moisture content was weighed accurately and transferred to a I lit beaker. About 300 ml of 0.25 N HCl was added and heated to boiling with continuous stirring. The Stirring was continued for 5 min after the flame was removed. The material was then allowed to settle, the supernatant was filtrate through a rough crucible fitted with an asbestos mat. The procedure was repeated thrice with the residue in the beaker using 300 m1 of Acid each time. The combined liquid was concentrated to less than 100 m1 over a water bath, cooled and made upto 100 ml mark in a volumetric flask. Exactly 50 ml of the concentrate was transferred to china dish and evaporated to almost dryness on boiling water bath and finally dried in an electric oven , maintained at 100 ± 5 ^{0}C cooled in a desiccator and weighed, the procedure of drying and weighing, was repeated at 30 min intervals , until the difference between the two consecutive was less than 5 gm.

$$\text{Acid soluble Matter (\%)} = \frac{A}{M-X}\, x\, 100$$

A = Mass of the residue (g)

M = Mass of the material taken for test (g)

X = Percent of moisture present in the material.

Carbon =9.6219

CONCLUSION

The present study shows that polyalthia longifolia (PALS) activated carbon modified with H_2O can be used as an effective adsorbent for the removal of methylene blue dye from aqueous solution. The characterization studies of SEM shows highly porous in nature; XRD give high degree of graphitization. The maximum adsorption capacity was obtained (90%) by using carbaneous polyalthia lomgifolia seed at $_P$H-6 with adsorbent dose of 100 mg and with agitation time of 50 minutes. PALS obeys the adsorption isotherms like freundlich, langmuir, temkin and D-R isotherms. It indicates that the dye adsorption on PALS was a potanous, endothermic in chemical reaction.

Based on the data of present study, PALS is an eco-friendly adsorbent of dye removal from coloured textile wastewater.

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