IRJIF. I.F. : 3.821

North Asian International Research Journal of Sciences, Engineering & I.T.

ISSN: 2454-7514 Vol. 4, Issue-3, March-2018

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

A Peer Reviewed Refereed International Journal

TAMARIND SEED SHELLCARBONASANADSORBENTACOMPARATIVE STUDY ON ADSORPTION OF MONOBASIC ACIDS

PALED MAHESHWARI[1],

[1]*Assistant Professor Department of chemistry Government First Grade College Bidar email id paled.maheshwari@gmail.com*

ABSTRACT

In this study, adsorption of different monobasic acids was performed on Tamarindseed shell carbon, which was used as an adsorbent, as it is serves as eco-friendly adsorbents. It has proven to be significantly effective with the provision of satisfactory adsorption capacities for the removal of pollutants from waste water. We have studied adsorption on different monobasic and dibasic acid by taking Tamarind seed shellcarbon as an adsorbent. The monobasic acids an understudy were Formic acid, Acetic acid, Propionic acid and Butyric acid. India is the largest producer of tamarind in the world According to Exportimportdata.in, India produces 162,000 metric tons annually, making it the top exporter of tamarind globally. Thailand is another major producer, known for its high-quality tamarind paste. Tamarindprocessingby–productsincludetamarindshell.Currently,thesematerials are disposed of in lands or used as soil amendments, which results in negativeenvironmentalimpactsandphytotoxicitytoplants,respectively.Thesematerialsneedtobe economically and environmentally managed.

Tamarind shells have increasingly been explored as sustainable, low-cost, and efficient adsorbents for removing various pollutants from water. These agricultural by-products offer high porosity and surface area, particularly when converted into biochar or chemically modified. Recent studies emphasize their potential in adsorbing heavy metals, dyes, emerging contaminants, and nutrients like phosphates. Modifications such as activation with $ZnCl_2$ or incorporation into biochar composites further enhance adsorption capabilities. The experimental isotherm data were analyzed using Freundlich and Langmuir models. The adsorption isotherm for Langmuir adsorption isotherm and Freundlich adsorption isotherm was studied for different monobasic and dibasic acid by taking Walnut shellcarbon as an adsorbent.

The results obtained when compared with different acids the conclusion obtained was compared with different monobasic acids (Formic acid, Acetic acid, Propionic acid and Butanoic acid), From graph the readings obtained we observed that extent of adsorption of Formic acid > Ethanoic acid > Propanoic acid > Butanoic acid. Formic acid (0.01336)> Ethanoic acid (0.01334)> Propanoic acid (0.0130)> Butanoic acid (0.0128) The reason behind the above conclusion may be the presence of CH_2 group in propanoic acid and absence ofCH_2group in acetic acid.

INTRODUCTION

Rapid industrialization has led to increased discharge of pollutants into water bodies, creating severe environmental and health hazards. Adsorption is one of the most efficient and widely used methods for water purification due to its simplicity and high removal efficiency. However, the high cost of commercial adsorbents such as activated carbon necessitates the search for sustainable, low-cost alternatives. Tamarind seed shell, a lignocellulosic waste material from the food processing sector, offers an eco-friendly solution.

TSS primarily contains cellulose, hemicellulose, lignin, and polyphenolic compounds. These components contribute to a porous structure and a variety of functional groups including hydroxyl, carboxyl, and phenolic groups. Key characteristics include: High fixed carbon content Good thermal stability, Abundant surface functional groups and Low cost and widespread availability.

ADSORBENT USED

Fig.1 Tamarind shell nut shell Fig.2 crushed Tamarind shell Nut shell Fig.3 Tamarind shell nut shell

Properties and Preparation of Tamarind Seed Shell Carbon

Raw Material Characteristics

Tamarind seed shells consist of cellulose, hemicellulose, lignin, and polyphenolic compounds. Upon carbonization, these structures generate a porous carbon matrix.

Preparation of Activated Carbon: TSSC is commonly prepared through:**Carbonization** at 400–800°C**Chemical activation** using KOH, H_3PO_4, or $ZnCl_2$ Thermal **activation** for improved surface area.

Physicochemical Properties: High surface area and porosity, Presence of oxygen-containing functional groups (–COOH, –OH), Good thermal and chemical stability and Negatively charged surface under certain pH conditions.

Monobasic Acids Considered in This Study

The selected monobasic acids include:**Formic Acid (HCOOH), Acetic Acid (CH_3COOH),Propionic Acid (C_2H_5COOH) and Butyric acid(C_3H_7COOH)**

These acids differ in molecular size, polarity, and dissociation constants (pKa), affecting their adsorption behavior.

Isotherm Models

The adsorption behavior fits well into:

- **Langmuir isotherm** (monolayer adsorption)
- **Freundlich isotherm** (heterogeneous surface interactions)

Formic acid typically shows highest Langmuir monolayer capacity.

STRUCTURE OF TAMARIND SHELL NUTSHELL CARBON

Tamarind shell shell-derived carbon is increasingly utilized in environmental remediation, energy storage, and catalysis due to its *high fixed carbon content, low ash, and hierarchical porous structure*. The conversion of Tamarind shell shells into carbonaceous material involves carbonization and activation (physical or chemical), which tailors the structure, surface area, and functional groups of the resultant carbon. Key structural features include **Amorphous carbon** matrix with disordered graphitic layers.**Porous structure**, especially when chemically or physically activated. Presence of **micropores (<2 nm)**, **mesopores (2–50 nm)**, and sometimes **macropores (>50 nm)**, depending on the activation method.**High surface area** (often >500 m^2/g when activated) beneficial for adsorption applications.

PREPARATION OF TAMARIND SHELL NUT SHELL CARBON

The tamarind fruit shell was initially washed with deionized water and dried in a hot air oven at 100 °C for 6 hThe dried shells are ground into a fine powder.

2. MATERIALS AND METHODS

Adsorption process of different mono basic acid (Formic acid, Acetic acid, Propionic acid and Butanoic acid)

Materials Used: Tamarind seed shell carbon, Mono basic acid (Formic acid, Acetic acid, Propionic acid and Butanoic acid), NaOH, Phenolphthalein, Stoppered bottle, Burette, Pipette, Funnel, Conical flask.

PROCEDURE:

Prepared aqueous solution of acids into numbered flask as labelled, the total volume of each solution is 50ml taken in Stoppard bottles. Transfer 10ml of the solution from each bottle into the conical flask. Add 2-3 drops of Phenolphthalein indicator and titrate against NaOH. Once the end point is reached, read the burette reading. The volume of base$V_{1.}$ Calculate the actual concentration of oxalic acid C_1 in the flask number 1 to 5 respectively, and write it down in the table. Using practical balance weigh 5 portions of walnut shell carbon, each portion1 gram. PlacedTamarind shellcarbon into numbered flask into stoppered bottle and shake them, wait for 20 minutes, the process of adsorption is in progress. Mix the mixtures for several times by shaking the flask. (The process of adsorption is a function of times it is important to put on ion feel into flask at the same time to provide adsorption for the same period in each flask). Filter the mixtures into clean and dry flask to avoid disturbing effect of adsorption of acid into filtering paper, remove away the first portion of filtration approximate of 5ml. Determine the final concentration of acid C, in each of the flask after adsorption from each solution, pipette out 10ml of oxalic acid solution and transfer it to clean and dry conical flask. To this conical flask containing oxalic acid solution at 2 to 3drops of Phenolphthalein indicator. Now, titrate this solution against NaOH in the burette, note down the burette reading. The volume of base V_2

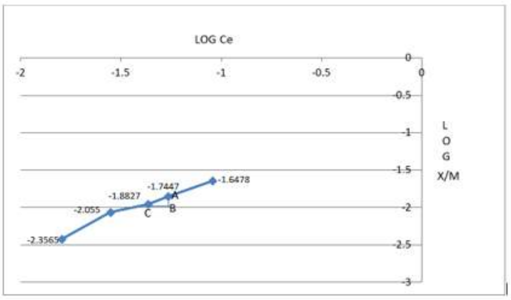
PROCEDURE TABULAR COLUMN: -Dilution ofacids

Bottle No.	Vol. of acid added (0.1N)	Volume of water added in ml	Amount of Tamarind shell nut shell carbon added in gm
1	50	00	1
2	40	10	1
3	30	20	1
4	20	30	1
5	10	40	1

TABULARCOLUMN: Formic acid

SI. NO	Initialconcentrationof Formicacid(Co)	Vol.oftitranttakenin ml	AmountofTamarind Seed Shell Carbon	Burettereading	Ce = B.R*0.1/10Eq.con.of	X=Co-Ce/20 Amount adsorbed in moles	x/m	Log(x/m)	Log Ce	Ce(x/m)
1	0.5	10	1	5	0.05	0.0225	0.0225	-1.6478	-1.3010	0.001125
2	0.4	10	1	4	0.04	0.018	0.018	-1.7447	-1.3979	0.00072
3	0.3	10	1	3.8	0.038	0.0131	0.0131	-1.8827	-1.4202	0.0004978
4	0.2	10	1	2.4	0.024	0.0088	0.0088	-2.0555	-1.6197	0.002112
5	0.1	10	1	1.2	0.012	0.0044	0.0044	-2.3565	-1.9208	0.0000528

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (FORMIC ACID)



Scale= X-axis – 1 unit =0.5 cm

Y- axis - 1 unit=0.5cm

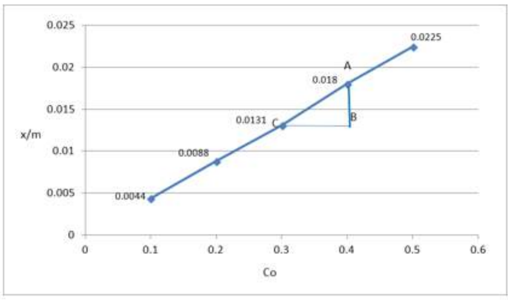
SLOPE= AB / BC

= (-1.744)-(-1.8827) / (-1.3979)- (-1.4202)

= 0.138 / 0.0223

= 6.188

GRAPH: LANGMUIR ADSORPTION ISOTHERM (FORMIC ACID)



Scale= X-aixs – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

SLOPE= AB / BC

= (0.018)-(0.0131) / (0.4)-(0.3)

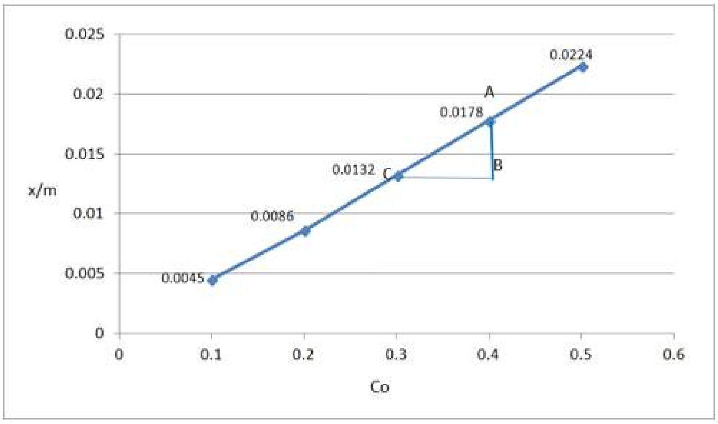
= 0.0049 / 0.1

= 0.049

TABULARCOLUMN: - ACETIC ACID

SI. NO	Initial concentration of Ethanoic acid(Co)	Vol.oftitranttakeninml	Amount of Tamarind Seed ShellCarbonaddedingm	Burettereading	Ce=B.R*0.1/10Eq.con.ofacid inmol/dm^3	X=Co-Ce/20Amountadsorbed inmoles	x/m	Log(x/m)	Log Ce	Ce(x/m)
1	0.5	10	1	5.2	0.052	0.0224	0.0224	-1.6497	-1.2839	0.001164
2	0.4	10	1	4.4	0.044	0.0178	0.0178	-1.7495	-1.3565	0.0007832
3	0.3	10	1	3.6	0.036	0.0132	0.0132	-1.8794	-1.4436	0.000475
4	0.2	10	1	2.8	0.028	0.0086	0.0086	-2.0655	-1.5528	0.0002408
5	0.1	10	1	1	0.01	0.0045	0.0045	-2.3467	-2	0.000045

GRAPH: LANGMUIR ADSORPTION ISOTHERM (ETHANOIC ACID)



Scale= X-axis – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

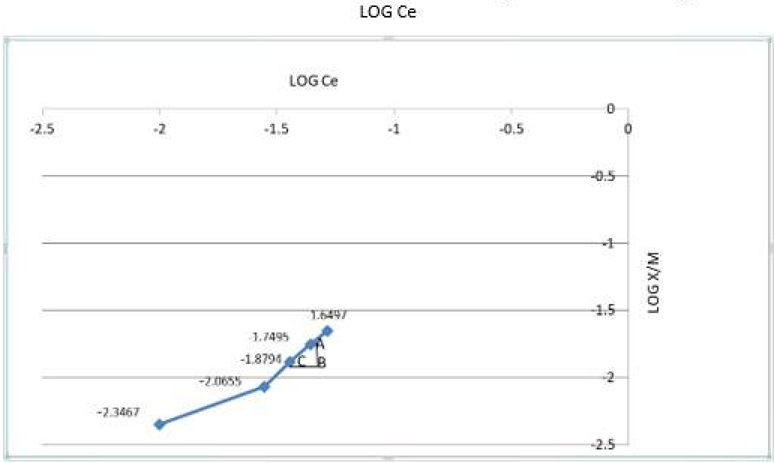
SLOPE= $\frac{AB}{BC}$

$= \frac{(0.0178)-(0.0132)}{(0.4)-(0.3)}$

$= \frac{0.0046}{0.1}$

= 0.046

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (ETHANOIC ACID)



Scale= X-axis – 1 unit =0.2cm

Y- axis - 1 unit=0.5cm

SLOPE= $\frac{AB}{BC}$

$= \frac{(-1.7495)-(-1.8794)}{(-1.3565)-(-1.4436)}$

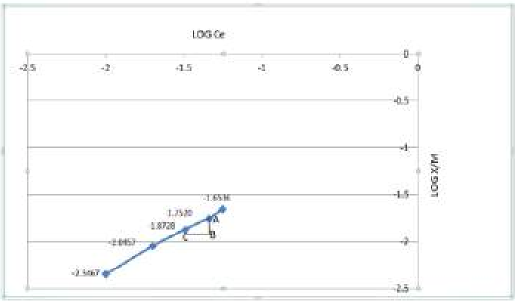
$= \frac{0.1299}{0.0871}$

= 1.4913

TABULARCOLUMN: - Propanoic acid

SI. NO	Initialconcentrationof Propionicacid(Co)	Vol.oftitrantakeninml	Amount of Tamarind SeedShellCarbonadded	Burettereading	Ce = B.R*0.1/10Eq.con.ofacid	Amount adsorbed in X=Co-Ce/20	x/m	Log(x/m)	Log Ce	Ce(x/m)
1	0.5	10	1	5.6	0.056	0.0222	0.0222	-1.6536	-1.2518	0.001243
2	0.4	10	1	4.6	0.046	0.0177	0.0177	-1.7520	-1.3372	0.0008142
3	0.3	10	1	3.2	0.032	0.0134	0.0134	-1.8728	-1.494	0.0004288
4	0.2	10	1	2	0.02	0.009	0.009	-2.0457	-1.6989	0.00018
5	0.1	10	1	1	0.01	0.0045	0.0045	-2.3467	-2	0.000045

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (PROPIONIC ACID)



Scale= X-axis – 1 unit =0.2cm

Y- axis - 1 unit=0.5cm

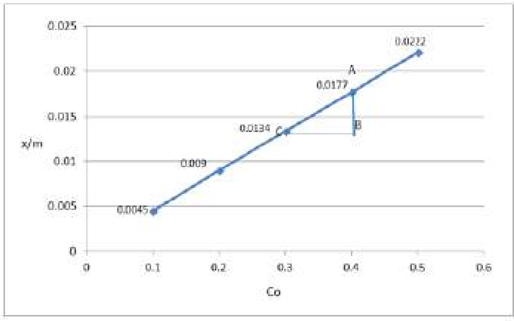
SLOPE= AB/BC

= (-1.7520)-(-1.8728) / (-1.3372)- (-1.494)

= 0.1208 / 0.1568

= 0.770

GRAPH : LANGMUIR ADSORPTION ISOTHERM (PROPIONIC ACID)



Scale= X-axis – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

SLOPE= AB/BC

SLOPE = (0.0177)-(0.0134) / (0.4)-(0.3)

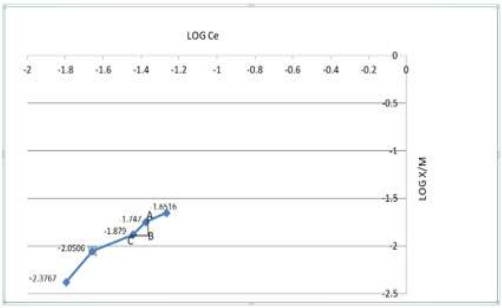
= 0.0043 / 0.1

= 0.215

TABULARCOLUMN: -Butanoic acid

SI. NO	Initial concentration of Butanoic acid(Co)	Vol.oftitranttakeninml	AmountofTamarindSeed Shell Carbonaddedingm	Burettereading	Ce=B.R*0.1/10Eq.con.of acid inmol/dm^3	X=Co-Ce/20 Amount adsorbed in	x/m	Log(x/m)	Log Ce	Ce(x/m)
1	0.5	10	1	5.4	0.054	0.0223	0.0223	-1.6516	-1.2676	0.001204
2	0.4	10	1	4.2	0.042	0.0179	0.0179	-1.747	-1.3767	0.0007518
3	0.3	10	1	3.6	0.036	0.0132	0.0132	-1.879	-1.4436	0.0004752
4	0.2	10	1	2.2	0.022	0.0089	0.0089	-2.0506	-1.6575	0.000195
5	0.1	10	1	1.6	0.016	0.0042	0.0042	-2.3767	-1.7958	0.0000672

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (BUTANOIC ACID)



Scale= X-axis – 1 unit =0.5cm

Y- axis - 1 unit=0.5cm

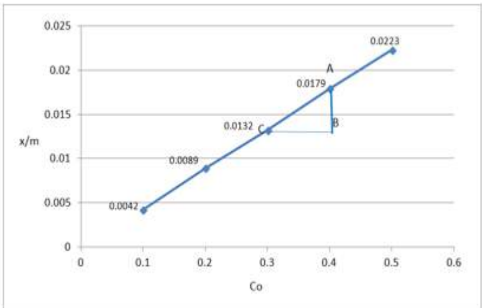
SLOPE= $\frac{AB}{BC}$

$= \frac{(-1.747)-(-1.879)}{(-1.3767)-(-1.4436)}$

$= \frac{0.132}{0.0669}$

= 1.9730

GRAPH: LANGMUIR ADSORPTION ISOTHERM (BUTANOIC ACID)



Scale= X-axis – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

SLOPE= $\frac{AB}{BC}$

$= \frac{(0.0179)-(0.0132)}{(0.4)-(0.3)}$

$= \frac{0.0047}{0.1}$

= 0.047

CONCLUSION

Tamarind seed shell carbon is a promising bio-adsorbent for the removal of monobasic acids from aqueous solutions. Its adsorption performance varies based on molecular size, polarity, and dissociation behaviour of the acids. Comparative analysis suggests that TSSC is most effective for formic acid, followed by acetic and propionic acids. With proper activation and optimization, TSSC can serve as a sustainable alternative in wastewater treatment technologies.

From graph the readings obtained we observed that extent of adsorption of Formic acid > Ethanoic acid > Propanoic acid > Butanoic acid. Formic acid (0.01336)> Ethanoic acid (0.01334)> Propanoic acid (0.0130)> Butanoic acid (0.0128)

REFERENCES

1. Gradziel T.M. Tamarind Seed Shell (Prunus dulcis) breeding. In: Jain S.M., PriyadarshanP.M., editors.BreedingPlantationTreeCrops:Temperate Species. Springer; NewYork, NY, USA: 2009. pp.

2. TamarindSeedShellBy-Products:ValorizationforSustainabilityandCompetitiveness oftheIndustryFoods2021,10,1793.
3. https://doi.org/10.3390/foods10081793www.mdpi.com/journal/foods

4. Chen,S.H.;Zhang,J.; Zhang, C. L.; Yue,Q. Y.; Li,Y.; Li,C.;Desalination, 2010, 252,149-156.
5. Mehrasbi, M. R.;Farahmandkia,Z.; Taghibeigloo, B.; Taromi,A.; Water Air Soil Pollut, 2009, 199, 343–351.
6. Liminana, P.; Garcia-Sanoguera, D.; Quiles-Carrillo, L.; Balart, R.; Montanes, N. Optimization of maleinized linseed oil loading as a biobased compatibilizer in poly(butylene succinate) composites with Tamarind Seed Shell flour. Materials 2019, 12, 685.
7. Liminana, P.; Garcia-Sanoguera, D.; Quiles-Carrillo, L.; Balart, R.; Montanes, N. Optimization of maleinized linseed oil loading as a biobased compatibilizer in poly(butylene succinate) composites with Tamarind Seed Shell flour. Materials 2019, 12, 685.