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

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

IRJIF. I.F. : 3.821

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

A Peer Reviewed Refereed International Journal

ONION PEEL CARBON AS AN ADSORBENT: A COMPARATIVE STUDY ON ADSORPTION OF MONOBASIC ACID

PALED MAHESHWARI[1]

[1]*Department of chemistry Government First Grade College Bidar Paled Emaheshwari@gmail.com*

ABSTRACT

Agricultural waste–derived adsorbents are gaining attention as sustainable alternatives to commercial activated carbon. Onion peel, an abundant kitchen waste, contains lignocellulosic components suitable for carbonization. In this study, onion peel carbon (OPC) was prepared and evaluated for its adsorption efficiency toward monobasic acids such as acetic acid, formic acid, propionic acid and Butanoic acid. Batch adsorption experiments were conducted to determine the effects of contact time, adsorbent dosage, pH, and initial acid concentration. The results revealed that OPC exhibits appreciable adsorption capacity, with maximum removal efficiency observed for formic acid. Adsorption behavior follows the Langmuir isotherm and pseudo-second-order kinetics, indicating chemisorption. OPC demonstrates potential as a low-cost, eco-friendly adsorbent for the removal of acidic contaminants from wastewater.

1 INTRODUCTION:

Industrial effluents frequently contain organic acids, including monobasic acids such as acetic, propionic, and formic acids. These acids contribute to high chemical oxygen demand (COD), low pH, and environmental toxicity if discharged untreated. Conventional treatment methods are expensive; therefore, low-cost biosorbents from agricultural waste materials are preferred.

Onion peel—a primary kitchen and food-processing waste—is rich in cellulose, hemicellulose, lignin, and phenolic compounds, making it suitable for producing activated carbon. Utilizing onion peel not only adds value to waste but also supports sustainable waste-to-wealth approaches. This study aims to investigate the adsorption

efficiency of onion peel carbon for monobasic acids and compare its performance among different acid types.

2. MATERIALS AND METHODS:

2.1 Collection and Preparation of Onion Peel Carbon: Onion peels were collected, washed, and dried at 105°C.The dried peels were carbonized at 400–500°C in a muffle furnace. The carbonized peel was ground and sieved (100–150 μm).Activation was done using phosphoric acid (H_3PO_4) and subsequent heating at 600°C.

2.2 Adsorbents: Monobasic acids used:

- Acetic acid (CH_3COOH), Formic acid (HCOOH), Propionic acid (C_2H_5COOH) and Butanoic acid(C_3H_7COOH)

2.3 Adsorption Isotherms: Langmuir and Freundlich isotherm model**s** were applied.

ADSORBENT USED

Fig.1OnionPeel *Fig.2CrushedOnionPeel* *Fig.3OnionPeel carbon*



Materials Used: Onion peel Carbon, Monobasic acids (Acetic acid (CH_3COOH), Formic acid (HCOOH), Propionic acid (C_2H_5COOH) and Butanoic acid(C_3H_7COOH), 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 baseV_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. Placed Onion peel carbon 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

PROCEDURETABULARCOLUMN: -Dilution of Formicacid

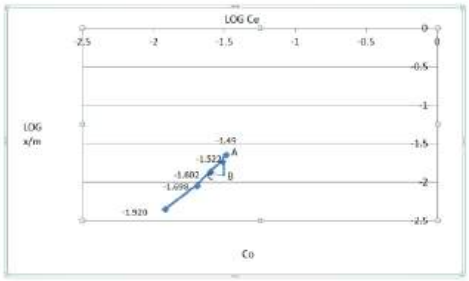
Bottle No.	Vol.ofFormicacidadded (0.1N Formic acid)	Volumeofwater added in ml	Amount of Onion Peel carbonadded in gm
1	50	00	1
2	40	10	1
3	30	20	1
4	20	30	1
5	10	40	1

TABULARCOLUMN:

SI. NO	Initialconcentrationof Formicacid(Co)	Vol.oftitranttakenin ml	AmountofOnionPeel Carbonaddedin gm	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	3.2	0.032	0.023	0.023	-1.638	-1.4948	0.00073
2	0.4	10	1	3	0.03	0.0185	0.0185	-1.7328	-1.5228	0.00055

3	0.3	10	1	2.5	0.025	0.0137	0.0137	-1.8632	-1.6020	0.00035
4	0.2	10	1	2	0.02	0.009	0.009	-2.0457	-1.6989	0.00018
5	0.1	10	1	1.2	0.012	0.0044	0.0044	-2.3565	-1.9208	0.000052

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (FORMIC ACID)



Scale= X-axis – 1 unit =0.5 cm

Y- axis - 1 unit=0.5cm

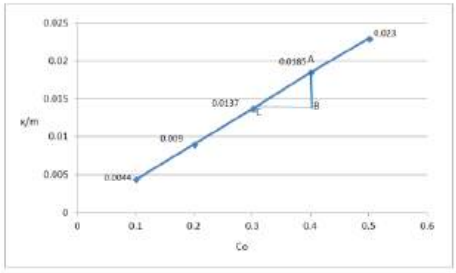
SLOPE= AB/BC

= (-1.7328)-(-1.8632) / (-1.5228)-(-1.602)

= 0.13/0.0791

= 1.6468

GRAPH: LANGMUIR ADSORPTION ISOTHERM (FORMIC ACID)



Scale= X-axis – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

SLOPE= AB/BC

= (0.0185)-(0.0137) / (0.4)-(0.3)

= 0.0045/0.1

= 0.048

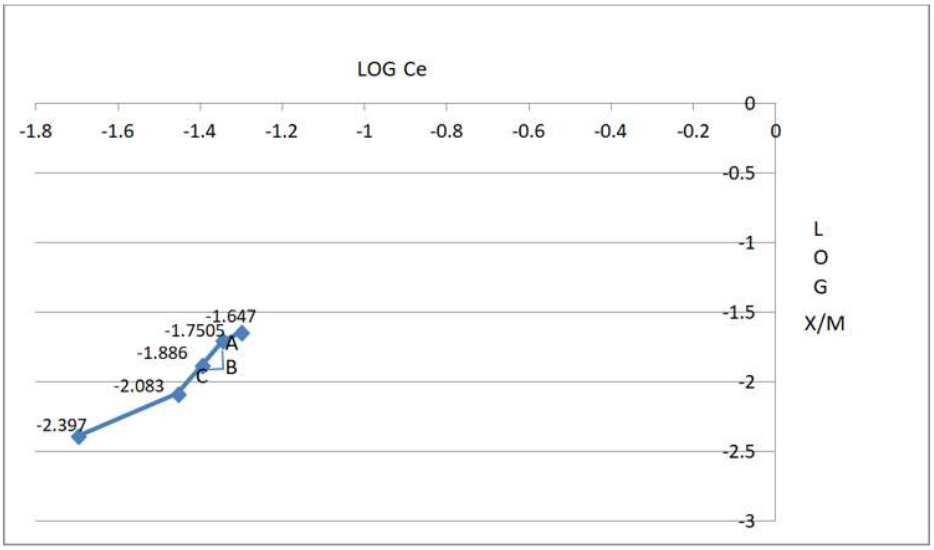
TABULAR COLUMN; ACETIC ACID/ETHANOIC ACID

SL. NO	Initial concentration of Ethanoic acid(Co)	Vol.oftitranttakeninml	AmountofOnionPeelCarbon addedingm	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	0.05	0.0225	0.0225	-1.6478	-1.3010	0.00112
2	0.4	10	1	4.5	0.045	0.0177	0.0177	-1.7508	-1.3467	0.00079
3	0.3	10	1	4	0.04	0.013	0.013	-1.1886	-1.3979	0.00052

4	**0.2**	**10**	**1**	**3.5**	**0.035**	**0.0082**	**0.0082**	**-2.08354**	**-1.4559**	**0.00028**
5	**0.1**	**10**	**1**	**2**	**0.02**	**0.004**	**0.004**	**-2.3979**	**-1.698**	**0.00008**

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (ETHANOIC ACID)

LOG Ce



Scale= X-axis – 1 unit =0.2cm

Y- axis - 1 unit=0.5cm

SLOPE=AB

BC

=(-1.7508)-(-1.8860)

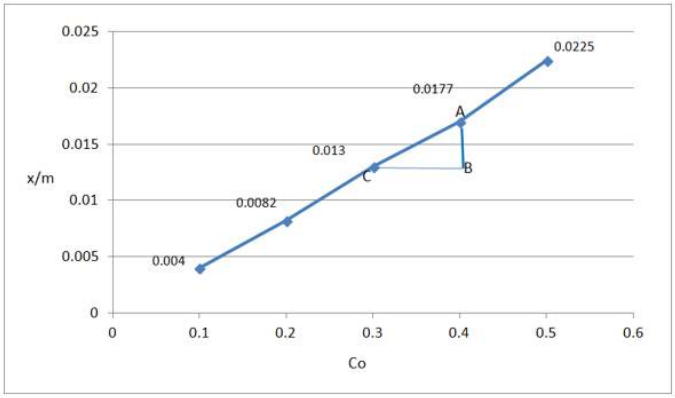
(-1.3467)-(-1.3979)

=0.13

0.0512

=2.6

GRAPH: LANGMUIR ADSORPTION ISOTHERM (ETHANOIC ACID)



Scale= X-axis – 1 unit =0.1cm

Y- axis - 1 unit=0.005cm

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

$= \frac{(0.01775)-(0.013)}{(0.4)-(0.3)}$

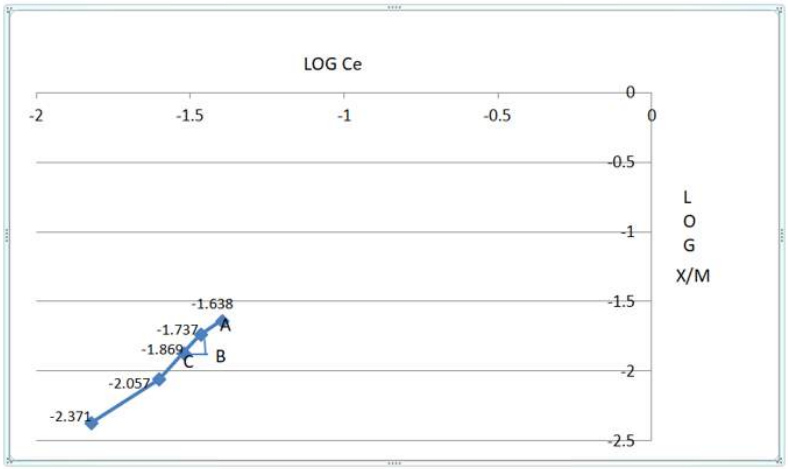
$= \frac{0.00475}{0.1}$

$= 0.0475$

TABULARCOLUMN:- Propanoic acid

SL. NO	Initialconcentrationof Propionicacid(Co)	Vol.oftitranttakeninml	AmountofOnionPeel	Burettereading	Ce B.R*0.1/10Eq.con.ofa	X=Co-Ce/20 Amount adsorbed	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	0.00112
2	0.4	10	1	4.5	0.045	0.01775	0.01775	-1.75080	-1.3467	0.00079
3	0.3	10	1	4	0.04	0.013	0.013	-1.88605	-1.3979	0.00052
4	0.2	10	1	3.5	0.035	0.00825	0.00825	-2.0835	-1.4559	0.00028
5	0.1	10	1	2	0.02	0.004	0.004	-2.3979	-1.6989	0.00008

GRAPH: FREUNDLICH ADSORPTION ISOTHERM (BUTANOIC ACID)



Scale= X-axis – 1 unit =0.5cm Y- axis - 1 unit=0.5cm

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

$= \frac{(-1.7375)-(-1.8696)}{(-1.468)-(-1.522)}$

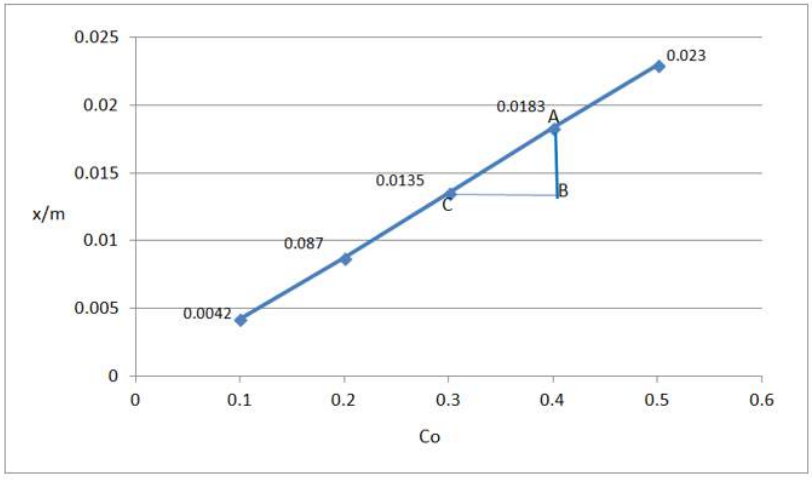
$= \frac{0.1321}{0.0543} = 2.433$

TABULARCOLUMN:- Butanoic acid

SI. NO	Initialconcentrationof Butanoic acid(Co)	Vol.oftitranttakeninml	AmountofOnionPeel Carbonaddedin gm	Burettereading	Ce = B.R*0.1/10Eq.con.ofacid	X=Co-Ce/20 Amount adsorbed in	x/m	Log(x/m)	Log Ce	Ce(x/m)

1	0.5	10	1	4	0.04	0.023	0.023	-1.6382	-1.3979	0.00092
2	0.4	10	1	3.4	0.034	0.0183	0.0183	-1.7375	-1.4685	0.00062
3	0.3	10	1	3	0.3	0.0135	0.0135	-1.86966	-1.52286	0.00040
4	0.2	10	1	2.5	0.025	0.00875	0.00875	-2.0579	-1.6020	0.00021
5	0.1	10	1	1.5	0.015	0.00425	0.00425	-2.3716	-1.8239	0.000063

GRAPH: LANGMUIR ADSORPTION ISOTHERM (BUTANOIC ACID)



Scale= X-axis – 1 unit =0.1cm Y- axis - 1 unit=0.005cm

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

$$= \frac{(0.0183)-(0.0135)}{(0.4)-(0.3)}$$

$$= \frac{0.0048}{0.1} = 0.048$$

3. RESULTS AND DISCUSSION

3.1 Physicochemical Characteristics of Onion Peel Carbon

- High porosity and surface area due to acid activation.Presence of functional groups such as –OH, –COOH, and C=C enhances adsorption.SEM images show irregular pores and heterogeneous morphology**.**

3.2 Comparative Adsorption of Monobasic Acids

Order of adsorption efficiency:

Formic acid > Acetic acid > Propionic acid This trend is consistent with:

- Molecular size, Diffusion rate Interaction with the carbon surface

3.3 Isotherm Analysis

- **Langmuir isotherm** showed higher correlation ($R^2 > 0.98$), indicating monolayer adsorption.
- Maximum adsorption capacity (qmax) was highest for **formic acid**.

The reason behind the above conclusion is the presence of 3 CH2 group in glutaric acid, and absence of 1 CH2 group in succinic acid, or 2 CH2 group in malonic acids, or 3 CH2 group in oxalic acid.

REFERENCES

1. Panigrahi, T.; Santhoskumar, A.U. Adsorption process for reducing heavy metals in Textile Industrial Effluent cost adsorbents. Prog. Chem. Biochem. Res. 2020, 3, 135-139, https://doi.org/10.33945/SAMI/PCBR.2020.2.7.
2. 2. Liu, Q.; Li, Y.; Chen, H.; Lu, J.; Yu, G.; Möslang, M.; Zhou, Y. Superior adsorption capacity of functionalised straw adsorbent for dyes and heavy-metal ions. J. Hazard. Mater. 2020, 382, 121040, https://doi.org/10.1016/j.jhazmat.2019.121040.
3. Onion (Allium Cepa) Processing Waste as a Sorption Material for Removing Pollutants from Aqueous Media Ildar G. Shaikhiev 1 , Natalia V. Kraysman 2,* , Svetlana V. Sverguzova 3
4. A. Bhatnagar *et al.* A review of emerging adsorbents for nitrate removal from waterChem. Eng. J.(2011)
5. Sagar NA, Pareek S, Benkeblia N, Xiao J (2022) Onion (Allium cepa L.) bioactives: chemistry, pharmacotherapeutic functions, and industrial applications. Food Front 3(3):380–412. https://doi.org/10.1002/fft2.135
6. Celano R, Docimo T, Piccinelli AL, Gazzerro P, Tucci M, Di Sanzo R, et al. (2021) Onion peel: turning a food waste into a resource. Antioxidants (Basel) 10(2). https://doi.org/10.3390/antiox10020304
7. Bonaccorsi, P., Caristi, C., Gargiulli, C. & Leuzzi, U. 2008. Flavonol glucosides in Allium species: A comparative study by means of HPLC-DAD-ESI-MS-MS. Food Chemistry 107: 1668-1673.

8. Downes, K., Chope, GA. & Terry, LA, 2010. Postharvest application of ethylene and 1-methylcyclopropeneeither before or after curing affects onion (Allium cepa L) bulb quality during long-term cold storage.Postharvest Biology & Technology 55: 36-44.
9. C. Y. Cheng, V. N. Misra, J. Clough and R. Muni, Miner. Eng., 1999, 12,1083-1092
10. P. Delvasto, A. Valverde, A. Ballester, J. A. Munoz, F. Gonzalez, M. LBlazquez,J. M. Igual and C. Garcia-Balboa, Hydrometallurgy, 2008, 92, 24-129.
11. K. lonkov, S. Gaydardzhiev, A. Corream de Araujo, D. Bastin and M. Lacoste,Miner Eng, 2013, 47, 119-127.
12. A. P. L. Nunes, C. L. L. Pinto, G. E. S. Valad ao and P. R. M. Viana, Miner.Eng, 2012, 39, 206-212.
13. P.J. Williams and T. E. Cloete, J. Biotechnol., 2010, 150, 372-373.
14. HQ. Tang, Z. C. Guo and Z. L. Zhao, J. Iron Steel Res Int., 2010, 17, 1-6.
15. W. T. Xia, Z. D. Ren and Y. F. Gao, J. Iron Steel Res. Int., 2011, 18, 1-411.18, 9-13