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Preparation and Characterization of Activated Carbon Derived From Waste Materials and Its Application in the Removal of Fluoride from Ground Water

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Abstract : *Pollution has been a major challenge to environmental engineers today due to the contaminants from natural and anthropogenic origins that are hazardous to human health. Over the last few decades, adsorption has gained importance for purification, separation and recovery process. Among various adsorbents used, activated carbon is well known for its high adsorption capacity due to large surface area and pore volume. Now a days, immense research has been focused towards converting the waste materials into activated carbon, since this technology not only solves the problem of waste disposal but also converts wastes into a valuable product, that can be used as an adsorbent for various treatments. Researchers have studied the production of activated carbon from various materials using physical and chemical processes . However, the adsorption capacity of the activated carbon for a specific adsorbate varies strongly with the type of raw material and the processing techniques used. Muringa pods, Rooster feathers, and Mangosteen Fruits are selected as the precursor for the preparation of activated carbon in the present investigation. Activated carbon was prepared through chemical activation using orthophosphoric acid, zinc chloride, and potassium hydroxide. The effect of various process parameters on porous characteristics of the activated carbon was investigated.*

Activated Muringa Pod impregnated with OPA shows activated carbon with high adsorptive capacity at an optimised activation temperature of $600^{o}c$, activation time of 2 hours and 60% impregnation ratio of orthophosphoric acid. Adsorption Capacity Decreased in the Order,M 3 > M 1 > M 2. Development of AC was influenced by various factors such as type of chemical reagents used for impregnation, impregnation ratio, carbonization temperature, holding time etc. 7 out of 15 water samples collected from bore wells in Palakkad district exceed the safe permissible limit for fluoride. Experimental results indicated that the prepared activated carbon was suitable for the removal of turbidity, color, total suspended solids and fluoride from ground water.
Keywords: *Activated Carbon, Adsorption, Chemical Activation, Fluoride, Ground Water.*

I. INTRODUCTION

Groundwater fluoride contamination is a growing problem in many parts of the world. In India approximately 66 million people are exposed to groundwater with elevated fluoride levels. Fluoride is an essential element for human health, but in excessive doses it can lead to chronic fluoride poisoning, fluorosis, which harms teeth enamel and bone tissues. The people living in rural areas are more exposed since there is no centrally supplied treated water in these areas. Instead, groundwater accessed through dug wells, is their only water supply.

Among various treatments used, activated carbon is a powerful adsorbent due to large surface area and pore volume that can be used for water treatment. The challenge has been first, the search for suitable precursor and chemical species for impregnation and, second, determining the most appropriate operating carbonization conditions that will favors the production of the most desirable properties per surface area in the activated carbon.

II. Objective

The objective of this study was to investigate the fluoride levels of the ground water and its removal by the application of activated carbon prepared from waste materials.

III. NEED FOR THE STUDY

Kerala, as a state, has mild problems with fluoride contamination, but locally it can be a large problem. The fluoride levels in this study that exceeded the WHO standards and the limits have to be brought under control. So methods are to be implemented for reducing the fluoride content thereby groundwater fluoride contamination problem can be reduced. Activated carbon is being used as an adsorbent there by reduces the fluoride and at present prescribed standard limit 1.5mg/L can be maintained.

IV. PREPARATION OF ACTIVATED CARBON

- ✓ PHYSICAL ACTIVATION
- ✓ CHEMICAL ACTIVATION

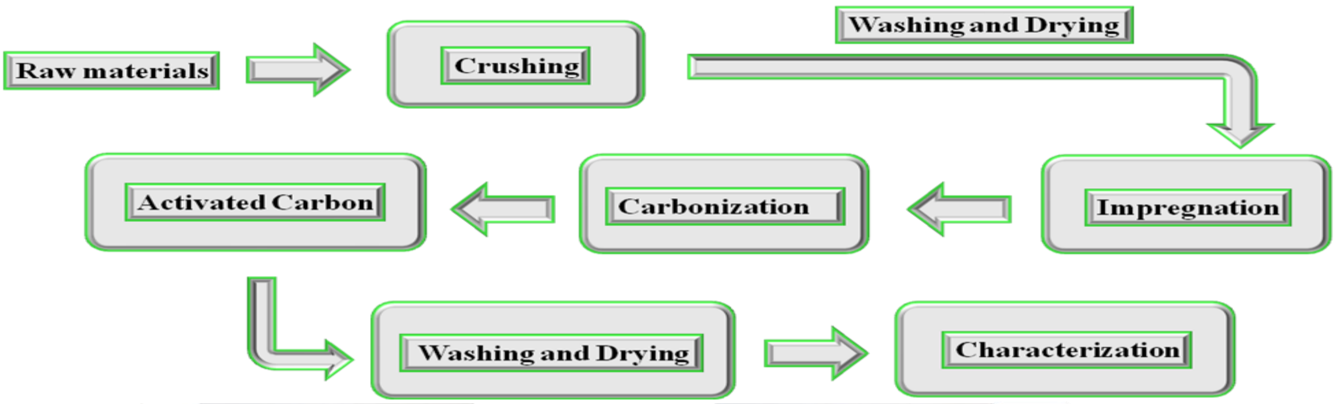
✓ CHEMICAL ACTIVATION

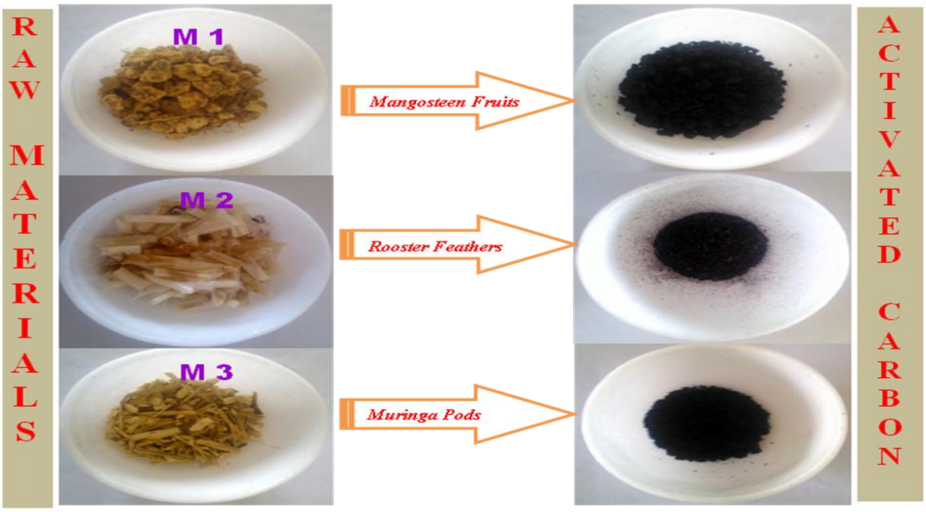
Preparation of activated carbon by chemical activation is a single step process in which carbonization and activation is carried out simultaneously. Initially the precursor is mixed with chemical activating agent, which acts as dehydrating agent and oxidant. Chemical activation offers several advantages over physical activation which mainly include lower activation temperature (< 800^{o}C) compared to the physical activation temperature (800 – 1100^{o}C), single activation step, higher yields, shorter activation times and better porous characteristics.

V. METHODOLOGY

Preparation Method

CHEMICAL ACTIVATION





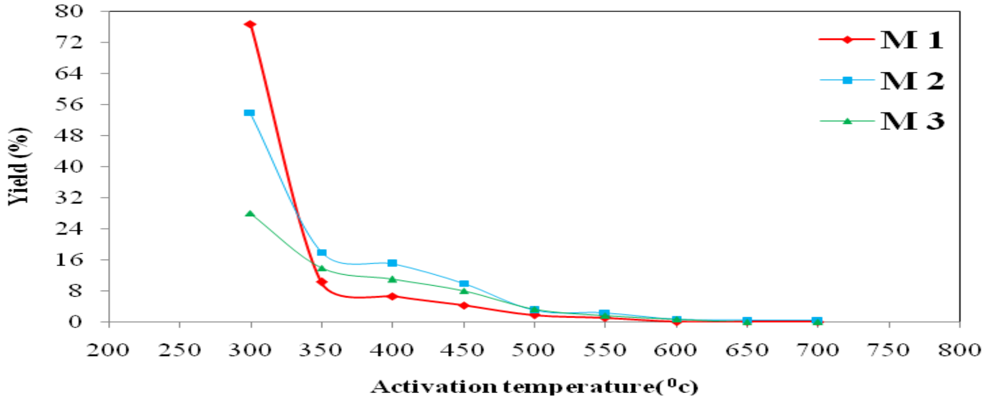
VI. RESULTS AND DISCUSSIONS

CHARACTERIZATION OF PRECURSOR - PROXIMATE ANALYSIS

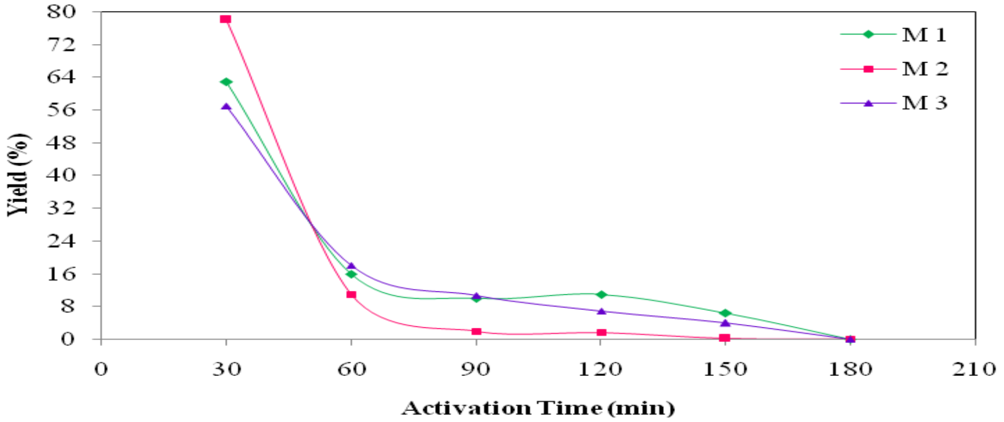
Sl.NO	Raw Materials	Moisture content (%)	Volatile Matter (%)	Ash content (%)	Fixed Carbon (%)
1	M 1	7	69	5	19
2	M 2	12	55	19	14
3	M 3	4	71	3	22

VII. Effect Of Various Preparation Parameters

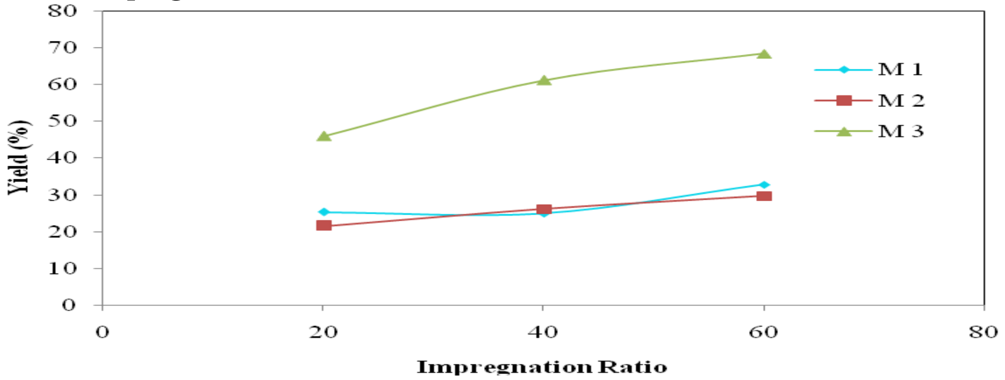
1. Effect Of Carbonization Temperature On Yield Of Activated Carbon



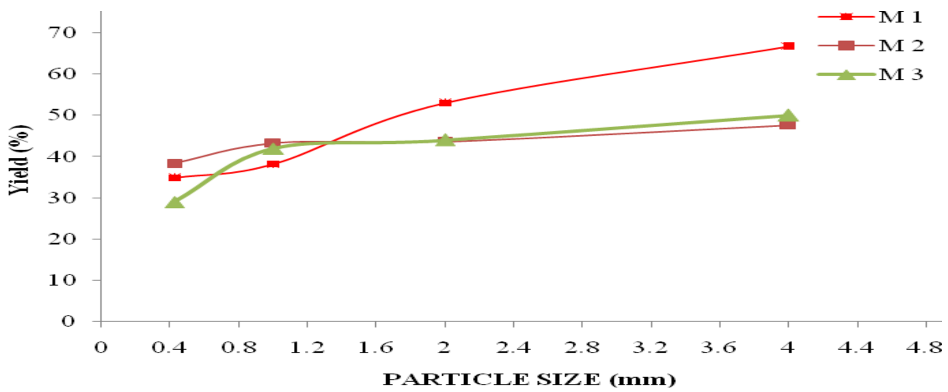
2. Effect Of Carbonization Time On Yield Of Activated Carbon



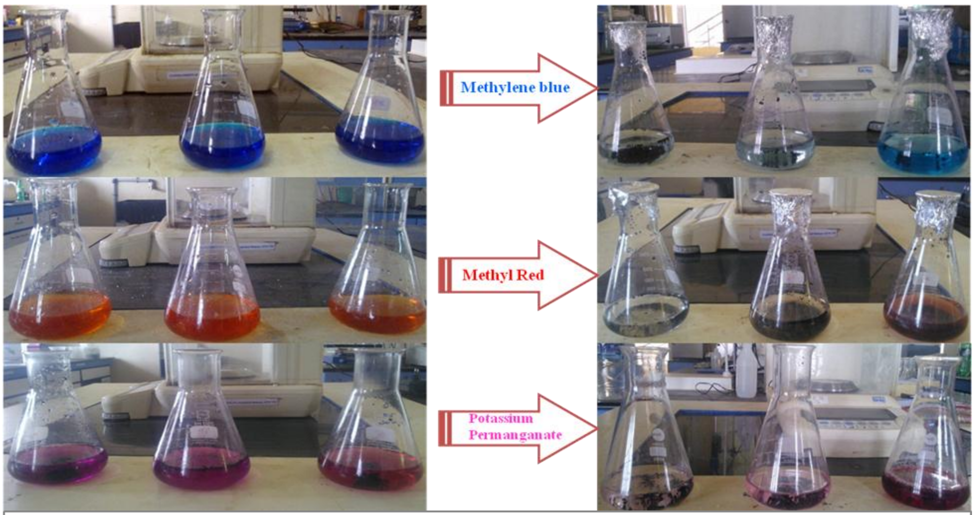
3. Effect Of Impregnation Ratio On Yield Of Activated Carbon

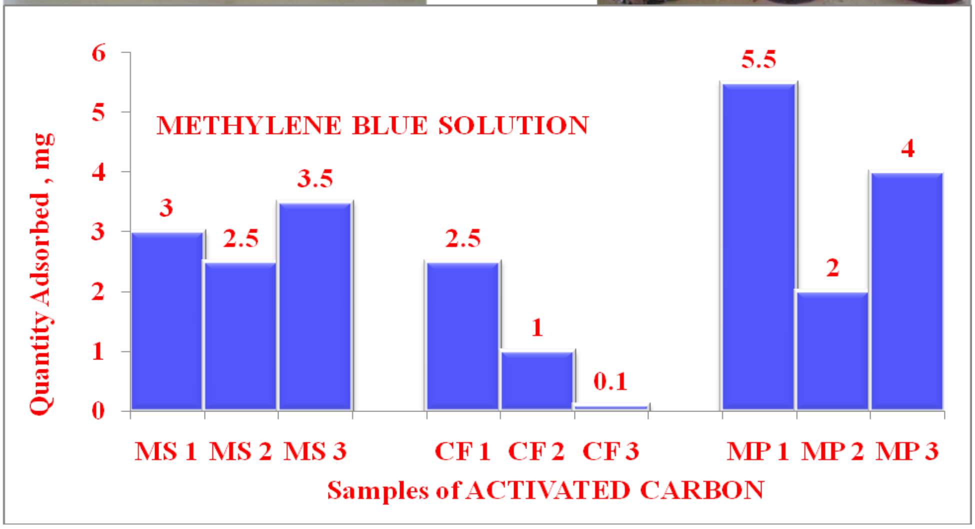


4. Effect Of Particle Size On Yield Of Activated Carbon



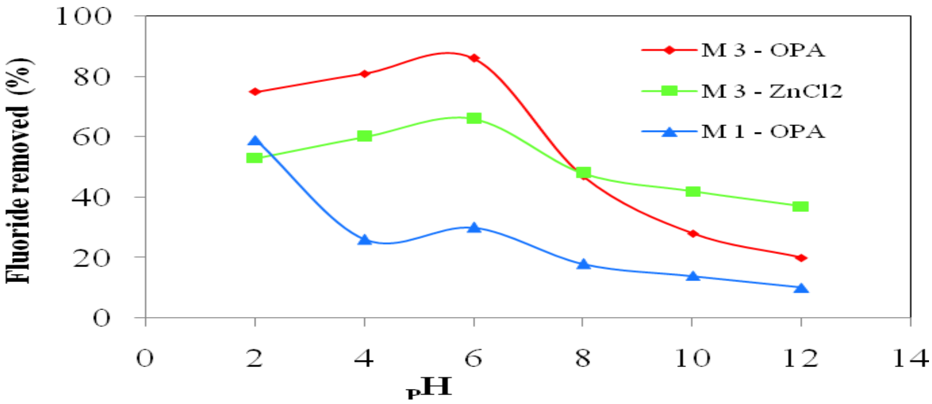
VIII. ADSORPTION CAPACITY Of ACTIVATED CARBON BASED On DECOLOURISATION Of SOLUTIONS



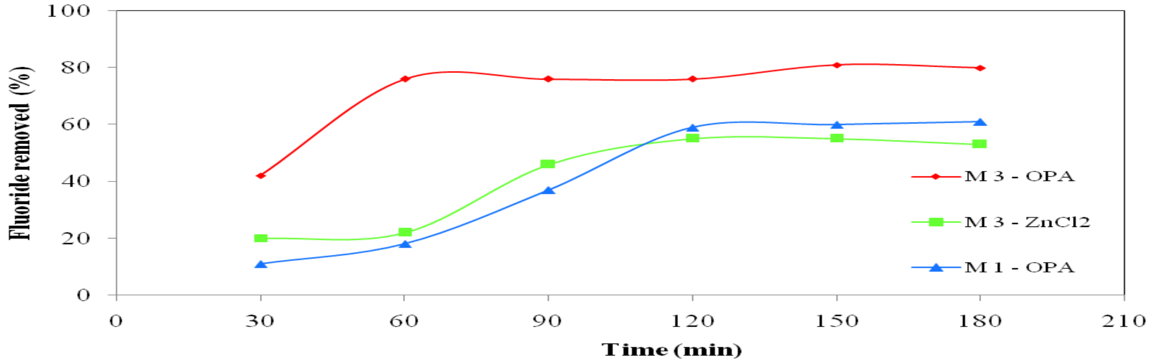


IX. OPTIMIZATION OF FLUORIDE REMOVAL

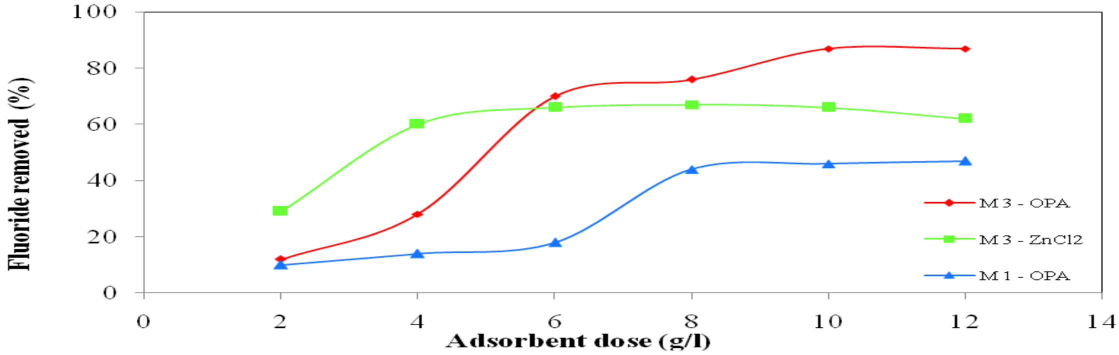
1. Effect Of $_{P}$h On % Removal Of Fluoride



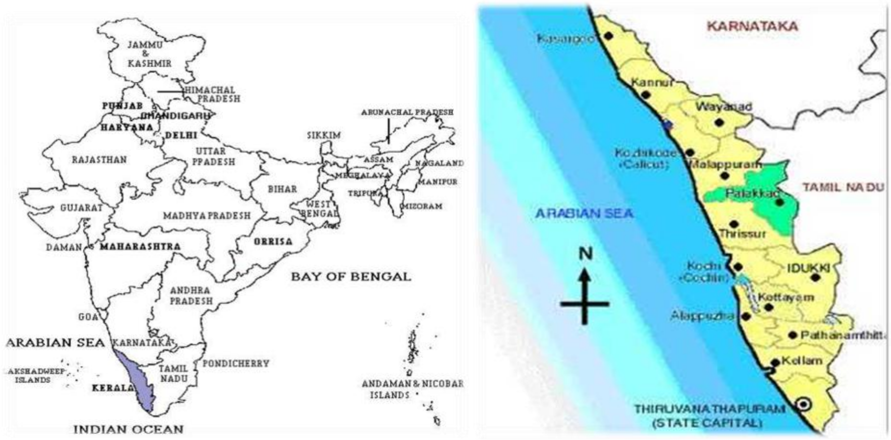
2. Effect Of Time On % Removal Of Fluoride



3. Effect Of Adsorbent Dose On % Removal Of Fluoride



Location of Palakkad district were bore well samples are collected



ANALYSIS RESULT

Analysis result of Bore Well samples from Palakkad District										
Sample No's	Location	pH	EC(μ S/cm)	TH as CaCO3	Ca	Mg	SO_4	Cl	F	NO_3
1	Anakkathy	8.72	1465	54	36	4.4	150	64	0.94	0.36
2	Kulukkur	8.34	660	400	48	85.5	69	120	2.56	0.24
3	Chullimada	8.56	250	176	24	37	21	21	0.35	3.7
4	kadumthuruthi	8.18	130	470	68	98	8	28	0.26	1.63
5	Eruthenpathy	8.94	1900	430	24	99	127	42	1.75	0.47
6	Kadapuram	7.88	285	110	12	24	10	11	0.68	14
7	Athikodu Puzhappalam	8.24	3600	860	82	189	69	182	1.72	8.2
8	Kanjirapuzha	7.72	140	48	8	10	61	78	0.55	5
9	Kannadi	8.32	1480	410	16	96	17	121	0.94	1.4
10	Chinnamoolathara	8.37	1800	340	86	62	149	224	2.95	12
11	Kaipamangalam	7.96	820	530	34	120	3	10	0.8	10
12	Villoonni	8.01	1170	360	76	69	11	68	1.98	4.6
13	Kopanur	8.6	1966	452	104	85	42	146	4.82	2.5
14	Kollamkodu	7.7	450	145	60	21	30	32	0.85	18
15	Meenkara	8.3	1255	260	26	57	12	199	1.53	0.2

VIII. CONCLUSION

- ✓ Activated Muringa Pod Impregnated With OPA Shows Activated Carbon With high Adsorptive Capacity .
- ✓ Adsorption Capacity Decreased In The Order,

  M 3 > M 1 > M 2
- ✓ Development of AC was influenced by various factors such as type of chemical reagent used for impregnation, impregnation ratio, carbonization temperature and holding time etc.
- ✓ 7 out of 15 water samples collected from bore wells in Palakkad district exceed the safe permissible limit for fluoride.
- ✓ Experimental results indicated that the prepared activated carbon is suitable for the removal of turbidity, color, total suspended solids and fluoride from ground water.

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