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Der Chemica Sinica, 2016, 7(3):57-61

Pelagia Research Library
ISSN: 0976-8505
CODEN (USA) CSHIA5

Synthesis, Characterization and Biological Activity Studies of Novel Polymer derived from 2-Hydroxy Acetophenone, Melamine and Trioxane

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ABSTRACT

The present work is devoted for synthesis of new novel polymer derived from 2-Hydroxy acetophenone, Melamine as starting materials along with Trioxane as a bridge forming agent; followed by its characterization employing various physicochemical and spectral techniques like FTIR, UV-Visible and H^1 NMR spectroscopy. On the basis of physicochemical and spectral evidences the most probable structure has been elucidated for the new polymer. The number average molecular weight of this polymer has been determined with the help of conductometric titration method in non aqueous media. The applicability of this novel polymer under investigation towards its biological (antibacterial & antifungal) activities has been studied. The polymer has been found to possess good antimicrobial activities for microorganisms like Escherichia coli and Candida albicans.

Keywords: Novel Polymers, FTIR, NMR, biological activity, E. coli, C. albicans

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INTRODUCTION

In recent years there has been a growing interest in designing and synthesis of novel polymers and organic copolymers due to their special properties and potential applications in sorption, waste water treatments, organic synthesis, hydrometallurgy, catalysis, antimicrobial, antifungal, luminescence and recovery of trace metal elements [1-4].

The synthesis of polymeric resins from hydroxyl aromatic compounds like acetophenone and other hydroxyl compounds has also attracted the attention. Significant research is being done in recent years on organic terpolymers/copolymers because of their antifungal, antibacterial and other biomedical applications. Some of the polymers become conducting upon doping with oxidizing and reducing agents. In biological application, conducting copolymers are used as biosensors. Conducting copolymer based biosensors may be used to obtain clinical information for control of diseases.

Area of polymer resin has wide inter-relevance between various fields of science, engineering discipline and wide industrial applications. Therefore researchers in various disciplines are attracting towards these fields. The interdisciplinary approach in the polymer resins research has given rise due to major applications in waste water treatment, hydrometallurgy, catalysis, recovery of trace metals, biological activity and electrical conductance. Hence it develops special interest mostly to waste water treatment and antibacterial/antifungal properties.

It is of 100 years since DeGeiso and Donaruma and his research group first suggested the use of copolymer and phenolic resins for ion-exchange purposes[5-8]. Recently several copolymers have been reported [9-15] that possess properties useful for ion-exchange and biological activity purposes.

The present research article reports synthesis of a new novel polymer using 2-Hydroxy acetophenone and Melamine as starting materials along with Trioxane as a bridge forming agent; followed by its characterization employing

various physicochemical and spectral techniques like FTIR and H^1 NMR. On the basis of physicochemical and spectral evidences the most probable structure has been elucidated for the new polymer. Finally biological (antibacterial & antifungal) activities of the polymer under investigation have been carried out.

MATERIALS AND METHODS

All chemicals used during this investigation were of AR or chemically pure grade. The new polymer has been prepared by condensation of 2-Hydroxyl Acetophenone with Melamine along with trioxane , after adjusting the proper/appropriate molar ratios of the starting materials in the presence of 2M HCl as a catalyst. This polymer has been synthesized by cationic polymerization/polycondesnation method. The number average molecular weight of the new polymer has been determined by conductometric titration method in nonaqueous medium. Antibacterial & antifungal activities were studied using known methods.

RESULTS AND DISCUSSION

The newly synthesized polymer has been abbreviated as:
2-HAMT (2-Hdroxy Acetophenone Melamine Trioxane) polymer

Elemental analysis & Molecular weight determination

The results of elemental analysis & molecular weight determination have shown in Table 1 for 2-HAMT polymer. The results are in good agreement with the proposed structure for the new polymer.

Table1. Elemental Analysis & molecular weight data of 2-HAMT polymer

Polymer	% of Carbon found (calculated)	% of Hydrogen found (calculated)	% of Nitrogen found (calculated)	% of Oxygen found	Empirical formula of repeat unit	Molecular weight of repeating unit
2-HAMT	54.02 (54.54)	4.34 (4.93)	29.23 (29.35)	11.18	$C_{13}H_{14}N_6O_2$	286.12

FTIR Spectra

Fig. 1 represents the FTIR spectrum of 2-HAMT polymer. The various absorption bands observed in the spectrum prove the presence of various functional groups/linkages as per proposed structure indicating successful synthesis of the new polymer.

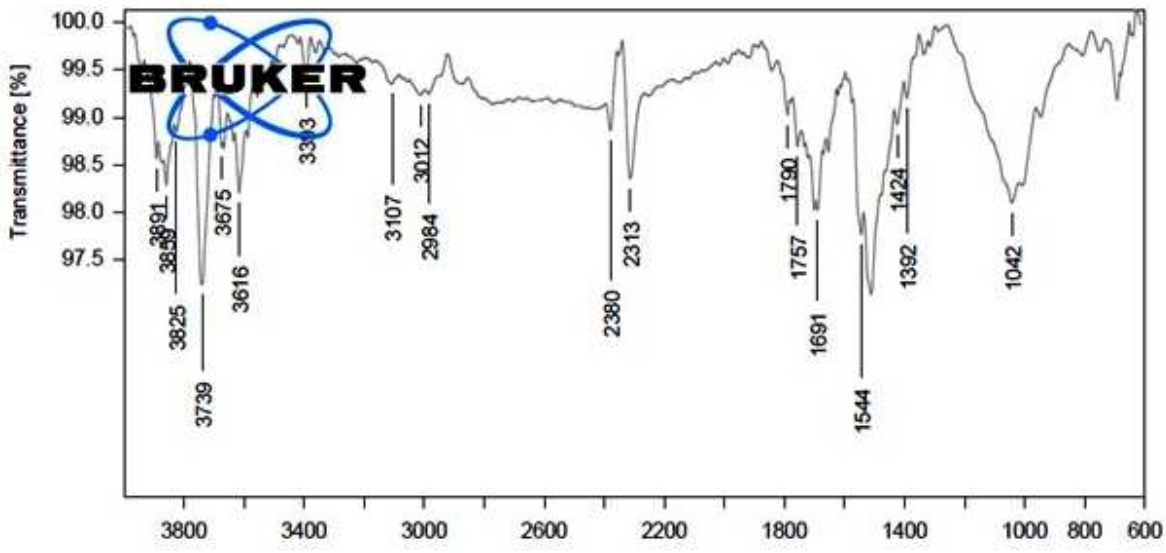

Figure 1 FTIR spectrum of 2-HAMT Polymer

FTIR analysis confirmed the incorporation of all monomers in the resultant polymer. The FTIR spectrum of the 2-HAMT polymer provides qualitative information about the composition of the polymer. A band at 1490-1520 cm^{-1} is due to aromatic ring stretching. Appearance of band at 3391-3564 cm^{-1} is due to aromatic C-H stretching and 1148-1038 cm^{-1} is due to aromatic C-H bending (in the plane). Appearance of band at 900-670 cm^{-1} may be because

of asymmetric aromatic C-H bending (out of plane). All other peaks in the polymer are shifted in comparison with the corresponding peaks of the homopolymers of the monomers as per the standard reference. This shows that the polymer formed is a true polymer and not a mixture of homopolymers.

UV-Visible Spectra

UV-Visible spectrum of newly synthesized, purified and properly dried polymer has been recorded in DMF (Dimethyl formamide). The spectrum is incorporated in Fig 2.

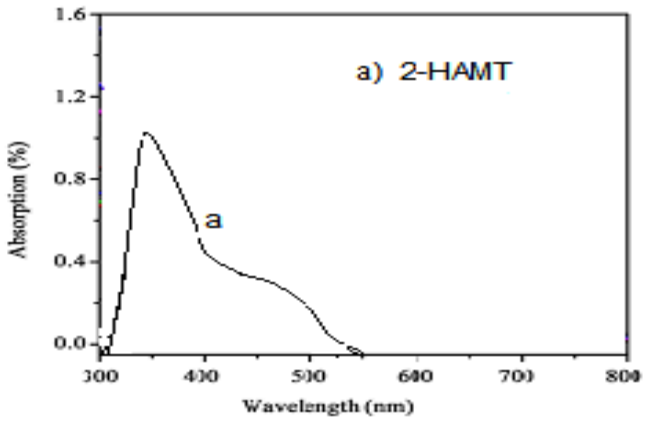

Fig. 2 Electronic spectrum of 2-HAMT

The new 2-HAMT polymer gives characteristic bands at 340nm and 390nm. These observed positions for the absorption bands exhibit the presence of carbonyl (>C=O) group having Carbon-Oxygen double bond which is in conjugation with the aromatic nucleus.

NMR Spectrum

H^1-NMR spectrum of 2-HAMT polymer has been presented in Fig 3. Number of sets of equivalent protons and position of the signals are matching with the most probable (proposed) structure, which is again an indicative of successful synthesis of the new polymer.

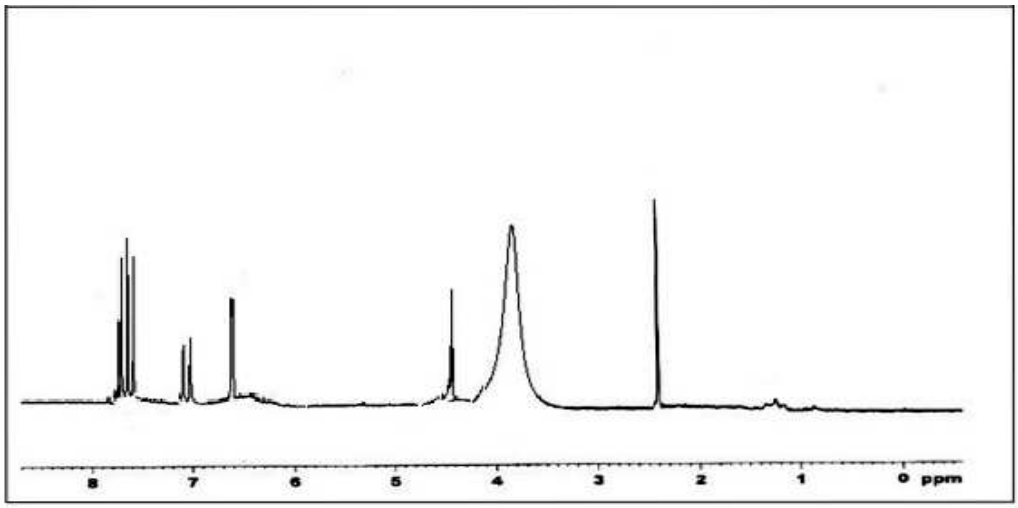

Figure 3 ^1H NMR spectrum of 2-HAMT Polymer

On the basis of all above physicochemical and spectral evidences the most possible tentative structures of 2-HAMT Polymer has been constructed and which has been shown in Fig. 4.

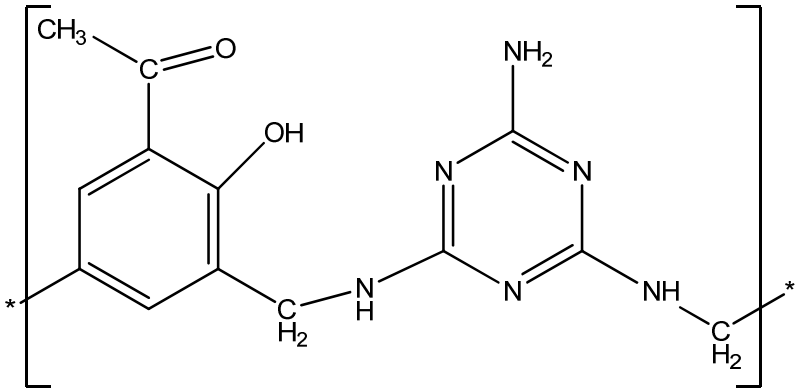

Fig. 4 Structure of 2-HAMT Polymer

Antimicrobial and Antifungal (Biological) Activity Studies

In the present investigation, the antimicrobial activity of 2-HAMT novel polymer using petriplate method has been evaluated. In this analysis, the novel polymer displayed antimicrobial activity against a few pathogenic microorganisms. The results have been presented in Table 2. From the results it can be concluded that, the novel polymer under present investigation has shown a good antimicrobial activity against *Escherichia coli* and *Candida albicans*. The petriplates were marked as A and B where A contains culture supernatant and (B) Polymer control respectively (Fig.5).

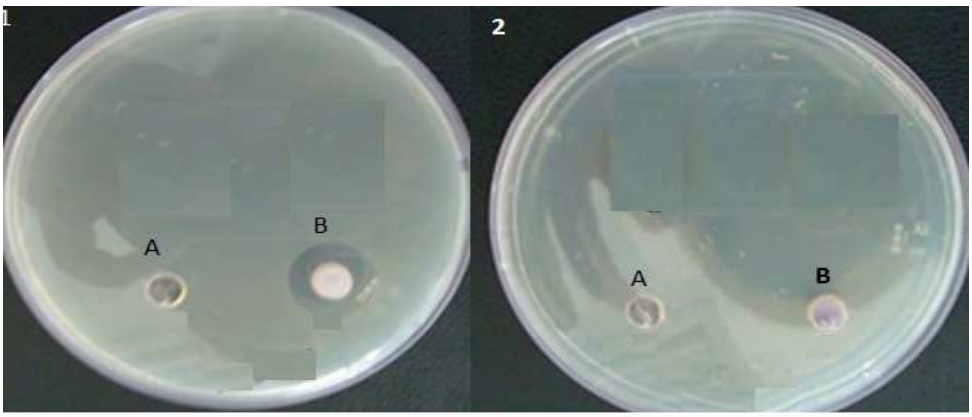

Fig. 5 Antimicrobial activity of 2-HAMT Polymers(Plate1 for Escherichia coli & plate 2 for Candida albicans). Each plate shows (A) culture supernatant and (B) Polymer control respectively

Table 2. Diameter zone of inhibition by 2-HAMT polymer against a few microorganisms

Polymer	Microorganism	Zone of inhibition (mm in diameter)
2-HAMT	*Escherichia coli*	16.98
	Candida albicans	11.26

CONCLUSION

- New novel polymer has been successfully synthesized using starting the materials 2-hydroxy acetophenone, melamine and trioxane(bridge forming agent).
- The newly synthesized polymer has been abbreviated as 2-HAMT.
- This new novels polymer has been characterized using various physicochemical and spectral methods.
- On the basis of physicochemical and spectral evidences the most possible chemical structure for the new polymer has been proposed and reported (Fig.4).
- The antimicrobial activities of the new novel polymer under investigation have been evaluated for microorganisms like *Escherichia coli* and *Candida albicans*. The polymer has been found to possess good antimicrobial activities for above mentioned microbes.

Acknowledgements
Author is highly thankful to Dr. S. M. Bhuskute, Principal, Bhawabhuti Mahavidyalaya Amgaon and Dr. D. K. Burghate, Principal, Shri Shivaji Science College Nagpur for providing laboratory and library facilities. He is also grateful to UGC (WRO) for sanctioning MRP and providing financial assistance.

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