

Microwave assisted synthesis and IR spectral analysis of a L-Arabinose compound with ditertiary butyl chromate

Kriti Kumari¹ and Hari Om Pandey²

¹Research scholar, Dept. of Chemistry, Ranchi University, Morabadi Ranchi, Jharkhand India

²Associate prof. Deptt. of Chemistry, Ranchi University, Morabadi Ranchi, Jharkhand India

E-mail kkriti51@gmail.com hopandey01@gmail.com

Manuscript received online 27 February 2024, accepted on 15 March 2024

Abstract: This research presents a detailed investigation into the study and characterization of compounds resulting from the reaction between L-Arabinose and TBC (Tertiary Butyl Chromate) under the influence of microwave irradiation as the primary source of energy. The application of microwave energy in chemical synthesis is known for its efficiency in promoting rapid reactions and enhancing yields. The choice of distilled water as the solvent underlines the interest in environmentally friendly and readily available solvents. In this study, the microwave-assisted synthesis of compounds from the L-Arabinose and TBC reaction was carefully conducted, aiming to exploit the benefits of this energy source in terms of reaction acceleration and selectivity. The compounds were analysed using a combination of chemical and instrumental techniques, like Elemental analysis, Fourier Transform Infrared Spectroscopy (FTIR), and Differential Thermal Analysis/Thermogravimetric Analysis (DTA/TGA) to assess mass loss patterns. This investigation contributes valuable insights into the chemical reactivity of L-Arabinose with TBC in aqueous conditions, offering potential applications in organic synthesis and demonstrating the significance of using distilled water as a sustainable solvent.

Keywords : Microwave, L-Arabinose, Ditertiary butyl chromate (TBC), Distilled water (DW), Tertiary butyl alcohol (TBA) and FTIR spectroscopy, TGA-DTA.

Introduction

The utilization of microwave irradiation in organic reactions not only accelerates reaction rates significantly but also yields higher product quantities when contrasted with traditional heating methods. This phenomenon emphasized

the advantages of microwave-assisted synthesis, offering a more rapid and efficient pathway to desired organic compounds. Under conventional heating methods, the employment of a microwave oven in chemical reactions drastically reduces reaction times from several hours to mere minutes or even seconds, all while maintaining comparable reaction temperatures. In many cases, microwave assisted organic techniques have proved to be more efficient than classical heating methods¹⁻⁴. The success of microwave-assisted organic techniques be superior to that of classical heating methods in numerous instances. Tertiary butyl chromate stands out as a potent and versatile oxidizing agent, demonstrating its effectiveness in various oxidation reactions. The combination of microwave irradiation and this powerful oxidant proves to be a highly efficient and versatile approach in organic synthesis. The application of tertiary butyl chromate (TBC) as an oxidant in organic synthesis has assembled substantial support through extensive research conducted since its initial use by R.V. Oppenauer and H. Oeberrauch⁵⁻⁹

L-arabinose¹⁰ is an aldopentose sugar with the molecular formula $C_5H_{10}O_5$. It is a pentose sugar, meaning it contains five carbon atoms. The chemical structure of L-arabinose consists of a linear chain with a carbonyl group (aldehyde) and hydroxyl groups attached to each carbon atom. It is a non-caloric sweetener and has gained attention for its potential applications¹¹ in the food and pharmaceutical industries. L-arabinose is found in various plant

sources¹², such as fruits, vegetables, and hemicellulose-rich plant materials.

Material and Methods

1. Chemical used: The chemicals used in synthesis of complex from Acros, Rankem and Merck. Exclusively freshly prepared solutions were employed throughout this study. The chemicals utilized included L-Arabinose, DW (Distilled water), TBA (Tertiary butyl alcohol), acetone, Chromium (VI) oxide, silver nitrate, potassium persulphate, ammonium iron (II) sulphate (Mohr's salt), potassium dichromate, barium diphenylamine-4-sulphonate.

2. Synthesis: - L-Arabinose was initially dissolved in distilled water and then subjected to treatment with chromium trioxide in tertiary butyl alcohol (TBA) at varying molar ratios. Several reactions occurred, resulting in distinct outcomes. In the case of ADW21 (2:1) molar ratio, a bluish-colored compound was obtained, while the ADW31 (3:1) molar ratio led to the formation of a light blue compound. The resulting

products were subsequently washed with water and acetone, finalizing the purification process.

3. Experimental analysis: - At BIT Mesra, the elemental composition of carbon (C), hydrogen (H), and oxygen (O) was analyzed, while the chromium (Cr) percentage was determined through titration.

Results and Discussion

1. Elemental analysis

(a) **Compound A.2(ADW21):** - The bluish colour solid product A.2 contains chromium 27.63%, carbon 15.90%, hydrogen 2.09% and oxygen 54.38%. The expected formula for this set is $\text{Cr}_2\text{C}_5\text{H}_8\text{O}_{13}$.

(b) **Compound A.3(ADW31):** - The light blue colour solid product A.3 contains chromium 26.29%, carbon 20.90%, hydrogen 3.69% and oxygen 49.12%. The expected formula for this set is $\text{Cr}_2\text{C}_7\text{H}_{14}\text{O}_{13}$.

2. FTIR analysis

The assignments of various IR band and spectrum of sample (ADW21) and (ADW31) are shown as given below: -

A.2 (ADW21)

Peak	Nature of peaks	Group assignment
3327.82	Broad	O-H stretching of -COOH
2884.40	Weak	C-H stretching of alkyl
1558.64	Sharp	C=O stretching for carbonyl
1367.24	Sharp	O-H bending
1063.00	Small	O-H bending
999.16	Small	C-C stretching
775.07	Medium	Cr=O stretching of chromium oxide
494.16	Medium	Cr-O stretching of chromium oxide

A.3 (ADW31)

Peak	Nature of peaks	Group assignment
3326.82	Broad	O-H stretching of -COOH
2881.20	Weak	C-H stretching of alkyl
1561.30	Sharp	C=O stretching for carbonyl
1368.56	Sharp	O-H bending
1062.48	Weak	O-H bending
995.13	Weak	C-C stretching
781.54	Medium	Cr=O stretching of chromium oxide
499.9	Medium	Cr-O stretching of chromium oxide

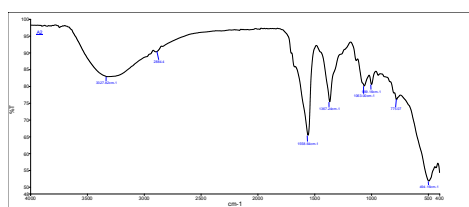


Fig 1 (ADW21)

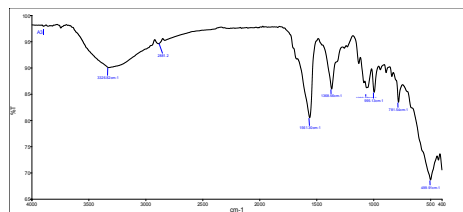


Fig 2 (ADW31)

3. Thermal analysis

The thermogravimetric change and thermal change showing loss formula weight and percentage loss for ADW21 as table (1) & for ADW31 as table (2).

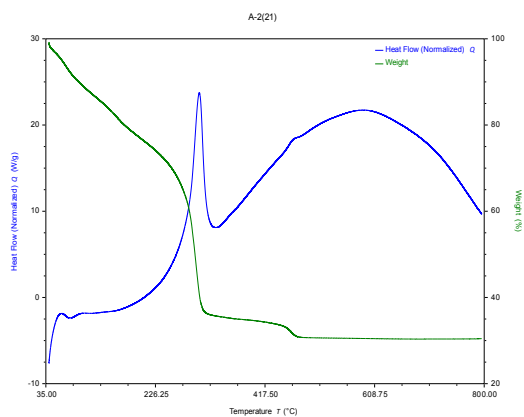


Fig. 3 (ADW21)

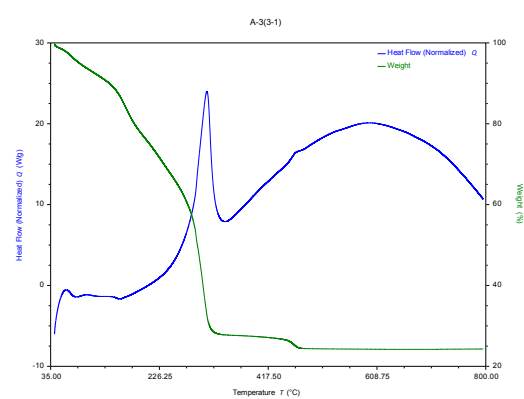


Fig. 4 (ADW31)

Table 1
(Thermogravimetric loss pattern of ADW21)

Temperature	Formulation Sequence showing changes	Percentage Loss	
		Experimental	Theoretical
35°-250°C	$2\text{CrO}(\text{C}_3\text{H}_3\text{O}_4)(\text{C}_3\text{H}_2\text{O}_5)(\text{H}_2\text{O})_2$ ↓ Loss of $\text{C}_3\text{H}_2\text{O}_5$	29.00	31.05
250°-400°C	$2\text{CrO}(\text{C}_3\text{H}_3\text{O}_4)(\text{H}_2\text{O})_2$ ↓ Loss of $\text{C}_2\text{H}_2\text{O}_4, \text{H}_2\text{O}$	30.02	28.41
400°-470°C	$2\text{CrO}(\text{H}_2\text{O})$ ↓ Loss of H_2O	3.90	4.73
	2CrO Chromium and its oxides	37.08	35.81

Table 2 (Thermogravimetric loss pattern of ADW31)

Temperature	Formulation Sequence showing changes	Percentage Loss	
		Experimental	Theoretical
35°-240°C	$2\text{CrO}(\text{C}_3\text{H}_2\text{O}_2)_2(\text{C}_3\text{H}_5\text{O}_4)(\text{H}_2\text{O})_2$ ↓ Loss of $\text{C}_3\text{H}_5\text{O}_4$, H_2O	31.12	29.75
240°-400°C	$2\text{CrO}(\text{C}_3\text{H}_2\text{O}_2)_2(\text{H}_2\text{O})_2$ ↓ Loss of $(\text{C}_3\text{H}_2\text{O}_2)_2$, H_2O	34.22	32.67
400°-450°C	$2\text{CrO}(\text{H}_2\text{O})$ ↓ Loss of H_2O	3.80	4.39
	2CrO Chromium and its oxides	30.86	33.19

Acknowledgments: The authors express their gratitude to the Department of Chemistry, Ranchi University, Ranchi, as well as CIF BIT, Mesra, for conducting DTA-TGA analysis and providing FTIR spectra. Additionally, special thanks are extended to SAIF, CDRI, Lucknow, for their valuable contribution by supplying essential data for elemental analysis and FTIR spectra.

Conclusion : In conclusion, this study employed microwave-assisted synthesis to efficiently produce compounds from the reaction of L-Arabinose and TBC. The carefully analysis, utilizing elemental analysis, FTIR, and DTA/

TGA, revealed accelerated reactions and enhanced selectivity under microwave conditions. Moreover, the use of distilled water as a sustainable solvent highlights the environmentally conscious aspects of the methodology, emphasizing its relevance in green chemistry practices. Very large amount of energy is absorbed as evident from endothermic peak of DTA curve. It is also important to note that the different between ignition point and explosion point is remarkable very low. So, it can be used as potential energetic and explosive for number of purposes.

References

1. RA Abramovitch *Organic Preparations and Procedures International*, Vol. **23**, No.6 683 (1991)
2. J. Azizian, M.K. Mohammadi, OR Firuzi, Mirza B, R. Miri, *Chemical Biology & Drug Design*, Vol. **75**, No. 4, pp. 375 (2010)
3. S. Caddick, *Tetrahedron*, Vol. **51**, No. 38, 10403 (1995)
4. CR Strauss, RW Trainor, *Australian Journal of Chemistry*, Vol. **48**, No. pp. 1665 (1995)
5. RV Oppenauer, H. Oberrauch, (Univ. Innsbruck, Austria), *Anaus Assoc. Guin-Argentina* **37**, pp 246 (1949)
6. T. Suga, Kelichkihara, T. Matsuura, (University of Hiroshima), *Bull. Chem. Soc. Japan*, **38**, 6, pp. 893 (1965)
7. G Dupont, R. Dulor, O. Mondou, *Bull. Chem Soc. France*, pp. 60 (1953)
8. E. Menini, JK Noryonberski, (Jessop Hosp. Women, Sheffield, Eng. I) *Bio. Chem. J.*, **195** (1962)
9. a. Sangita Katre, Pandey HO, *International J. of Green Chemistry & Bioprocesses*, 2013, Vol. **3(3)**, pp 30 (2013)
- b. Sagita Katre, Pandey HO, *Scholars Research Library – Archives of Applied Science Research*, Vol. 5 (3), pp 134 (2013)
10. <http://en.wikipedia.org/wiki/Arabinose>
11. K. Okuma, *Metabolism*, **55(5)**, 549 (2006).
12. J.S. Kim, Sa, H. K., J.H. Jeon, J.H. Oh, & Y. Kim, *Food and Chemical Toxicology*, **44(10)**, 1704 (2006)

An International Peer Reviewed Research Journal of Chemistry

Abstracted / Indexed in : Chemical Abstract U.S.A.

JC- 1569/2K24 (ISSN:0973-239X), INDIA

Journal Chemtracks Vol. 26 (1&2), 37-40, January to December 2024