Antimicrobial evaluation of Schiff base synthesised from cinnamaldehyde and aniline using gooseberry extract

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ABSTRACT

Natural acid catalysed organic reactions have gained popularity in recent years, since the majority of solvents are either toxic or flammable and add considerably to the cost of an overall synthesis. The objective of this study focuses on the green synthesis of Schiff base from cinnamaldehyde and aniline using gooseberry extract. The Schiff base synthesised from gooseberry extract is characterized by UV-Visible and FT-IR spectral techniques. The synthesised Schiff base shows an absorption maximum at 287 nm. The IR band at 1663 cm^{-1} is due to the presence of azomethine group, this confirms the formation of Schiff base. The antimicrobial activity of this Schiff base is tested against bacteria and fungi and it shows activity on Escherichia coli, Staphylococcus aureus, Klebsiella pneumonia and Candida albicans. Compared with traditional methods, this method is eco-friendly and shows maximum efficiency with reduced reaction time.

Keywords: Green synthesis; Gooseberry extract; Schiff base; Characterization; Antimicrobial activity

1. Introduction

Green chemistry approach is an eco-friendly approach and has tremendous application for the synthesis of various organic compounds and key intermediates in recent past. This technique involves as an alternative reaction media to replace hazardous and expensive solvents routinely used in organic synthesis [1]. Organic reactions under solvent-free conditions have gained in popularity in recent years, since the majority of solvents are either toxic or flammable and add considerably to the cost of an overall synthesis. These solvent-free reactions usually need shorter reaction time, simple and more efficient work up procedures, more improved selectivities and easier separations and purifications than conventional solvents [2]. Recently fruit juice is known to be a potential organic solvent for the synthesis of compounds of pharmaceutical interest [3]. Fruit juice is being used on regular basis in various organic transformation reactions [4,5]. The widespread applications of different fruit juices are due to their non-toxic, safe, inexpensive and environmentally benign nature [6].

Schiff bases are condensation products of primary amines with carbonyl compounds and they were first reported by Hugo Schiff in 1864. The common structural feature of these compounds is the azomethine group with a general formula RN=CH-R_1, where R and R_1 are alkyl, aryl, cycloalkyl or heterocyclic groups which may be variously substituted. Schiff bases that contain aryl substituents are substantially more stable than alkyl substituents. Schiff bases of aliphatic aldehydes are relatively unstable and readily polymerizable, while those of

aromatic aldehydes have effective conjugation and stability [7]. Schiff bases are important intermediates for the synthesis of various bioactive products and they are used as fundamental materials for the synthesis of various Schiff base ligands which are used as chiral auxiliaries in asymmetric synthesis [8]. Schiff bases have been reported to show a variety of biological actions by virtue of the azomethine linkage, which is responsible for various antibacterial, antifungal, herbicidal and clinical activities [9-11]. Schiff bases have been associated with various significant catalytic and photochromic properties [12]. They form an interesting class of ligands that has enjoyed popular use in the coordination chemistry of transition, inner transition and main group elements.

In recent years, environmentally benign green synthetic methods have received considerable attention for the synthesis of Schiff base. Many researchers have reported various eco-friendly methods for the synthesis of Schiff bases and the reported methodologies have some disadvantages such as prolonged reaction time, the high reaction temperatures, an excess of costly dehydrating reagents/catalysts, moisture sensitive catalysts, and special apparatus [13,14]. Based on the literature survey, the present work focuses on the green synthesis of Schiff base from cinnamaldehyde and aniline using gooseberry extract. The Schiff base synthesised from gooseberry extract is characterized by UV-Visible and FT-IR spectral techniques. The antimicrobial activity of synthesised Schiff base is tested against bacteria and fungi.

2. Experimental Section

Fresh and ripened gooseberry fruit were obtained from the local market. Cinnamaldehyde and aniline used for the synthesis of Schiff base were procured from Merck. Double-distilled deionized water was used for the preparation of the gooseberry extract.

2.1. Preparation of gooseberry extract

Ripened gooseberry was used for the preparation of the extract. 25 g of this ripened fruit was thoroughly washed with distilled water, dried and cut into small pieces. Grind the pieces by a pestle and mortar and the resulting extract was filtered using Whatmann filter paper. The filtrate was collected and then centrifuged for about 8,000 rpm for about 10 minutes. The supernatant extract was collected and used for the synthesis of Schiff base.

2.2 Synthesis of Schiff base from gooseberry extract

Equimolar amount of cinnamaldehyde (0.1 mol) and aniline (0.1 mol) was taken in a beaker. Add 1 ml of gooseberry extract to the mixture and then kept for 5 to 10 minutes. Then the mixture was stirred for 10 minutes at room temperature, pale yellow solid crude product

was formed. After completion of the reaction, the product was washed with distilled water and purified by recrystallization with minimum amount of ethanol.

2.3 Characterization Techniques

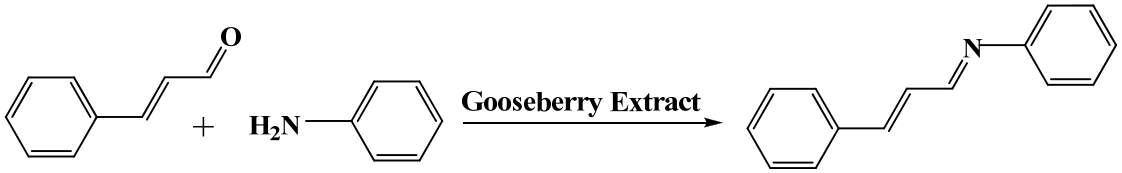
The absorption spectrum of Schiff base in ethanol was carried out using Shimadzu UV-1800 spectrophotometer. FTIR analysis of the Schiff base in ethanol was carried out through the potassium bromide (KBr) pellet (FTIR grade) method in 1:100 ratio and spectrum was recorded using Shimadzu IR Affinity-1 FT-IR spectrophotometer with the range of 4000-400 cm^{-1} at the resolution of 4 cm^{-1}.

2.4 Antimicrobial Activity

Antimicrobial activities of synthesized Schiff base against bacteria and fungi cultures of *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas fluorescens*, *Klebsiella pneumonia*, *Candida albicans* and *Aspergillus niger* were assayed by Kirby-Bauer discs diffusion method. These antimicrobes were grown in LB broth for 24 h. Approximately 20 ml of molten and cooled Muller Hinton agar was poured into the Petri dishes. The tested organisms were swapped over the agar medium and the Schiff base containing disks were kept over the medium using sterile forceps. Antimicrobial activity was evaluated by measuring the zone of inhibition for the test organisms. The diameters of zones were measured to the nearest millimetre with vernier calipers.

3. Results and Discussion

The role of gooseberry extract in the synthesis of biologically active Schiff base from cinnamaldehyde and aniline (**Scheme 1**) is reported in this section. The synthesised Schiff base is characterized by UV-Visible and FT-IR spectral analysis. Gooseberry extract contains ascorbic acid, cirtic acid, gallic acid, and ellagic acid. The acid present in the gooseberry extract gives H^+ ions for protonation. The carbonyl oxygen of the aldehyde abstracts the proton and gives the protonated form of the aldehyde. The nucleophilic attack of the amine on the carbonyl carbon followed by dehydration gives the Schiff's base. This synthetic method is non-polluting, does not employ any toxic materials and quantifying it as a green approach for the synthesis of Schiff bases.



Scheme 1 Synthesis of Schiff base from cinnamaldehyde and aniline

3.1 Absorption Spectral Analysis

The formation of Schiff base using gooseberry extract is preliminary confirmed by UV-Visible spectrophotometric analysis. The absorption spectrum of Schiff base is carried out in ethanol. The Schiff base shows an absorption maximum at 287 nm (**Fig.1**). The higher energy band appearing at 287 nm is attributed to π-π* transition of the azomethine group.

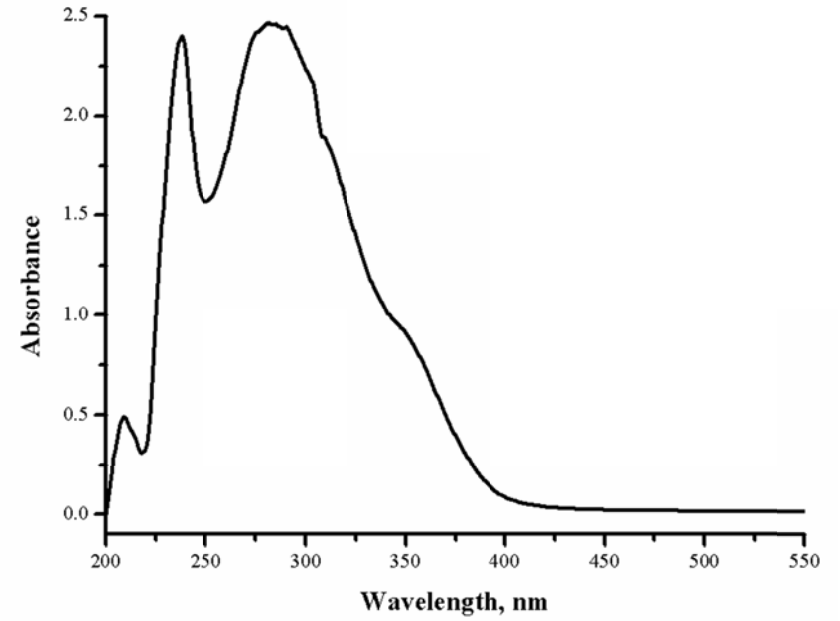


Fig. 1 UV spectrum of Schiff base synthesised from cinnamaldehyde and aniline

3.2 FT-IR Spectral Analysis

Schiff base synthesised from cinnamaldehyde and aniline with gooseberry extract shows IR bands at 3458, 3141, 2913, 2832, 2750, 1663, 1581, 1454, 1018, 937, 792 and 674 cm^{-1} respectively (**Fig. 2**). The FT-IR spectrum of the synthesised Schiff base shows a band around 3458 cm^{-1} is due to the O–H stretching of the solvent ethanol, since the FTIR spectrum of Schiff base is taken in ethanolic solution. Weak band at 3141 cm^{-1} is due to the stretching vibration of aromatic C-H group. The presence of weak band at 2913, 2832 and 2750 cm^{-1} corresponds to the C-H stretching of alkene and the aromatic system. The IR band at 1663 cm^{-1} is due to the presence of azomethine group, this confirms the formation of Schiff base. IR spectrum exhibits weak bands at 1581 and 1454 cm^{-1} are due to the stretching vibration of aromatic C=C bond. The band at 1018 cm^{-1} is due to ring stretching. Aromatic C-H bending vibrations occur at 937, 792 and 674 cm^{-1} respectively.

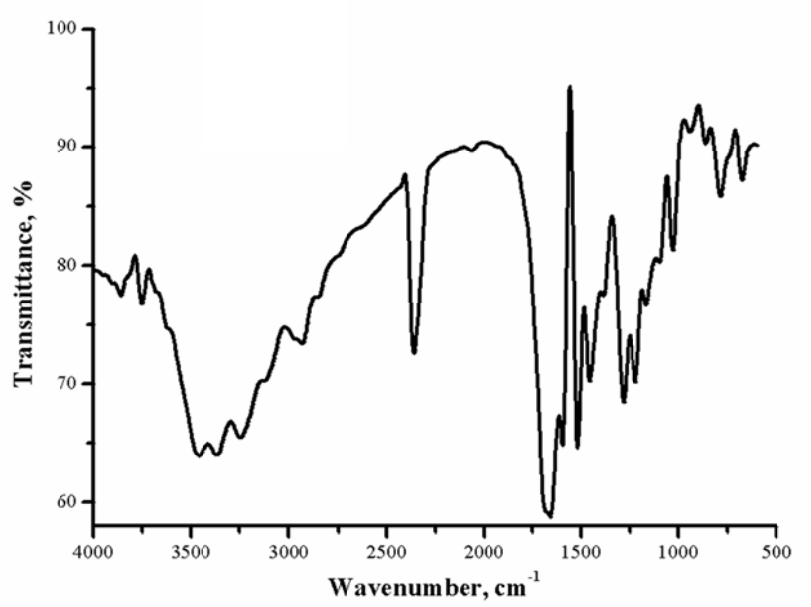


Fig. 2 FT-IR spectrum of Schiff base from cinnamaldehyde and aniline

3.3 Antimicrobial activity of synthesised Schiff base

The antimicrobial activity of synthesised Schiff's base is tested on *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas fluorescens*, *Klebsiella pneumonia*, *Candida albicans* and *Aspergillus niger* **(Fig. 3)**. Standard antibiotic disc Amikacin is used as the reference drug for the evaluation of antibacterial activity. The Schiff base synthesised from cinnamaldehyde and aniline shows higher activity on *Escherichia coli* **(Table 1)**. The drug Flucanazole is used as the control for the evaluation of antifungal activity. The Schiff base synthesised from cinnamaldehyde and aniline shows activity on *Candida albicans*. The synthesised compound from gooseberry extract interacts directly with the outer membrane of the microorganism, causing the membrane to rupture and kills the microbes. Thus the Schiff base synthesised from cinnamaldehyde and aniline using gooseberry extract may have a potential use in the biomedical applications due to its antimicrobial activity.

Table 1 Antimicrobial activity of Schiff base from cinnamaldehyde and aniline

Microbes	Zone of Inhibition (mm)
Escherichia coli	30
Staphylococcus aureus	17
Pseudomonas fluorescens	-
Klebsiella pneumonia	10
Candida albicans	11
Aspergillus niger	-

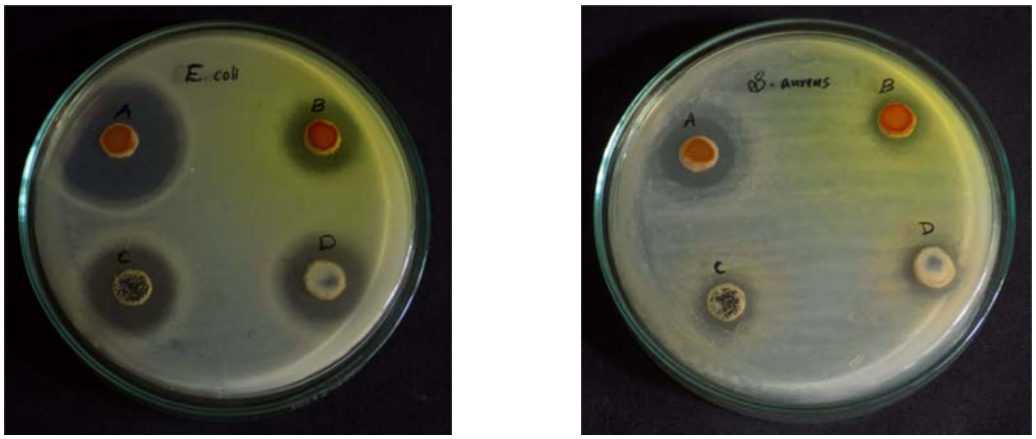


Fig. 3 Antimicrobial activity of Schiff base from cinnamaldehyde and aniline

Conclusion

An eco-friendly route for the synthesis of Schiff base from cinnamaldehyde and aniline using gooseberry extract has been investigated. The role of natural acid catalyst in the synthesis of biologically active Schiff base has been well demonstrated. The synthesised Schiff base shows an absorption maximum at 287 nm. The IR band at 1663 cm^{-1} is due to the presence of azomethine group, this confirms the formation of Schiff base. The antimicrobial activity results prove that the synthesized Schiff base can be used for the treatment of diseases caused by microbes. The biological activity of this compound will trigger more interest in the synthesis of such compounds from the easily available starting materials.

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