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SPECTRAL AND BIOLOGICAL ACTIVITIES OF GREEN SCHIFF BASES USING NATURAL ACID CATALYSTS

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ABSTRACT

The objective of present research work focused on green methodologies for the synthesis of Schiff bases. The utilization of green chemistry techniques are considerably reduces the chemical wastes and reaction time. To illustrate these advantages, the present synthesis was introduced. This involves in the synthesis of Schiff base using natural acid catalyst. Here in we reported the synthesis of Schiff base from amino acid with carbonyl compound via natural acid prepared from *citrus sinensis* and *solanum lyopersicum*. The synthesized product was identified by its physical properties like melting point, molar conductance and UV-Visible, FTIR and XRD spectral techniques. Biological studies like antibacterial, antifungal, antioxidant and larvicidal was carried out for the synthesized Schiff bases. Compared with conventional methods, these methods were more fitting and provided higher yield, shows maximum efficiency, held without generation of pollution in shorter reaction time, safer to analyst, low cost and simple to run.

KEYWORDS: Green chemistry, Schiff bases, Natural acid catalysts, Biological studies.

INTRODUCTION

Green chemistry is one of the focused areas of chemistry deals designing of products, processes that diminish the use and generation of hazardous substances and it is moreover described as sustainable chemistry**.** Green Chemistry is ready to lend a hand for the chemists in research, expansion and construction also for the growth of more eco-friendly and efficient products which may also have momentous financial benefits and this techniques now become

a necessary tool in artificial chemistry.[1] The current awareness in green chemistry has posed a new challenge for organic synthesis in that new reaction conditions need to be found which reduces the emission of volatile organic solvents and the use of hazardous toxic chemicals.[2] They boost selectivity, reaction time and simplify separation and purification of products than the conventional methods.[2] The present work involves the synthesis of Schiff base using sustainable catalysts and new environmentally benign processes[3] have been investigated which are economically and technologically feasible.[4] An **e**co-friendly and inexpensive natural catalysts like *Solanum Lyopersicum* (tomato) juice and *Citrus sinensis* (sweet orange) juice acted as catalyst for the synthesis of Schiff base.

Condensation reaction between primary amines and carbonyl compounds with different solvent results in Schiff base reported by Hugo Schiff.[5] An important goal in Green chemistry is the replacement of volatile Organic solvents in organic reaction processes is an important green chemistry goal. Azomethine group with general formula RHC=N-R, where R and R1 are alkyl, aryl, cyclo alkyl or heterocyclic groups which may be variously substituted mainly considered as common structural feature of Schiff base also known's as anils, imines or azomethines.[6] Schiff base ligands are of considerably important and take part in industry, technology and life processes pigments and dyes, catalysts, intermediates in organic synthesis and as polymer stabilizers.[6,7,8] Based on above backdrop, our prime aim is to synthesis Schiff base using natural acid catalyst and to characterize by various analytical and spectral studies. In addition to this, biological properties like antibacterial, antioxidant and larvicidal activity also examined.

MATERIALS AND METHODS

Materials

All chemicals and reagents used were of analytical grade and used as such.

Melting point

Melting points of the synthesized compounds were measured using a melting point apparatus obtained from Guna Enterprises, Chennai.

Molar conductance

The molar conductance values of the freshly prepared Schiff base (10^{-3} M) were recorded in DMF solution at room temperature using Digital conductivity meter, Global electronics, Model: DCM 900.

Ultraviolet-Visible spectroscopy

The Ultraviolet-Visible spectra of the compounds were recorded on a SYSTRONICS 2201 spectrometer using DMSO in the wavelength range of 800-200 nm.

FTIR Spectroscopy

The FTIR spectra of the synthesized compounds were recorded using SHIMADZU spectrometer in 4000 – 400 cm^{-1} using KBr pellet.

X-Ray Diffraction analysis

X-ray diffractogram of samples were taken using XRD-SHIMAZUXD-D1, Ni-filter and Cu Ka radiation source.

PREPARATION OF NATURAL ACID CATALYSTS

Preparation of *Solanum Lyopersicum* juice

Fresh *Solanum Lyopersicum* fruits were procured locally and washed with tap water followed by distilled water and were pressed into fruit juicer to get semisolid mass which was then filtered with cotton to get liquid juice to used as catalyst.[9]

Preparation of *Citrus sinensis* juice

Easily available *Citrus sinensis* fruits were collected and peeled off then washed many times using tap water followed by distilled water. The fruit slices were pressed into fruit juicer to get liquid juice act as a catalysts.[9]

Preliminary phytochemical analysis

Phytochemical examinations were carried out for natural acid catalyst *Solanum Lyopersicum* and *Citrus sinensis* as per the standard methods.[10,11]

SYNTHESIS OF THE SCHIFF BASES

Synthesis of Compound -I

L-histidine (3 mmol) was dissolved in minimum amount of double distilled water and taken in a beaker. To this o-hydroxybenzaldehyde (3 mmol) was added. To this equimolar reaction mixture the natural acid catalyst *Solanum Lyopersicum* in variable amounts (0.5 ml, 1 ml, 1.5 ml, 2 ml) were added in drops. The reaction mixture was stirred for about 20 minutes in a magnetic stirrer at room temperature. The solution turned yellow. The resultant product was filtered and dried. The above procedure was repeated for the different concentration of *Citrus sinensis* extract as natural acid catalyst.

Synthesis of Compound -II

The above procedure was repeated for an equimolar mixture of L-Tyrosine (3 mmol) and o-hydroxyacetophenone (3 mmol) for the different concentration of *Solanum Lyopersicum* and *Citrus sinensis* extract. The resultant product was filtered and dried.

Antimicrobial studies (*in vitro*)

All the synthesized **Compound-I** and **Compound-II** were tested by *in vitro* method to examine the antimicrobial studies against bacterial strains such as *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa* and fungal strains such as *Aspergillus niger and Pencillium notatum.* Modified antibacterial test was performed using the agar well diffusion method. The microorganisms were inoculated on Muller Hinton Agar and spread uniformly using sterile spreader in Petri plates. Three wells of 6 mm in diameter were made on Muller Hinton Agar using a sterile well puncher. The cut agar blocks were carefully removed by the use of forceps sterilized by flaming. 50 µL and 100 µL of the freshly prepared solution of metal complex (1 mg / mL) in DMF were poured into two wells and negative control DMF is poured in one well and the plates were allowed to stand for 1 h at room temperature for the diffusion of the substances and before the growth of organism commenced, the plates were incubated at 37°C for 4 h. Antimicrobial activity was determined by measuring the diameter of zones showing complete inhibition.

Antioxidant activity

Hydrogen peroxide scavenging activity is one of the best methods to study the antioxidant property.[12] A solution of hydrogen peroxide (40 mM) was prepared in phosphate buffer (50 mM, pH 7.4). Synthesized compounds 2 mg / mL in DMF were added to hydrogen peroxide and absorbance at 230 nm were determined after 10 minutes against a blank solution containing phosphate buffer without hydrogen peroxide. The percentage of hydrogen peroxide scavenging activity was calculated using the below equation.

Scavenging activity = (Ac-As) / Ac x 100

Ac - absorbance of control, As - absorbance of sample

Larvicidal bioassay

The eggs and egg rafts of *Culex. quinquefasciatus* were received from Zonal Entomological Unit, Vellore, Tamil Nadu. The eggs and egg rafts of *C. quinquefasciatus* were dipped into a plastic bottle containing 500 mL of dechlorinated water for 30-40 min to hatch out larvae. They were maintained in the laboratory as per literature.[12, 13] Mosquito larvae were fed with

powdered nutrient broth once a day. After 4 days the hatched larvae turned into larvae in early fourth stage and were subjected for further experiment. The larvicidal activity was assessed by the procedure of WHO guide lines with some modification.[14,15] The negative control was set up with sterile distilled water without **Compound-I** and **Compound-II** while the positive control was the commercial larvicide with synthesized **Compound-I** and **Compound-II** with different concentrations. Percentage of mortality was assessed after 24 h of incubation. A number of dead larvae in each batch were counted every hour for 24 h exposure period. The treated larvae was mounted on a slide and examined under a microscope for image capture.

RESULTS AND DISCUSSION

All the synthesized compounds are found to be freely soluble in DMSO, DMF and ethanol. The lower molar conductivity values of the **Compound-I** and **Compound-II** (10^{-3} M) in DMSO at 25°C indicates their non-electrolytic nature.[16,17]

Table 1: Analytical data of the synthesized Compounds.

Compounds	Molecular formula	Molecular weight	Decomposition point (C°)	Molar Conductance Ohm^{-1} $Cm^{2}mol^{-1}$	Element Analysis found(Calculated) %		
					C	N	H
Compound-I	$C_4H_9O_3N$	259.260	>236° C	3.2	60.38 (60.23)	16.32 (16. 11)	5.13 (5.01)
Compound-II	$C_9H_{11}O_3N$	299.321	>241° C	3.8	68.38 (68.20)	14.57 (14.68)	5.78 (5.68)

(Where **Compound-I** = Schiff base derived from L-histidine and o-hydroxybenzaldehyde, **Compound-II** -II = Schiff base derived from L-Tyrosine and o-hydroxyacetophenone).

Table 2: Yields of the Compound-I.

S.No	Amount of Catalyst (m L)	Product yield Obtained with Tomato juice		Product yield obtain With orange juice	
		Product Yield (g)	Percentage Yield (%)	Product Yield (g)	Percentage Yield (%)
1	0.5	2.1345	88.93	1.7157	82.18
2	1	2.0156	84.47	1.5321	73.21
3	1.5	1.9448	80.02	1.3054	65.17
4	2	1.8328	75.37	1.2306	58.60
5	2.5	1.7101	71.25	1.1247	52.74

Table 3: Yields of the Compound-II.

S.No	Amount of Catalyst (mL)	Product yield Obtained with Tomato juice		Product yield obtained With orange juice	
		Product Yield (g)	Percentage Yield (%)	Product Yield (g)	Percentage Yield (%)
1	0.5	2.2468	93.60	1.7527	82.18
2	1	2.1426	89.06	1.5438	73.17
3	1.5	2.0126	84.13	1.3865	65.14
4	2	1.7543	78.17	1.3260	58.35
5	2.5	1.6479	73.76	1.1258	51.24

The data presented in the above table was clearly showed that on increasing the amount of acid catalysts product yields were decreasing because of acid concentration cannot be too high due to the basicity of amines. If the amine is protonated and becomes non nucleophilic, equilibrium is pulled to the left and carbinolamine formation cannot ocuur.[2] therefore many Schiff bases synthesis are best carried out at mildly acidic pH.

UV-Visible Spectra

The electronic absorption spectra of Schiff bases **Compound-I** and **Compound-II** (10^{-3}M) were recorded at room temperature using DMSO.

Table 4: UV-Visible spectra of Compounds.

Compounds	Absorption (λ_{max} nm)	
	$\pi - \pi*$	n--$\pi*$
Compound-I	276	318
Compound-II	273	325

The absorption maximum appeared around 276 nm and 318 nm corresponds to $\pi \rightarrow \pi*$ transition of aromatic chromophore and n$\rightarrow \pi*$ of transitions of imine moiety of **Compound-I** and **Compound-II** respectively.[18]

FTIR spectra

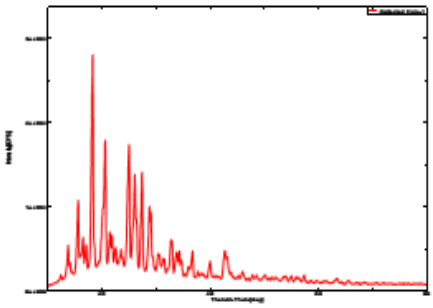
The synthesized **Compound-I** and **Compound-II** were exhibited a characteristic intense absorption band around 1604 cm^{-1} due to the coordinated imine moiety.[19] The band appeared around 1700 cm^{-1} corresponds to carboxylate group.[20]

Table 5: FTIR Spectra of the Compounds.

Compounds	ν (coordinated H_2O/ Lattice) cm^{-1}	ν (C=N) azomethine cm^{-1}	ν (Coo^-) Carboxylate group cm^{-1}	ν (C-H) out of plane bending cm^{-1}
Compound-I	3404.36	1602.85	1737.86	837.11
Compound-II	3197.96	1579.70	1710.22	790.81

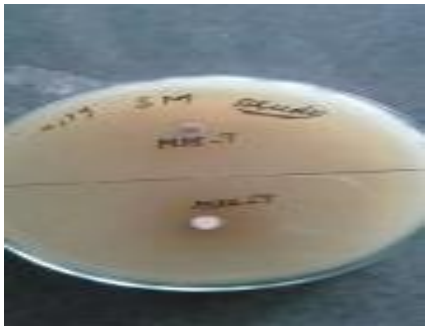
X-Ray Diffraction Studies

X-ray diffraction analysis is useful tool in determining the crystallization nature. The XRD pattern exposed that synthesized of **Compound-II** were crystalline in nature. According to Debye–Scherer equation the average particle size was found to be 4.97 nm and the lattice strain was calculated as 0.0357. The percentage was crystalline was determined as 45.11%.



"Fig. 1" XRD Diffraction Studies of Schiff base Compound-II Antibacterial activity.

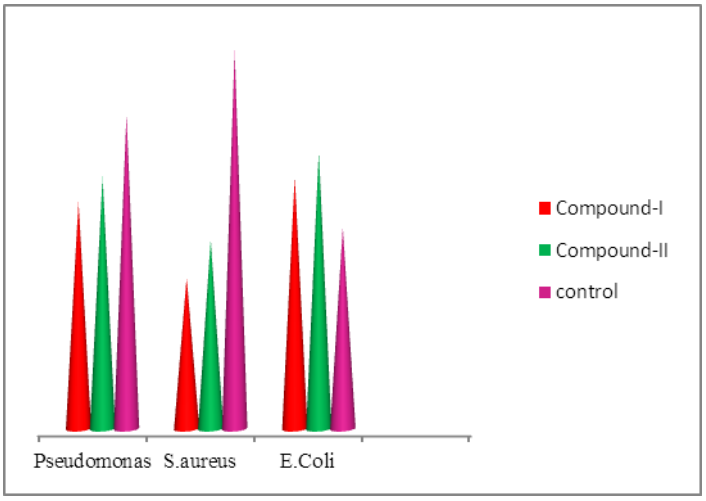
The zone of inhibition values of the synthesized **Compound-I** and **Compound-II** against the growth of the selective bacteria was measured in mm. The zone of inhibition values less than 10 mm is considered to be a resistant towards the corresponding microorganisms. All the synthesized Schiff bases were showed very good antibacterial activity against *Pseudomonas and E. coli* and measured values were compared with the standard Ampicillin.



"Fig. 2"Antibacterial activity of the Compounds.

Table 6: Antibacterial activity of the Compounds.

Organism(bacteria)	Zone of inhibition(mm)		Control
	Compound-I	Compound-II	Ampicillin
Pseudomonas	18	20	25
S. aureus	12	15	30
E. coli	20	22	16



"Fig. 2" Graphical representation of Compounds.

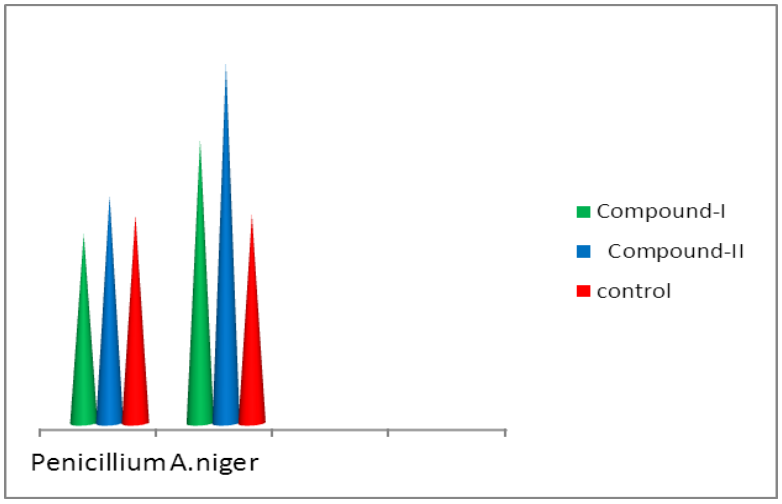
Antifungal activity

In vitro antifungal activity of the Schiff bases studied by well diffusion method against fungi such as *Aspergillus flavus* and *Penicilium*. Synthesized Schiff bases showed moderate to strong activity and zone of inhibition values were compared with the standard Polymyxin B Sulphate.

Table 7: Antifungal activity of the Compounds.

Organism(fungi)	Zone of inhibition(mm)		Control
	Compounds-I	Compounds-II	Polymyxin B sulphate
Penicillium	10	12	11
A.niger	15	19	11

Compound-II posses good activity against *Penicillium* when compare with the standard and **Compound-I** and **Compound-II** exhibits good avtivity against *A.niger* compared with the standard polymyxin B-sulphate.



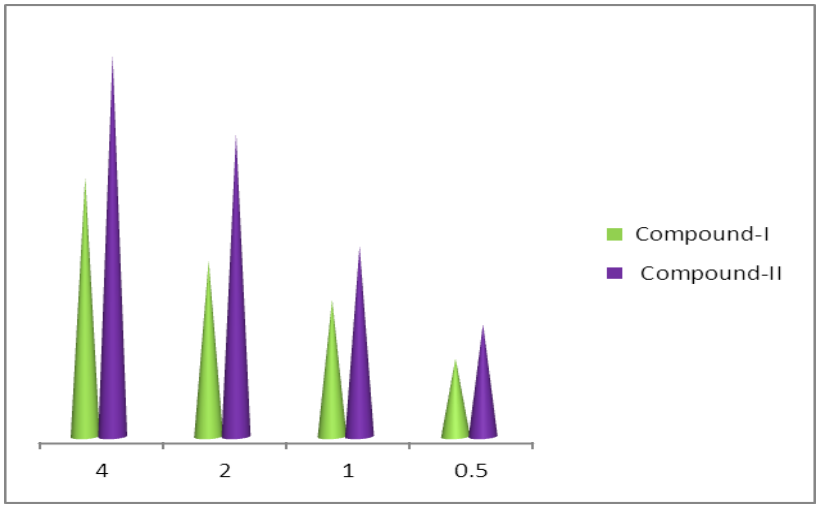
"Fig. 3" Graphical representation of antifungal activity of the Compounds.

Antioxidant activity

The antioxidant activity has mainly been designated as the peroxide value of oxidation products and the oxidation rate of coexisting lipids to study of the antioxidant potential through free radical scavenging by the **Compounds**. Average scavenging activity was calculated for the different concentrations of Schiff bases. **Compound-II** exhibits good scavenging activity at highest concentrations than **Compound-II.**

Table 8: Antioxidant activity of the Compounds (H_2O_2 method).

Concentrations mg / 200 mL	Scavenging activity Compound-I	Scavenging activity Compound-II
4.0	53%	78%
2.0	36%	62%
1.0	28%	39%
0.5	16%	23%



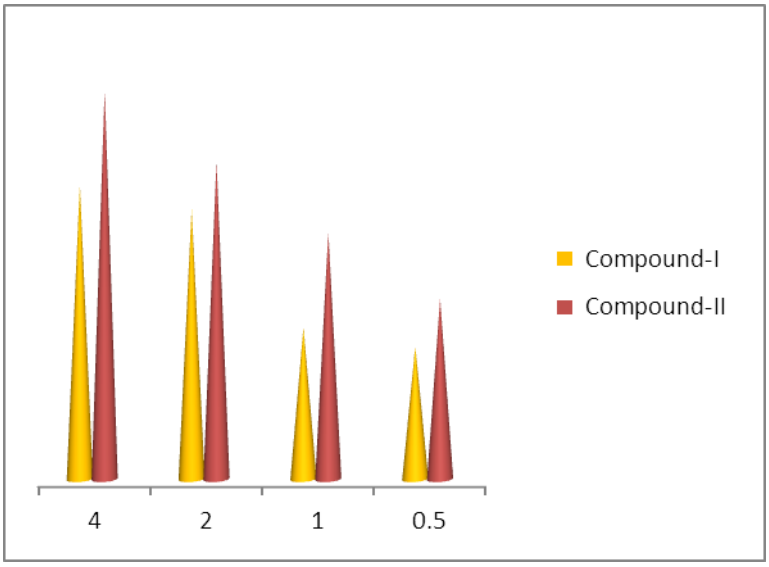
"Fig. 4" Graphical representation of antioxidant activity of the Schiff bases.

Larvicidal activity

Larvicidal activity of the synthesized **Compounds** was performed against *culex quinquefasciatus* and average mortality was found in after 24 h exposure period. The highest morality was obtained for **Compound-II** than **Compound-I.**

Table 9: Larvicidal activity of the compounds.

Concentrations mg /200 mL	Mortality Compound-I	Mortality Compound-II
4.0	62 %	82 %
2.0	57 %	67 %
1.0	32 %	52 %
0.5	28 %	38 %



"Fig. 5" Graphical representation of average mortality of Compounds.

The synthesized **Compound-II** and **Compound-I** posses good percentage of mortality against larvae, the obtain results revealed that when the concentration of the compound increases, the percentage of mortality also increases.

CONCLUSION

In the present study natural acid was used as catalyst to synthesis the Schiff bases and characterized by various physico-chemical and spectral analyses. The molar conductance of all the compounds were suggested their non-electrolytic nature. The formation of azomethine group was confirmed by FTIR and UV spectra. Larvicidal and *in vitro* antimicrobial and antioxidant studies were carried out. The results discovered that the synthesized Schiff bases possess good antioxidant, antibacterial, antifungal and larvicidal activity.

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