RASĀYAN *J. Chem.*
Vol. 16 | No. 4 |2171-2180| October - December | 2023
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

ANTIMICROBIAL, ANTIFUNGAL, LARVICIDAL, AND ANTIOXIDANT ACTIVITY OF FRESHLYPREPARED CYANOPYRIDINE DERIVATIVES

A. Kistan[1,✉], V. Kanchana[2], C. Esther Jeyanthi[3] and K. Uma [4]
[1]Department of Chemistry, Panimalar Engineering College, Chennai-600123, (Tamil Nadu) India
[2]Department of Chemistry, Sree Sastha Institute of Engineering and Technology, Chennai-600123, (Tamil Nadu) India
[3]Department of Physics, Panimalar Engineering College, Chennai-600123, (Tamil Nadu) India
[4]Department of Chemistry, Prathyusha Engineering College, Aranvayal Kuppam, Tiruvallur taluk-602025, (Tamil Nadu) India
✉Corresponding Author: drakistan14@panimalar.ac.in

ABSTRACT
Using a microwave method, six distinct Cyanopyridine derivatives (1a–1f) are freshly synthesized with a high yield. These derivatives were characterized by MS-(ESI) ^{13}C-NMR, ^{1}H-NMR, IR spectral data, melting point analysis, and tried for their antibacterial action against Salmonella typhi, Staphylococcus aureus, Bacillus subtilis, and Staphylococcus aureus before being examined for their antibacterial, antifungal, Larvicidal, antioxidant properties. The findings indicated moderate to high antibacterial, antifungal, Larvicidal, and antioxidant activities.
Keywords: Cyanopyridine, Antibacterial, Antifungal, Larvicidal, Antioxidant, Carbonitrile.
RASĀYAN *J. Chem.*, Vol. 16, No. 4, 2023

INTRODUCTION

The pyridine structure is a key component of heterocyclic organic chemistry and is currently found in a variety of naturally occurring substances, including vitamin B-6, nicotinic acid, and nicotinamide, which play important roles in metabolism. The biological activities of the pyridine with different functional groups are extremely diverse. Antimicrobial resistance is currently the sole significant hazard to the welfare and advancement of humans. Additionally, in order to prevent infections from occurring and raise public awareness, the current antimicrobial treatments must be used as effectively as possible. Additionally, new medications should ideally function in novel ways.[1-3] Pyridine and its derivatives are present in nature in a variety of configurations and are an essential component of many natural materials. Both chemical and biological reactions can be catalyzed by the pyridine ring.

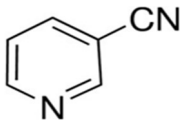

Fig.-1: The Basic Structure of Cyanopyridine

It is now shown that 2-amino-3-cyanopyridine derivatives have a wide range of biological effects, as well as antimicrobial, cardiotonic, and anti-inflammatory effects. In spite of the abundance of literature on the subject, the most popular methods for making 2-amino-3-cyanopyridines need multiple steps, toxic solvents like benzene or toluene, and microwave assistance, which leads to unsatisfactory yields. It is necessary to improve synthetic strategies that allow for an easy determination of these heterocyclic compounds due to the major features of pyridines and pyridine derivatives.[4–7] A number of substituted Cyanopyridine derivatives are found to function as intermediates in the synthesis of pharmaceutical, dye, photo, and agrochemical products. Various cyanopyridines have also received attention because of the wide range of well-known biological effects they have.

http://doi.org/10.31788/RJC.2023.1648523

Therefore, it will be compelling to determine the solubility of these materials given their applications in the biological and chemical areas. Pyridin-3-carbonitrile, another name for Cyanopyridine, is also accepted. A review of the literature reveals that notable Cyanopyridine derivatives were created through the condensation reaction of chalcones with ammonium acetate and malononitrile. The therapeutic properties of compounds derived from Cyanopyridine include antibacterial, antitubercular, analgesic, anti-allergic, anticonvulsant, antihypertensive, adrenergic, antifungal, and herbicidal properties. The majority of the derivatives are created through the manipulation of pyridine and its straightforward homologs using techniques similar to the chemistry of benzenoid.[8–10] The benefit of the current study is to plan and create a series of sophisticated Cyanopyridine derivatives and to examine the compound's antimicrobial, antifungal, larvicidal, and antioxidant properties, which have demonstrated medium to high activity. A new class of drug participants for conditions like cancer, TB, fungal contaminations, edema, and others may be approved for use in upcoming in vivo analyses based on biological evidence.[11-14] In order to obtain a high yield, chalcones Cyanopyridine derivatives were synthesized using a microwave approach while keeping in mind the chemical and biological significance of chalcones. The structural details of the prepared derivatives are shown by MS-(ESI), ^{1}H-NMR, ^{13}C-NMR, IR- spectrum data, melting point analyses, and examinations for in vitro antiseptic action against Salmonella typhi, Bacillus subtilis, Staphylococcus aureus, and Staphylococcus aureus. The bioactive heterocyclic moiety is present in six newly synthesized Cyanopyridine derivatives (1a–1f). Surprisingly, they were subjected to moderate to high larvicides, antifungals, and Antioxidant activities [15-19].

EXPERIMENTAL

Material and Methods

Synthesize Cyanopyridine Derivatives

Cyanuric chloride (0.01 mol) 1 and 4-amino acetanilide (0.01 mol) 2 react in a 30 ml acetone solution while being stirred continuously for 3 to 4 hours between 0 and 5 o C to produce Cyanopyridine derivatives. To neutralize the hydrochloric acid produced during the process, Na_2CO_3 (0.05 mols) was slowly poured into 10 ml of distilled water. The liquid was then poured into crushed ice. Filtration was used to isolate the usable solid, which was then washed away with deionized water. To create the product-3, the product is dried out and re-crystallized using ethanol. The reaction mixture was stirred for six hours after the addition of numerous substituted aldehydes (0.01mol) 30 milliliters of ethanol and 10% diluted sodium hydroxide to the compound (3). The crushed ice was mixed with the reaction mixing ingredients. Filtration was used to remove the solid, and double-distilled water was used for cleaning. After being dehydrated and recrystallized from ethanol, the Yield (product -1).[20-24]

Cyano Pyridine Derivatives Analytical Data

The Following Cyanopyridine Derivatives were Synthesized and Purified by Column Chromatography (CC)

- 5-(4,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)-Two of an amino43 carbonitrile, 4-methoxy-phenyl, and pyridine
- Five (4,5-(4,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)-Two-hydroxyTolylpyridine -4-p-tolylcarbonitrile
- The compound 5-(4,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)4-(4-chloro phenyl) two-aminoThree-carbonitrile pyridine
- Five (four,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)-Two-amino-4-(4-fluoro-phenyl)Carbonitrile pyridinium-3
- The compound 5-(4,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)Pyridine-3-carbonitrile -T-amino-4-(thiophen-2-yl)5-(4-(4,6-Dichloro-1,3,5-triazin-2-ylamino)phenyl-amino) in particular2-amino-4(dioxol-4-yl, [d][1,3]benzopyridine-3-carbonitrile)
- 5-(4,(4,6-Di-chloro-1,3,5-triazin-2-ylamino)phenyl-amino)triazine is a triazine.Thiophen-2-yl--T-amino-4-Three-carbonitrile pyridine5-(4-(4,6-Dichloro-1,3,5-triazin-2-ylamino)phenyl-amino) in particular2-amino-4(dioxol-4-yl, [d][1,3]benzopyridine-3-carbonitrile)

Spectral Structure Elucidation of Synthesis Cyano-Pyridine Derivatives

Synthesis of 5-(4(4, 6 di-chloro-1, 3, 5 tri-azin-2yl-amino) phenyl amino)-2 amino-4-(4-methoxyphenyl) pyridine-3carbonitrile 1(a)

N-(4 (4,6 Di-chloro-1,3,5 triazin-2yl-amino)phenyl) 3-(4-methoxyphenyl) is (E) a phenyl ring. Malononitrile, ammonium acetate, and 40 ml of ethanol were added to the acrylamide mixture, which was then refluxed for eight hours. The mixture was then placed in a beaker with crushed ice (18–24) and allowed to cool. The solid substance was filtered, separated, and then washed with double-distilled water before being reconstituted with ethanol. This thing was mentioned in 1(a). The stretching frequency of C-Cl at 604 cm^{-1} causes a modest peak in the IR spectra, while the C-N of the s-triazine ring at 773 cm^{-1} causes a second weak peak. The presence of the C=N group was indicated by a notably big peak at 1570 cm-1. Due to being in the C-N group, there is a faint peak at 2220 cm^{-1} that corresponds. There was a faint peak for the C-H stretching vibrations at 2926 cm^{-1}. The structure was further supported by a large peak at 3398 cm-1 that showed N-H stretching frequency to be present. Pyridine moiety exhibits a singlet signal in the ^{1}H NMR spectrum at δ = 9.892. In the range of δ = 6.978–7.009, aromatic protons were observed. Ar-NH_2 is responsible for a singlet peak at δ = 4.329, and Ar-NH is also responsible for singlet peaks at δ = 4.311 & 4.329, respectively. All of the carbon atoms in the molecule have their own distinctive peak in the ^{13}C NMR spectrum. Aliphatic carbon atoms ^{13}C NMR chemical shift value δ is δ = 55.51 ppm. S-triazine appears in the 13C spectrum at δ = 166.10 -168.38, and aromatic carbon appears at δ = 114.89 - 134.85.

ESI-MS Detected the Molecular Ion-Peaks at m/z 479 (M +)

Synthesis of 5-(4 (4- 6 di-chloro 1, 3, 5 triazin-2 yl-amino) phenyl amino)-2-amino-4-p-tolylpyridine-3-carbonitrile 1(b)

(E)-N(4(4,6 Di-chloro-1,3,5 triazin-2yl-amino)phenyl)phenyl)-3-p-tolyacrylamide The following ingredients were added and refluxed for eight hours: 40 ml of ethyl alcohol, 0.01 mol of 1(b), 0.01 mol of malononitrile, and 0.08 mol of ammonium acetate. After cooling, the liquid was transferred to a beaker filled with crushed ice. The solid components have been filtered, separated, cleaned with twice-distilled water, and recrystallized from ethanol. This thing was tallied as item 1(b). The stretching frequency of C-Cl causes a tiny peak in the IR spectrum at 796 cm^{-1}, and the C-N of the s-triazine ring causes another intermediate peak at 831 cm^{-1}. A feature of a peak close to 1557 cm^{-1} suggested the presence of the C=N group. Due to the existence of the C-N group, there is a faint peak that corresponds to 2207 cm^{-1}. The C-H stretching vibrations predicted a weak peak on 2926 cm^{-1}. 3420 cm^{-1} had a large peak that indicated the presence of N-H stretching frequency. The protons of the pyridine moiety show a single peak in the ^{1}H NMR spectrum at δ =9.903. The range of δ =7.518-7.638 saw the appearance of aromatic hydrogen (protons). A single peak on δ = 4.333 that corresponds to Ar-NH2 and two further singlet peaks at δ = 4.315 and δ = 4.320 that correspond to Ar-NH further validate the structure. All of the carbon atoms present in the molecule have their own distinctive peak in the ^{13}C NMR spectrum. Aliphatic carbon atoms ^{13}C NMR chemical shift value is δ =78.79 ppm. The s-triazine band in the ^{13}C spectra appears at δ =166.03–168.35 while the aromatic carbon band appears at δ =118.40–135.35.

ESI-MS Detected the Molecular Ion Peaks at m/z 464 (M+1)

Preparation of 5-(4-(4, 6-dichloro-1, 3, 5-triazin-2-ylamino) phenylamino)-2- amino-4-(4-chlorophenyl) pyridine-3-carbonitrile 1(c)

Chemically speaking, (E)-N-(4-(4, 6-Dichloro-1,3,5-triazin-2-ylamino)phenyl)-3-(4-chloro phenyl) exists. Acrylamide was prepared by combining 40 ml of ethyl alcohol with 0.01 mol of 4(c) and ammonium acetate and then refluxing the mixture for eight hours. After cooling for some time, the mixture was then added to a beaker of crushed ice. The solid substance was filtered and separated, then washed with double-distilled water before being crystallized once more from ethanol. This thing was tallied as item 1(c). While the C-N of the s-triazine ring provides a significant peak at 811 cm^{-1} in the IR bands, the C-Cl stretching frequency causes a high peak at 776 cm^{-1}. There was a prominent peak around 1582 cm-1 that was easily identifiable as belonging to the C=N group. The peak at 2177 cm^{-1} is consequently faint because it belongs to the C-N functional group. A modest peak at 2919 cm-1 was expected from the C-H

stretching vibrations. The structure was further supported by a large peak at 3416 cm-1 that indicated the presence of N-H stretching frequency. The protons of the pyridine moiety exhibit a singlet peak in the ^{1}H NMR spectrum at δ = 9.898. Aromatic protons were detected between δ - 7.269 and δ = 7.494 eV. A singlet peak at δ = 4.349 appropriately corresponds to Ar-NH_2, and more than singlet peaks at δ - 4.331-4.340 similarly validate the structure. All of the carbon atoms in the molecule reached their respective distinctive peak in the ^{13}C NMR spectrum. S-triazine appears in the ^{13}C spectrum shown at δ - 166.02-168.20, while aromatic carbon appears at δ = 119.02 - 134.94.
ESI-MS Detected the Molecular Ion-Peaks at m/z 467 (M^{+})

Synthesis of 5(4(4, 6, dichloro 1,3, 5 tri-azin-2yl-amino) phenylamino)-2- amino-4-(4-fluorophenyl)pyridine-3-carbonitrile 1(d)

N-(4 (4, 6, Di-chloro-1,3, 5-triazin-2yl-amino) phenyl)-3-(4-fluorophenyl) acrylamide is a compound in group E. After adding malononitrile (0.01 mol) and ammonium acetate (0.08 mol) concentrations, 40 cc of ethyl alcohol was mixed with 1(d) (0.01 mol). This reaction mixture was refluxed for eight hours. The liquid was then placed into a beaker with crushed ice after being given time to cool. Separation was used to remove the solid substance, it was cleansed with distilled water, and then it was crystallized once again with ethyl alcohol. This thing was dealt with as 1(d). The stretching frequency of the C-Cl ring causes a strong peak at 776 cm^{-1} in the IR spectra, while the C-N of the s-triazine ring causes a strong peak at 811 cm^{-1}. a prominent peak at 1582 cm^{-1} that was very strong and suggested the C=N group. The peak at 2177 cm^{-1}, which belongs to the C-N functional group, is consequently faint. The minor peak of the C-H stretching vibrations was at 2919 cm-1. A significant peak at 3416 cm^{-1}, which indicated that it possessed an N-H stretching frequency, further supported the structure's existence. The protons of the pyridine moiety exhibit a singlet peak in the ^{1}H NMR spectrum at about δ = 9.898. Aromatic protons appeared to be between δ = 7.269 and δ = 7494. The structure is further supported by two singlet peaks at δ = 4.331-4.340, both of which are due to Ar-NH and correspond to a singlet peak at 4.349, which is due to Ar-NH_2. All of the carbon atoms in the molecule have their own distinctive peak in the ^{13}C NMR spectrum. S-triazine is seen in the ^{13}C spectrum displayed at δ = 166.02–168.20, and aromatic carbon is visible at δ = 119.02–134.94.
ESI-MS detected the molecular ions peak at m / z 467 (M +)

Synthesis of 5-(4-(4, 6-dichloro-1, 3, 5 tri-azin-2yl-amino) phenylamino)-2-amino-4- (thiophen-2yl) pyridine-3 Carbonitrile's 1(e)

The acrylamide (E)-N-(4-(4,6-Dichloro-1,3,5-triazin-2-ylamino) phenyl)-3-(thiophen-2-yl)) is a dihydrochloride. Malononitrile (0.01 mol) and ammonium acetate (0.08 mol) quantities were added after 40 ml of ethyl alcohol and 4(e) (0.01 mol) were combined. This reaction mixture was refluxed for eight hours. The liquid was then placed into a beaker with crushed ice after being given time to cool. Filtration was used to extract the solid material, which was then washed with distilled water before being crystallized once more using ethyl alcohol. This thing was tallied as item 1(e). The stretching frequency of the C-Cl ring results in a strong peak at 716 cm^{-1} in the IR spectra, while the C-N of the s-triazine ring results in a strong peak at 837 cm^{-1}. The presence of the C=N group was indicated by a distinctively big peak at 1561 cm^{-1}. The peak at 2223 cm^{-1}, which belongs to the C-N group, is consequently weak. The C-H stretching vibrations showed a weak peak at 2981 cm-1. A significant peak at 3434 cm^{-1}, which indicated that it possessed an N-H stretching frequency, further supported the structure's existence. In the 1H NMR spectrum, protons from the pyridine moiety show a singlet peak at around 9.860. The apparent range of aromatic protons was 6.987–7.021. Corresponding singlet peaks at δ = 4.325, δ = 4.290, and δ = 4.307, respectively, are caused by Ar-NH and enhance the structure's confirmation. All of the carbon atoms in the molecule have their own distinctive peak in the ^{13}C NMR spectrum. S-triazine appears in the ^{13}C spectrum exhibit at δ = 166.10–168.40, and aromatic carbon appears at δ = 114.00–134.84.
ESI-MS detected the molecular ions peak at m/z 456 (M+ 1)

Synthesis of 5-(4(4, 6-di-chloro-1, 3, 5 tri-azin-2yl-amino) phenylamino,2-amino-4- (benzo [d][1,3]dioxol-4-yl) pyridine-Carbonitrile's 1(f)

(E)-N-(4-(4,6-dichloro-1,3,5-triazin-2-ylamino)phenyl)-3-(benzo[d][1,3]dioxol-7-yl)acrylamide

Malononitrile (0.01 mol) and ammonium acetate (0.08 mol) quantities were added after 40 ml of ethyl alcohol and 1(f) (0.01 mol) were combined. This reaction mixture was refluxed for eight hours. The liquid was then placed into a beaker with ice cubes and allowed to cool. Filtration was used to extract the solid material, which was then washed with distilled water before being crystallized once more using ethyl alcohol. This thing was tallied as item 1(f). In the IR spectrum, the C-N of the s-triazine ring exhibits a notable peak at 813 cm^{-1}. Around 1578 cm^{-1}, a notably low peak pointed to the C=N group's presence. There is a weak peak at 2210 cm-1 that correlates to being in the C-N group. The C-H stretching vibrations showed a weak peak at 2922 cm^{-1}. A significant peak at 3367 cm-1, which indicated the presence of N-H stretching frequency, further supported the structure's existence. In the 1H NMR spectrum, the protons of the pyridine moiety show a singlet signal at = 9.506. The structure is further supported by a singlet peak at = 4.330, which is associated with Ar-NH_2, three more singlet peaks at = 4.306 and 4.314, and a singlet peak at = 5.996, which is associated with the CH_2 group. All of the carbon atoms in the molecule have their own distinctive peak in the ^{13}C NMR spectrum. S-triazine is seen in the 13C spectrum shown at δ = 166.03–168.65, and aromatic carbon is visible at δ = 101.94–148.38.
The Molecular Ions Peak at m/z 495 [M+2] was Seen by ESI-MS

The Antibacterial Activity of Derivatives of Cyanopyridine

The newly combined Cyanopyridine derivatives were tested against Gram (+Ve) bacteria like *Bacillus subtilis and Staphylococcus aureus* as well as *Gram (-Ve) microbes like Escherichia coli and Salmonella typhi*. The evaluated inhibitory quantity was calculated in terms of g/mL.

Procedure for Antibacterial Activity

All bacterial strains were suspended in Brain Heart Distillation broth and diluted with distilled water to 105 colony-forming Units per mL. They were flood-immunized outside of the media (*Mueller Hinton Agar for bacteria and Sabouraud's Dextrose agar for fungi*), after which they wilted. 5 mm diameter wells were made in the agar using a cork-borer that had been cleaned and sanitized, and 30 L of the example solution (5 g mixture in 500 L DMSO) was then added. The plates were treated with microorganisms for 18 hours at 37°C. Antibacterial activity was determined by measuring the width of the inhibitory zone (in mm) against the microorganisms and the solvent examinations (Fig.-2 to 5).

Antibacterial Activity Plate I

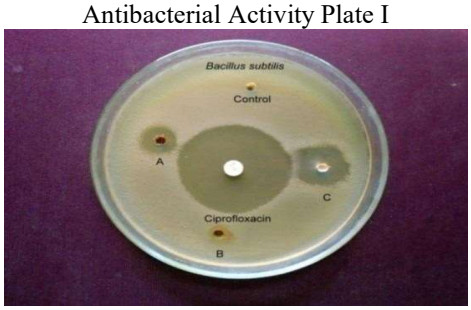

Fig.-2: *Bacillus Subtilis Standard – Ciprofloxacin*
A - Compound 1-a; B - Compound 1-b; C - Compound 1-c

Antibacterial Activity Plate II

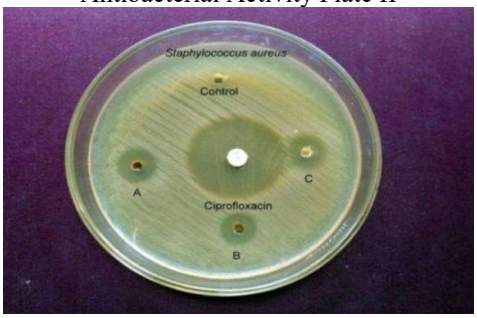

Fig.-3: *Staphylococcus aureus Standard – Ciprofloxacin*
A - Compound 1-a; B - Compound 1-b; C - Compound 1-c

Antibacterial Activity Plate III

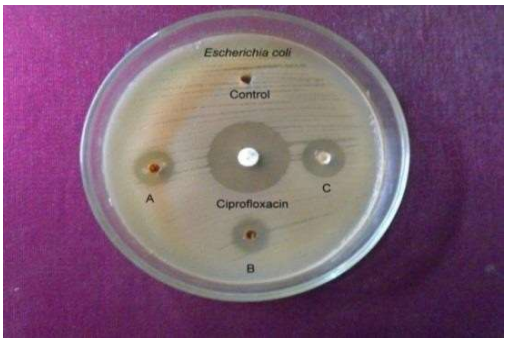

Fig.-4: *Escherichia coli Standard – Ciprofloxacin*
A - Compound 1-a; B - Compound 1-b; C - Compound 1-c

Antibacterial Activity Plate IV

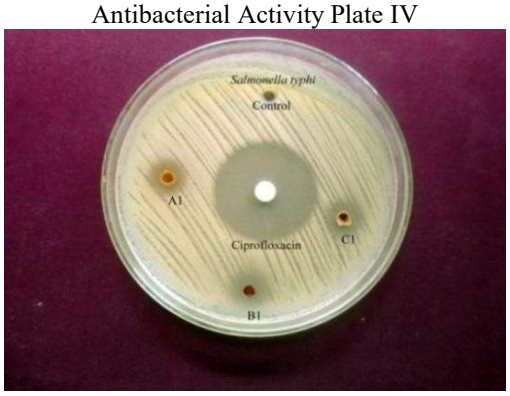

Fig.-5: *Salmonella typhi Standard – Ciprofloxacin*
A - Compound 1-a; B - Compound 1-b; C - Compound 1-c

Table-1: Antibacterial Activity of Cyanopyridine Derivatives

S. No.	Compounds	*Bacillus subtilis* (mm)	*Staphylococcus aureus*(mm)	*Salmonella typhi*(mm)	*Escherichia coli*(mm)
1	5-a	6	8	10	10
2	5-b	7	8	5	8
3	5-c	8	10	3	9
4	5-d	5	9	15	7
5	5-e	5	7	9	8
6	5-f	6	8	12	10
Standard	*Ciprofloxacin(mm*)	8	12	20	15
Control	DMSO				

Antifungal-Activity of Cyanopyridine Derivatives

The newly prepared compounds were evaluated against Candida albicans, and *Aspergillus Niger* the Measured inhibitory extents were represented in terms of µg /mL.

Procedure for *Antifungal* Activity

All isolated fungi were suspended in Brain Heart Infusion (BHI) broth and diluted with distilled water to 105 colony-forming units (CFU) per mL. After being flood-immunized onto the media's surface (*Sabouraud's Dextrose agar for fungi and Mueller Hinton Agar for bacte*ria), they were then dried. 5 mm diameter wells were cut from the agar using a cork-borer that had been cleaned and sanitized, and 30 L of the sample solution (5 g of chemical in 500 L of DMSO) was added to the wells. The fungal plates were incubated at room temperature for 48 hours. The zone of inhibition against the test bacteria and the solvent, measured in millimeters, was used to calculate the antifungal activity. As a solvent control, DMSO was employed. Ketoconazole was used to treat Candida sp., and Amphotericin B served as the standard antifungal treatment for mild cases. Triplicates of each experiment were performed (Table-2).

Table-2: Antifungal Activity of Cyanopyridine Derivatives

S.No.	Compounds	*Aspergillus*	*Candida albicans(mm)*
1	5-a	5	2
2	5-b	2	4
3	5-c	5	4
4	5-d	6	2
5	5-e	4	4
Standard	*Amphotericin-B(mm)*	12	10
Control	DMSO	-	-

***Larvicidal* Activity**

Larvae were separated into five collections of 20 for the bioassay studies and placed in 250 ml of distilled water with 1.0 ml of the specified extract of chemical concentration. After 20 hours of duration, the number of lifeless larvae was calculated, and the mortality rate was determined using the mean of 5 repeats.

***Mosquito Larvae* Consumed**

Larvae of Anopheles subpictus were acquired from the Pondicherry-based Vector Control Research Centre. The World Health Organization (WHO) technique was modified and applied skillfully to measure the larvicidal effect (Table-3).

Table-3: Larvicidal Activity of Cyanopyridine Derivatives

S.No.	Compounds designation	% of Inhibition
1	5-a	66%
2	5-b	76%
3	5-c	72%
4	5-d	60%
5	5-e	63%
6	5-f	52%

Antioxidant Activity

The reagents, chemicals, and solvents employed in the experiment were of analytical excellence. Hi Media Laboratory Pvt. Ltd. provided the ascorbic acid and DPPH (1, 1 di-phenyl-2 picryl-hydrazyl) for the study.

***In-vitro* Anti-Oxidant Activity**

DPPH-Scavenging Activity

To evaluate the 1, 3-diphenyl-2-propene-1-one derivatives' capacity to scavenge free radicals, the most stable radical available was 2, 2-diphenyl-picrylhydrazyl (DPPH). 1 ml of 1, 3 di-phenyl 2-propene-1-one derivatives (0.1 ml & 0.2 ml) produced in DMSO was mixed in DPPH (1x10-4 ml) solution, and the mixture was then given vigorous agitation to achieve total suspension. The DPPH solution was used as the control sample. By a UV-visible spectrometer on a wavelength of 517 nm with the blank solution (DMSO), the sample test tubes were sealed off with aluminum before adding the DPPH radical by the organic matter. The synthesized 1, 3-diphenyl-2-propene-1-one derivatives' 2, 2-diphenylpicrylhydrazyl (DPPH) scavenging abilities were evaluated using the following formula.[25-28]

Table-4: Anti-oxidant Activity of Cyanopyridine Derivatives by DPPH Scavenging Method % of DPPH Scavenging

S. No.	Compound	100µgml^{-1}	200µgml^{-1}	300µgml^{-1}
1.	1-a	64.43	75.80	78.80
2.	1-b	39.06	42.90	58.07
3.	1-c	48.73	58.21	62.30
4.	1-d	72.07	76.56	78.98
5.	1-e	42.37	58.07	68.54
6.	1-f	40.37	56.06	66.34
Standard	Ascorbic Acid	53.97	54.42	55.42

Ascorbic acid was used as the reference, and Table-1 lists the anti-oxidant activity displayed by the standard and 1, 3- diphenyl-2-propene-1-one derivatives at various concentrations. Figure-6 illustrates the

plot of the percent of inhibition against the various concentrations of the solutions and standard Ascorbic acid.

RESULTS AND DISCUSSION

All four of the examined microorganisms were inhibited by one or more of the compounds (1a–1f) with excellent and medium efficacy. The activity of synthetic chemicals increased with concentration. Verified substances' antibacterial efficacy and structural variations and alterations of their respective derivatives may be connected. Table 1's statistics on antibacterial activity show that compounds 1-b (-4-CH_3) and 1-c (-4-Cl) had exceptional activity against B. subtilis. Both compound 5-c (-4-Cl) and 1-d (pipernol) exhibited strong *anti-S Aureus* action. The compounds 1-d (-4-f) and 1-f (pipernol) have the best anti-S. typhi action. Compound 1-a (-4-OCH_3) showed strong anti-E-coli action. According to data on antifungal activity (Table 2), compounds 1-d (-4-F) showed reasonable effectiveness against A. Niger. While compounds 1-a, 1-d, 1-e, and 1-f had modest action, compound (5-b) showed good larvicidal activity. The findings of these experiments are presented in Tables 2, 3, and 4. Surprisingly, the majority of them demonstrated respectable larvicidal effectiveness. Compounds (1-a) through (1-e) showed very good, powerful antioxidant action, while (1-c), (1-e), and (1-f) showed moderate antioxidant activity. Compound (1-b) showed very little antioxidant activity. All of these recently created Cyanopyridine derivatives were tested for activity against the displayed species, ranging from mild to exceptional.

CONCLUSION

The creation and characterization of a novel set of six bioactive Cyanopyridine (1a-1f) derivatives. All six synthesized derivatives were produced using efficient two- or three-step processes. The structural elucidation of the freshly synthesized Cyanopyridine derivatives was determined by MS-(ESI), ^{1}H NMR, ^{13}C NMR, IR spectrum data, and melting point measurements. All six Cyanopyridine derivatives (1-a to 1-f) exhibited mild to considerable antibacterial, antifungal, larvicidal, and antioxidant properties. Against the test fungus, the fluoro-substituted medication (1-d) shows good activity. With concentration, these synthetic compounds become more active. Through their larvicidal actions, they indicated that compounds [1-(a) to 1-(f)] displayed good and moderate inhibition against the compounds. The compounds [1-a, 1-d] were the most active, although [1-f] was only moderately active based on their antioxidant results. Compound (1-b) is inactive, and compounds [1-c to 1-f] are moderately active. For their antimicrobial, antifungal, larvicidal, antioxidant, antitubercular, herbicidal, adrenergic, anticonvulsant, anti-allergic, and other activities in upcoming medical, biochemistry, microbiology, and biotechnology field research projects, the newly synthesized novel chalcones of Cyanopyridine derivatives may be highly recommended.

ACKNOWLEDGEMENTS

The Panimalar Engineering College (Autonomous) in Chennai, India, provided the authors with the support they needed as well as the essential research facilities, for which they are grateful.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

All the authors contributed significantly to this manuscript, participated in reviewing/editing, and approved the final draft for publication. The research profile of the authors can be verified from their ORCID IDs, given below:

A. Kistan https://orcid.org/0000-0003-1334-4331
V. Kanchana https://orcid.org/0000-0003-3528-5491
C. Esther Jeyanthi https://orcid.org/0000-0002-4320-2812
K. Uma https://orcid.org/0000-0002-6946-2129

REFERENCES

1. Kibou, Zahira, Nadia Aissaoui, Ismail Daoud, Julio A. Seijas, María Pilar Vázquez-Tato, Nihel Klouche Khelil, and Noureddine Choukchou-Braham, *Molecules*, **27(11)**, 3439(2022), https://doi.org/10.3390/molecules27113439
2. M.S. Rao, T.B. Rao and C.P. Koteswara, *Rasayan Journal of Chemistry*, **13(3)**, 1513(2020), http://dx.doi.org/10.31788/RJC.2020.1335799
3. Ismail, Magda MF, Amel M. Farrag, and Asmaa M. El-Nasser, Polycycli Aromatic Compounds (2022).
4. N. Sarvaiya, H. Samata, S. Gulati and H. Patel, *Rasayan Journal of Chemistry*, **15(1)**, 564(2020), http://dx.doi.org/10.31788/RJC.2022.1516656
5. H.A. Jasim, L. Nahar, M.A. Jasim, S.A. Moore, K.J. Ritchie and S.D. Sarker, *Biomolecules*, **11**, 1203 (2021); https://doi.org/10.3390/biom11081203
6. Babu, Donka Suresh, Doddaga Srinivasulu, Valaparla Bala Yesu, V. V. P. C. Narayana, Murali Vatturu, Sajitha Kethineni, and Meriga Balaji, *Rasayan Journal of Chemistry*, **16(1)**, 527(2023), http://doi.org/10.31788/RJC.2023.1618008
7. A.N. Mayekar, H. Li, H.S. Yathirajan, B. Narayana and N.S. Kumari, *International Journal of Chemistry*, **2**, 114 (2010); https://doi.org/10.5539/ijc.v2n2p114
8. M.K. Dahlgren, C.T. Oberg, E.A. Wallin, P.G. Janson and M. Elofsson, *Molecules*, **15**, 4423 (2010), https://doi.org/10.3390/molecules15064423
9. S. Puiac, X.H. Sem, A. Negrea and M. Rhen, *International Journal of Antimicrobial Agents*, **38**, 409 (2011), https://doi.org/10.1016/j.ijantimicag.2011.06.009
10. Allaka, Tejeswara Rao, and Naresh Kumar Katari, Recent Developments in the Synthesis and Applications of Pyridines, pp.605-625, (2023), https://doi.org/10.1016/B978-0-323-91221-1.00005-1
11. T. Constantinescu and C.N. Lungu, *International Journal of Molecular Sciences*, **22**, 11306(2021), https://doi.org/10.3390/ijms222111306
12. Ruby Kharwar and Ritu B. Dixit, *Rasayan Journal of Chemistry,* **14(1)**, 493(2021), http://dx.doi.org/10.31788/RJC.2021.1415922
13. Ismail, Magda MF, Amel M. Farrag, and Asmaa M. El-Nasser, *Polycyclic Aromatic Compounds*, **43(1)**, 630(2023), https://doi.org/10.1080/10406638.2021.201980
14. Alhakamy, Nabil A., Ahmad O. Noor, Khaled M. Hosny, Jenny J. Nasr, Moustafa MG Fouda, Tawfik Khattab, and Hatem E. Gaffer, *Current Organic Synthesis*, **17(7)**, 567(2020), https://doi.org/10.2174/1570179417666200628020602
15. R.M. Mohareb, D.H. Fleita and O.K. Sakka, *Molecules*, **23**, 16(2011), https://doi.org/10.3390/molecules16010016
16. M. Sapnakumari, B. Narayana, B.K. Sarojini and L.N. Madhu, *Medicinal Chemistry Research*, **23**, 2368 (2014), https://doi.org/10.1007/s00044-013-0835-6
17. Huang, Zhongshi, Xinglong Wang, Ning Li, Fuqiang Song, and Jingwen Zhou, *Bioresource Technology*, 128953 (2023). https://doi.org/10.1016/j.biortech.2023.128953
18. Momeni, Sarieh, and Ramin Ghorbani-Vaghei, *Scientific Reports*, **13(1)**, 1627(2023), https://doi.org/10.1038/s41598-023-27940-6
19. Tavassoli, Amir Mahdi, Mohammad Ali Zolfigol, and Meysam Yarie, *Research on Chemical Intermediates*, **49(2)**, 679(2023).
20. O. Mazimba, K. Wale, D. Loeto and T. Kwape, *Bioorganic & Medicinal Chemistry*, **22**, 6564 (2014), https://doi.org/10.1016/j.bmc.2014.10.015
21. R. Kant, V.K. Gupta, K. Kapoor, M. Sapnakumari, B. Narayana and B.K. Sarojini, *Acta Crystallographica Section E. Rep. Online*, **68**, 02917(2012), https://doi.org/10.1107/S1600536812038202
22. Liao, Shengliang, Shibin Shang, Minggui Shen, Xiaoping Rao, Hongyan Si, Jie Song, and Zhanqian Song, *Bioorganic & Medicinal Chemistry Letter*, **26(6)**, 1512(2016), https://doi.org/10.1016/j.bmcl.2016.02.024
23. EL-Hashash, Maher A., and Safaa S. Shaban, *Synthetic Communications,* **49(16)**, 630(2019), https://doi.org/10.1080/00397911.2019.1616096

24. Magda M. F. Ismail, Amel M. Farrag, and Asmaa M. El-Nasser, *Polycyclic Aromatic Compounds*, **43(1)**, 630(2023), https://doi.org/10.1080/10406638.2021.2019800
25. Hassan, Heba, Mohamed Hisham, Mohamed Osman, and Alaa Hayallah, *Journal of Advanced Biomedical and Pharmaceutical Sciences*, **6(1)**, 1(2023), https://dx.doi.org/10.21608/jabps.2022.162396.1166
26. Kumar, Nitin, Alka Chauhan, and Sushma Drabu, *Biomedicine & Pharmacotherapy,* **65(5)**, 380(2011), https://doi.org/10.1016/j.biopha.2011.04.023
27. Manoer, Afaf and Rehab M. Elbargisy, *Indian Journal of Chemistry-Section B*, **60(9)**, 1272(2021), http://op.niscpr.res.in/index.php/IJCB/article/view/30343
28. Abou-Zied, Hesham A., Eman AM Beshr, Hesham AM Gomaa, Yaser A. Mostafa, Bahaa GM Youssif, Alaa M. Hayallah, and Mohamed Abdel-Aziz, *Archiv der Pharmazie*, e2200464(2022), https://doi.org/10.1002/ardp.202200464
29. Nisheeth C. Desai, Jahnvi D. Monapara, Aratiba M. Jethawa, and Unnat Pandit, In Recent Developments in the Synthesis and Applications of Pyridines, pp.253-298(2023), https://doi.org/10.1016/B978-0-323-91221-1.00007-5

[RJC-8523/2023]