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Studies on synthesis, spectral characterization and antimicrobial evaluation of some 1,3,5-Triazine derivatives

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Abstract

In this work, new s-triazine derivatives were synthesized, characterized and screened to study the antimicrobial activities. Nowdays synthesis, characterization, and antimicrobial studies of some 1,3,5-Triazine derivatives is having importance due to very diverse medicinal properties of these compounds. The characterization techniques included are thermal and antimicrobial characterization methods used to characterize newly synthesized 1,3,5 triazine derivatives. The structural characterizations include X-ray diffraction (XRD), Fourier Transform IR Spectroscopy (FTIR) and some important properties like Thermal Properties. Scanning electron Microscopy (SEM) has been also done to study the compounds and characterization in more detail. The antibacterial, antifungal activities of 1,3,5-Triazine derivatives against different bacterial pathogens were analyzed. The overuse of chemicals against various infectious diseases has led to rapid emergence of resistivity against different bacteria. Therefore, the search for antimicrobials is a never ending task. For antimicrobial study different organisms like *Staphalococcus aureus* (Gram positive Bacteria), *Diplococcus aureus* (Gram positive Bacteria), *Pseudomonas fluorescens* and *Escherichia coli* (Gram negative Bacteria) and fungal species; *Candida albicans* and *Trichophyton rubrum* were used.

Keywords: Anti-Microbial, XRD, SEM, FTIR,

1. Introduction

1,3,5-Triazine derivatives are very important molecules and have attracted much attention in both academic and applied research. Among many synthesized chemical compounds, 1,3,5-triazine compounds have maintained the interest of researchers through decades of historical development in organic synthesis. 1,3,5-triazine derivatives have been used as medicinal compounds for centuries and form the basis for many common drugs.

Considering the importance of triazines, the design of new sustainable methods for their preparation is of paramount importance. In order to protect the environment [1] more resource-efficient and inherently safer design of molecules, materials, products, and processes are required. The future of chemistry is defined by the terms 'clean' and/or 'sustainable'. This is a relatively new field that is open for innovation, new ideas, and revolutionary progress. 1,3,5-Triazine is an important heterocycle and has gained much synthetic popularity due to its broad spectrum of biological properties such as antimicrobial, anticancer, anti-malarial, antiviral, antimycobacterial, antibacterial, [2] antiprotozoal, [3] antifungal, [4] anti-trypanosomal, [5] VLA-4 integrin antagonists, [6] cytotoxic, [7] herbicidal, [8] anticonvulsant, [9] anti-inflammatory, [10] analgesic, [11] acetylcholinesterase inhibitors, [12] antiasthamatic [13] and dihydrofolate reductase inhibitors. [14] Recent studies, based on the s-triazine scaffold showing anti-tumour [15] and anti-HIV activity have led these to be considered as most promising molecule to be employed as lead structures in the discovery of newer medicinally potent chemotherapeutic agents. 1,3,5-Triazine derivatives is one of the most important chemical structure having extensive study in recent years. The triazine provides the basis for the design of biologically relevant molecules with widespread applications.

Now a days interest is focused on the synthesis of triazine derivatives with potential medicinal applications. They are of wide interest because of their diverse biological and clinical applications. This created an interest in the present research work to synthesize variety of triazine derivatives also screened them for their various biological activities. The structural characterizations in the present work include X-ray diffraction (XRD), Fourier Transform IR Spectroscopy (FTIR) and some important properties like Thermal Properties. Scanning electron Microscopy (SEM) has been also done to study the compounds and characterization in more detail. The antibacterial, antifungal activities of 1,3,5-Triazine derivatives against different bacterial pathogens were analyzed. In this study, we prepared 1,3,5-triazine derivatives by replacing one, two, or three chlorine ions of cyanuric chloride.

2. Methodology

Experimental Technique:

This chapter focuses mainly on the fundamentals and basic principles of the preparation techniques of 1,3,5 triazine derivatives and the characterization tools, which are used in the present investigation. The characterization techniques include thermal and antimicrobial characterization methods used to characterize some newly synthesized 1,3,5 trizine derivatives. The structural characterizations include X-ray diffraction (XRD), Fourier Transform IR Spectroscopy (FTIR), ^{1}H and ^{13}C NMR and some important properties like Thermal Properties. Scanning electron Microscopy (SEM) has been also done to study the compounds and characterization in more detail.

Solvent Purification

Common solvents like acetone, ethanol and 1,4 -dioxane was used at various stages of this work are purified according to standard procedure described in Weissenburg series [16] andin quantitative analysis by Vogel [17].

Melting / Decomposition temperature

The melting points were determined by placing a finely powdered sample in a glass capillary and heating by using digital melting point apparatus. Precoated silica aluminium plates of Merck were used for TLC. Melting points were determined routinely in an open capillary tube and are uncorrected. Formation of synthesized 1,3,5 triazine derivatives (heterocyclic derivatives) was checked by TLC on silica gel-G plates of 0.5 mm thickness. Laboratory solvents were purchased from a commercial supplier, from Amravati and Nagpur.

Step 1- Reaction of cyanuric chloride with N-Phenylthiourea

Chemical required

Cyanuric Chloride
N-phenylthiourea
Acetone

Method

3.682 gram of Cyanuric chloride and 3.04 gm of N-phenylthiourea are taken. Stirred it for 4 hr, in ice cold condition, maintain the temperature between 0-5^{0}C. Solvent used is acetone. The product (Product B1) obtained in this reaction is 1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea (Fig.1).

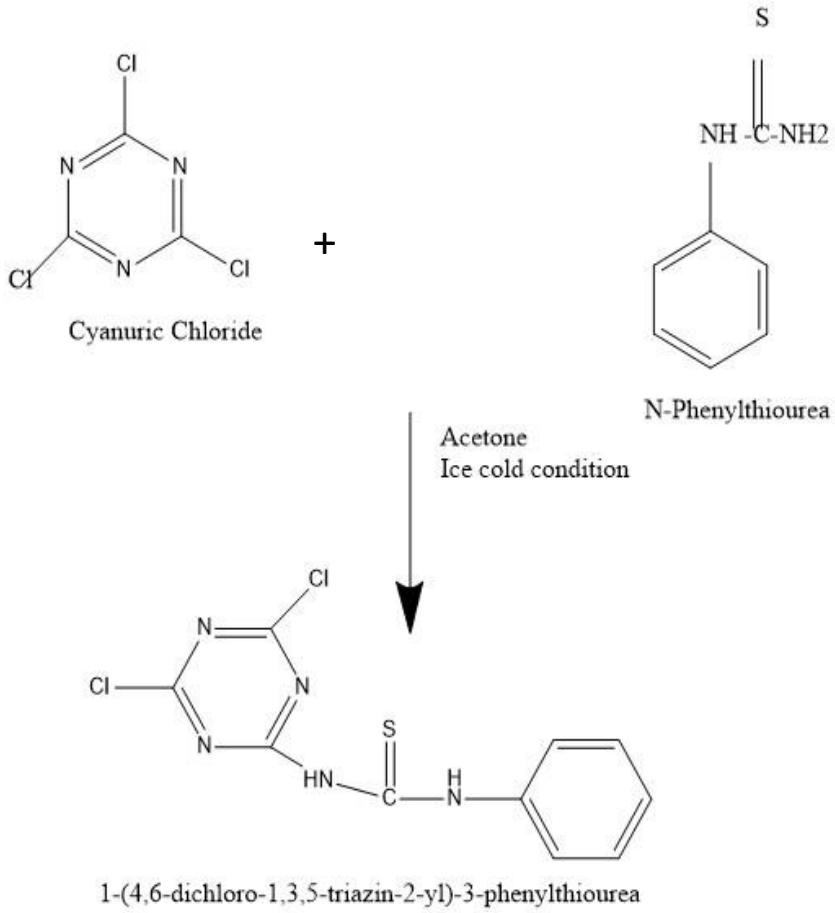


Figure 1: Synthesis of 1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea

Step 2- Reaction of 1-(4,6-dichloro-1,3,5-triazine-2-yl)-3-phenylthiourea (B1) with

N-phenylthiourea

Chemical required

1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea (B1)

N-phenylthiourea

Acetone

Method

1.45 gram of 1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea (B1) and 0.76 gm of N-phenylthiourea are taken. Stirred it for 2 hr, at room temperature. Solvent used is acetone. The product (Product B2) obtained in this reaction is 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (Fig.2).

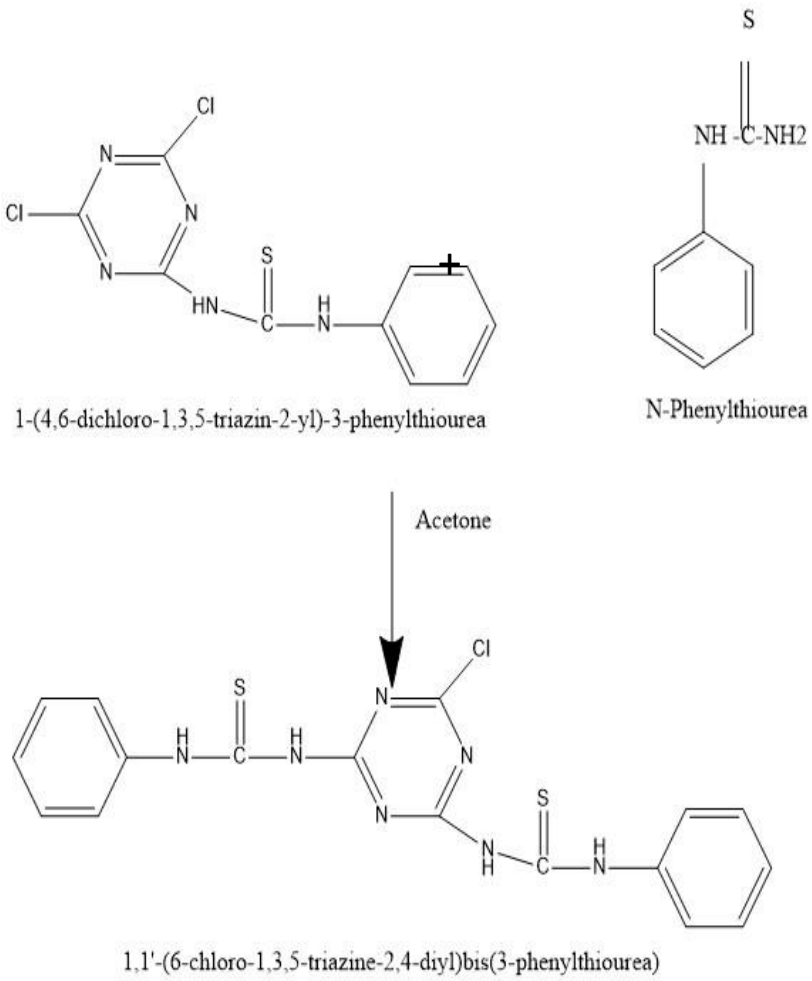


Figure 2: Synthesis of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Step 3- Reaction of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) with 4-nitroaniline

Chemical required

1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2)

4-nitroaniline

1,4-dioxane

Method

0.2075 gram of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) and 0.06 gm of 4-nitroaniline are taken. Reflux it for 3 hr. Solvent used is 1,4-dioxane. The product (Product B3a) obtained in this reaction is 1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (Fig.3).

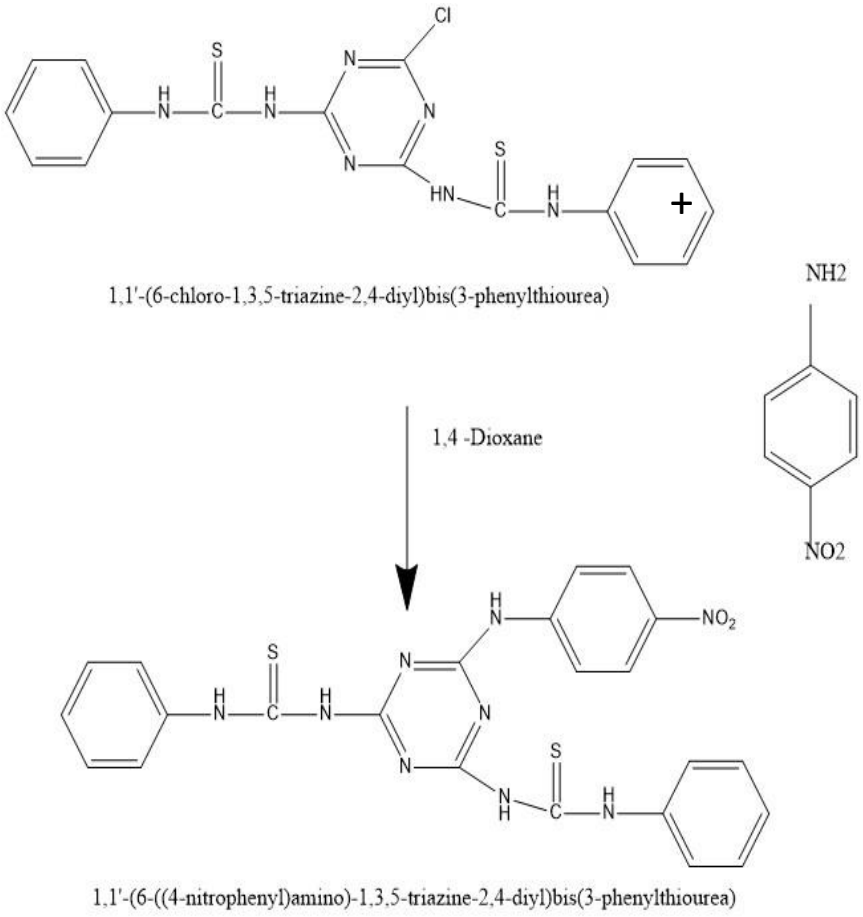


Figure 3: Synthesis of 1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Step 4- Reaction of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) with p-aminotoulidine

Chemical required

1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2)

p-aminotoulidine

1,4-dioxane

Method

0.2075 gram of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) and 0.0535 gm of p-aminotoulidine are taken. Reflux it for 3 hr. Solvent used is 1,4-dioxane. The product (Product B3b) obtained in this reaction is 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (Fig.9).

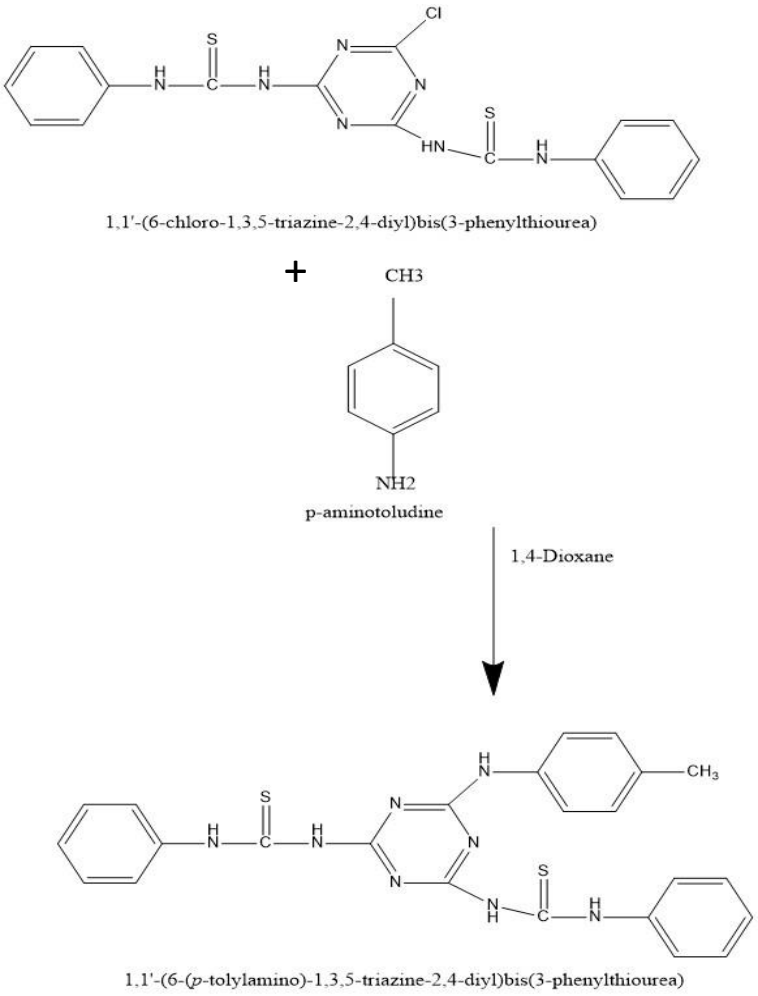


Figure 4: Synthesis of 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Step 5- Reaction of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) with 4-aminophenol

Chemical required

1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2)

4-aminophenol

1,4-dioxane

Method

0.2075 gram of 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (B2) and 0.0545 gm of 4-aminophenol are taken. Reflux it for 3 hr. Solvent used is 1,4-dioxane. The product (Product B3c) obtained in this reaction is 1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) (Fig.10).

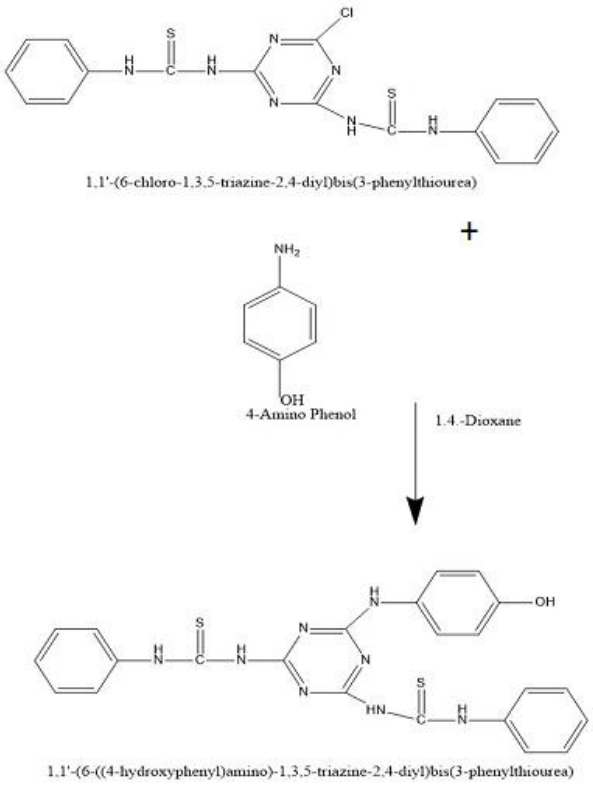


Figure 5: Synthesis of 1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Antimicrobial Evaluation of synthesized compounds

The antimicrobial evaluation of 1,3,5-Triazine derivatives against different bacterial pathogens were analyzed. To study the antimicrobial activities, organisms like *Staphalococcus aureus* (Gram positive Bacteria), *Diplococcus aureus* (Gram positive Bacteria), *Pseudomonas fluorescens* and *Escherichia coli* (Gram negative Bacteria) and fungal species; *Candida albicans* and *Trichophyton rubrum* were used.

3. Results and Discussion

Physical characterization, analytical Data

The triazine derivatives synthesized from Cyanuric Chloride were obtained in good yield. The analytical data and physical properties of synthesized compounds which are listed in Table 1.

Table 1: Physical Data of Newly synthesised s-triazine derivatives

Sr. No.	Compounds	Molecular Formula	Colour	Yield obtained	Melting Point
1.	B1	$C_{10}H_7N_5Cl_2S$	Dark Brown	75 %	250 ^{0}C
2.	B2	$C_{17}H_{14}N_7ClS_2$	Yellow	87%	255^{0}C
3.	B3a	$C_{23}H_{19}N_9S_2O_2$	White	81%	270^{0}C
4.	B3b	$C_{24}H_{22}N_8S_2$	White	77%	260^{0}C
5.	B3c	$C_{23}H_{20}N_8S_2O$	White	70%	265^{0}C

B1: 1-(4,6-dichloro-1,3,5-triazine-2-yl)-3-phenylthiourea

B2: 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

B3a: 1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

B3b: 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

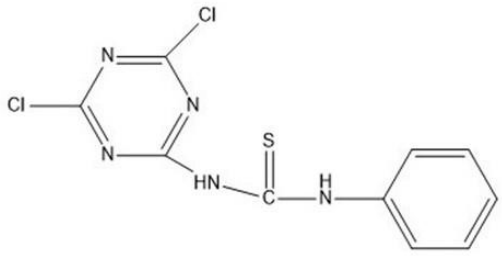
B3c: 1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Fourier Transform Infra Red Spectroscopy & NMR Spectroscopy

FTIR characterization newly synthesised compounds is found to be important for investigation of compounds structure that provides information about the complexation and interactions between the various constituents in the newly synthesised compounds. Each type of bond has a different natural frequency of vibration, so the identification of an absorption peak in the vibration portion of the infrared region will give a specific type of bonding. The FTIR spectra for newly synthesised compounds are shown in Figure 6 to Figure 10. FTIR Analysis details are as follows

B1: FT-IR(In cm^{-1}): 848.68 (C-Cl); 1639.49 (C=C); 1781.65 (C=N); 2048.40(C=S); 2867.76(C-H); 3278.09 (-NH), B2: FT-IR(In cm^{-1}): FT-IR(In cm^{-1}): 798.66 (C-Cl); 1587.90 (C=C); 1688.71 (C=N);2052.26(C=S); 3198.22 (C-H); 3177 .12 (-NH), B3a: FT-IR(In cm^{-1}): 1510.26 ($-NO_2$); 1543.05 (C=C); 1705.07(C=N); 3233.14(C-H);3213.41 (-NH),B3b: FT-IR(In cm^{-1}): `1419.61($-CH_3$attached to ring); 1543.05(C=C); 1649.14(C=N); 3126.61 (C-H); 3215.34 (-NH), B3c: FT-IR(In cm^{-1}): 1417.68 (C=C); 1649.14 (C=N); 3287.34(C-H); 3388.80 (-NH);3798.13(-OH)

In step 1 Cyanuric Chloride stirred with n-phenylthiourea in ice cold condition and we get 1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea (B1).



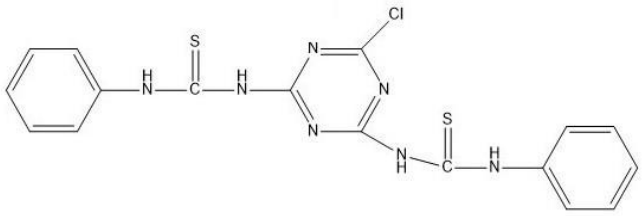
1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea

The 1 H-NMR of compound B1 in DMSO two proton of rings gives peak at 7.4137 ppm , another two proton from same ring gives 7.403 ppm , one proton from same ring gives peak at 7.3919 ppm , -NH attached to this ring gives singlet at 11.1543 ppm , another proton from -NH gives peak at 11.5906 ppm .

In 13CNMR four carbon from one ring gives peak at 120.71 ppm , one carbon from same ring gives peak at 121.00 ppm ,-NH attached carbon from same ring gives peak at 124.00 ppm , carbon attached to sulphur gives peak at 179.27 ppm , another ring contain three nitrogen and three carbon which gives peak at 147.82 ppm .

In IR carbon chlorine gives peak at 848.68 cm^{-1} , carbon double bond carbon gives peak at 1639.49 cm^{-1} , carbon double bond nitrogen gives peak at 1781.65 cm^{-1} , carbon double bond sulphur gives peak at 2048.40 cm^{-1} , carbon hydrogen gives peak at 2867.76 cm^{-1} , - NH gives peak 3278.09 cm^{-1}.

In second step when B1 react with N- phenylthiourea we get B2



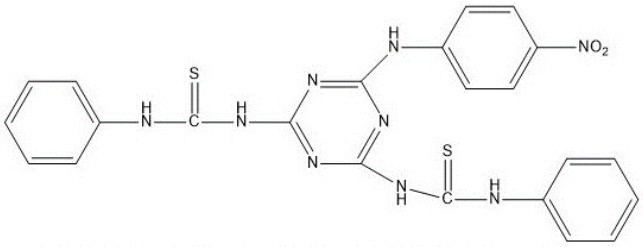
1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

In 1HNMR of B2 , two -NH attached to middle ring gives singlet at 12.3723 ppm , two -NH attached to two similar ring gives singlet at 11.1543 ppm , four proton from two rings just attached to -NH gives peaks at 7.4137 ppm , neighbouring four proton two from each ring gives value at 7.4058 ppm , two similar proton one from each ring gives value at 7.3919 ppm .

In 13CNMR OF B2 two carbon from middle ring attached to -NH gives value at 190.96 ppm , ring carbon attached to chlorine gives peak at 179.30 ppm , sulphur containing carbon gives peak at 147.85 ppm ,ring carbon from both the rings gives peak at 124.22 ppm , 124.15 ppm ,122.86 ppm , 122.43ppm .

In IR carbon chlorin gives peak at 798.66 cm^{-1}, carbon double bond carbon gives peak at 1587.90 cm^{-1}, carbon double bond nitrogen gives peak 1688.71 cm^{-1} , carbon double bond sulphur gives peak at 2052.26cm^{-1} , carbon hydrogen gives peak at 3198.22 cm^{-1}, -NH gives peak at 3177.12 cm^{-1}.

In third step B2 reflux with three different aromatic amines and we get three different product B3a, B3b and B3c.
In this step B2 is reflux with 4-nitroaniline and we get 1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) .



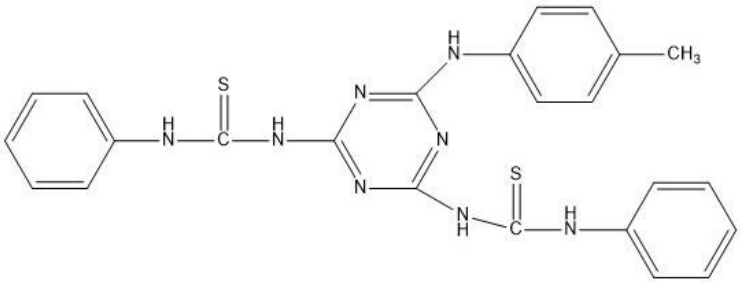
1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

In 1HNMR three proton of -NH attached to middle ring gives singlet at 11.1499ppm , another two proton from two -NH attached to two similar ring gives singlet at 10.7411ppm , four proton two from each ring gives peak at 7.3553ppm , neighbouring four proton two from each ring gives peak at 7.3394 ppm , two proton one from each ring gives peak at 7.1444ppm , in $-NO_2$ attached ring two proton directly attached to $-NO_2$ gives peak at 9.0173 ppm ,another two proton from same ring gives peak 7.5494ppm .

In 13CNMR $-NO_2$ attached carbon gives peak at 122.86 ppm , neighbouring two carbon gives peak at 122.43 ppm , neighbouring two carbon gives peak at 121.21 ppm , -NH attached ring carbon gives peak at 124.22 ppm , carbon attached to middle ring with nitrogen in double bond gives peak at 100.96 ppm , carbon double bond sulphur gives peak at 178.80 ppm , carbon from two similar rings gives peak at 128.48 ppm , 147.85 ppm ,149.92 ppm ,163.73 ppm .

In IR -NO2 gives peak at 1510.26 cm^{-1} , carbon double carbon gives peak at 1543.05 cm^{-1} , carbon double bond nitrogen gives peak at 1705.07 cm^{-1}, carbon hydrogen gives peak at 3233.14 cm^{-1} , -NH gives peak at 3213.41 cm^{-1}

Product B2b: In this step B2 reflux with p- amino toluidine and we get 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) .



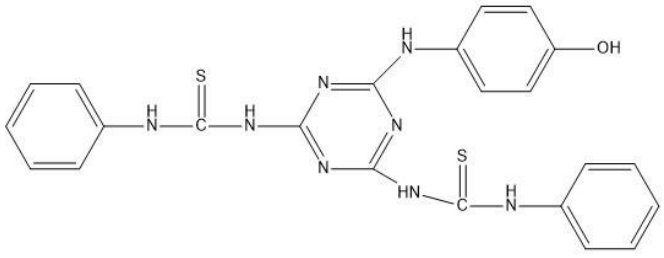
1,1'-(6-(*p*-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

In 1HNMR three proton of -NH attached to middle ring gives singlet at 11.4499ppm , another two proton from two -NH attached to two similar ring gives singlet at 10.7411ppm , four proton two from each ring gives peak at 7.3553ppm , neighbouring four proton two from each ring gives peak at 7.3553 ppm , two proton one from each ring gives peak at 7.1444ppm , in $-CH_3$ attached ring two proton directly attached to $-CH_3$ gives peak at 9.0173 ppm ,another two proton from same ring gives peak 7.5494ppm . Three $-CH_3$ proton gives singlet at 2.7352 ppm .

In 13CNMR $-CH_3$ attached carbon gives peak at 122.86 ppm , neighbouring two carbon gives peak at 122.43 ppm , neighbouring Two carbon gives peak at 124.15 ppm , -NH attached ring carbon gives peak at 124.22 ppm , carbon attached to middle ring with nitrogen in double bond gives peak at 100.96 ppm , carbon double bond sulphur gives peak at 178.30 ppm , carbon from two similar rings gives peak at 129.71 ppm , 129.60 ppm ,139.00 ppm ,163.73 ppm , $-CH_3$ carbon gives peak at 28.92 ppm .

In IR $-CH_3$ attached to ring gives peak at 1419.61 cm^{-1}, carbon double carbon gives peak at 1543.05 cm^{-1} , carbon double bond nitrogen gives 1649.14 cm^{-1} , carbon hydrogen gives peak at 3126.61 cm^{-1}, -NH gives peak at 3215.34 cm^{-1}.

Product B3c: In this reaction B2 is reflux with 4-amino Phenol and we get 1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea) .



1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

In 1HNMR three proton of -NH attached to middle ring gives singlet at 11.1498ppm , another two proton from two -NH attached to two similar ring gives singlet at 10.7411ppm , four proton two from each ring gives peak at 7.3553ppm , neighbouring four proton two from each ring gives peak at 7.3394 ppm ,two proton one from each ring gives peak at 7.1444ppm , in -OH attached ring two proton directly attached to -OH gives peak at 9.0173 ppm ,another two proton from same ring gives peak 7.7549ppm . -OH proton gives singlet at 9.785 ppm.

In 13CNMR -OH attached carbon gives peak at 122.86 ppm , neighbouring two carbon gives peak at 122.43 ppm , neighbouring Two carbon gives peak at 124.15 ppm , -NH attached ring carbon gives peak at 124.22 ppm , carbon attached to middle ring with nitrogen in double bond gives peak at 100.96 ppm , carbon double bond sulphur gives peak at 170.00 ppm , carbon from two similar rings gives peak at 139.53 ppm , 154.12ppm ,163.73 ppm .

In IR carbon double bond carbon gives peak at 1417.68 cm^{-1}, carbon double bond nitrogen gives peak at 1649.14 cm^{-1}, carbon hydrogen gives peak at 3287.34 cm^{-1}, -NH gives peak at 3388.80 cm^{-1} , -OH gives peak at 3798.13 cm^{-1}.

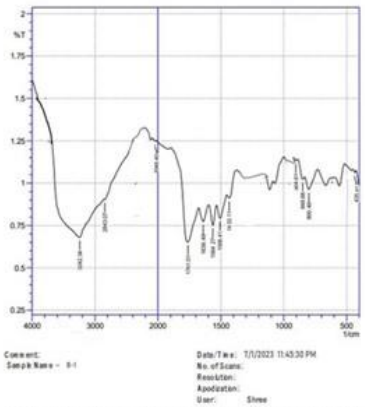


Figure 6: FTIR of B1: 1-(4,6-dichloro-1,3,5-triazine-2-yl)-3-phenylthiourea

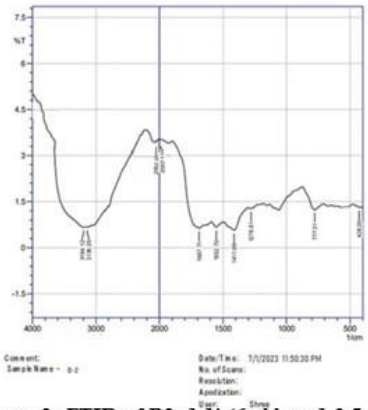


Figure 2: FTIR of B2: 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

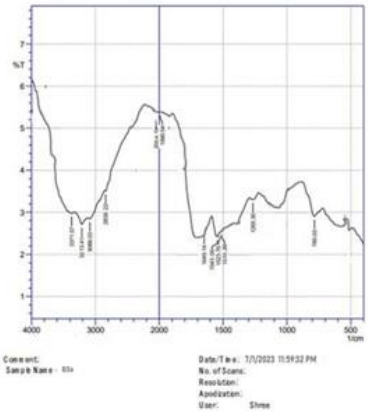


Figure 8: FTIR of B3a: 1,1'-(6-((4-nitrophenyl) amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

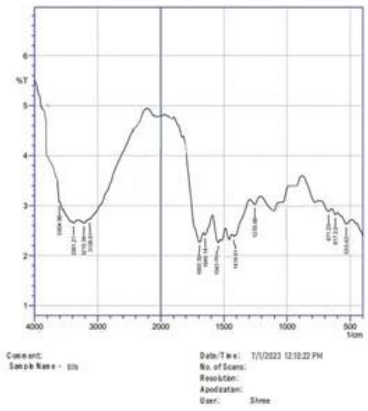


Figure 9: FTIR of B3b: 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

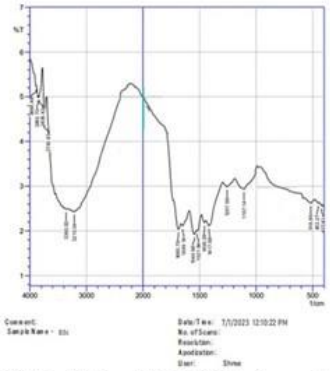


Figure 10: FTIR of B3c: 1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

Figure 12: XRD Graph of synthesized 1,3,5-Triazine Derivatives

Scanning Electron Microscopy (SEM)

To perform a visual analysis of a surface using scanning electron microscopy contributes to the identification of contaminates or unknown particles , the cause of failure and interactions between materials. In addition to surface evaluation, SEM analysis was utilized for particle characterization , such as wear debris generated during mechanical wear testing. The number, size, and morphology of small particles has been analyzed by using SEM which allowed to understand the wear properties of their material. SEM analysis for all the synthesized compounds has been done (Fig.11)

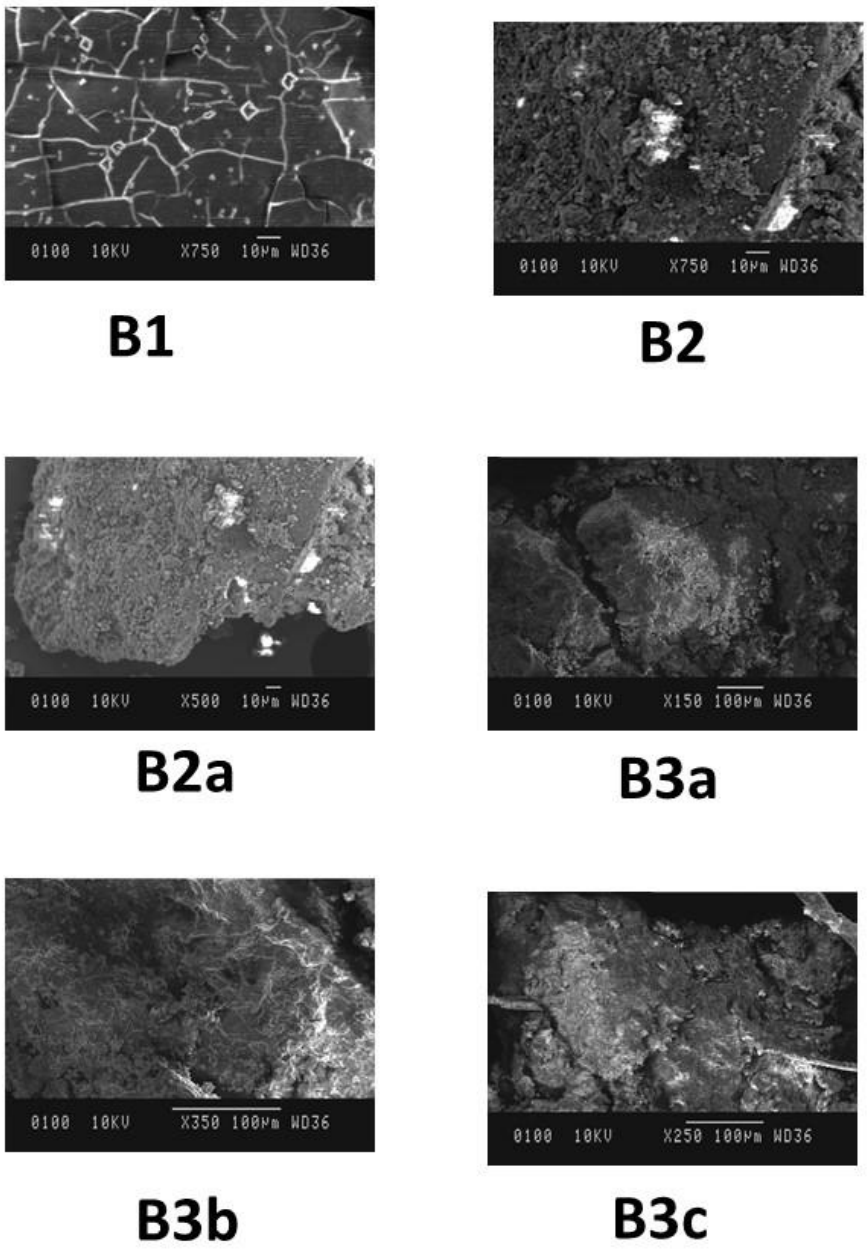


Figure 11: SEM of synthesized s-Triazine derivatives

X-Ray Diffraction (XRD)

The XRD profiles of synthesised 1,3,5-Triazine derivatives were recorded and shown in Figure 12.

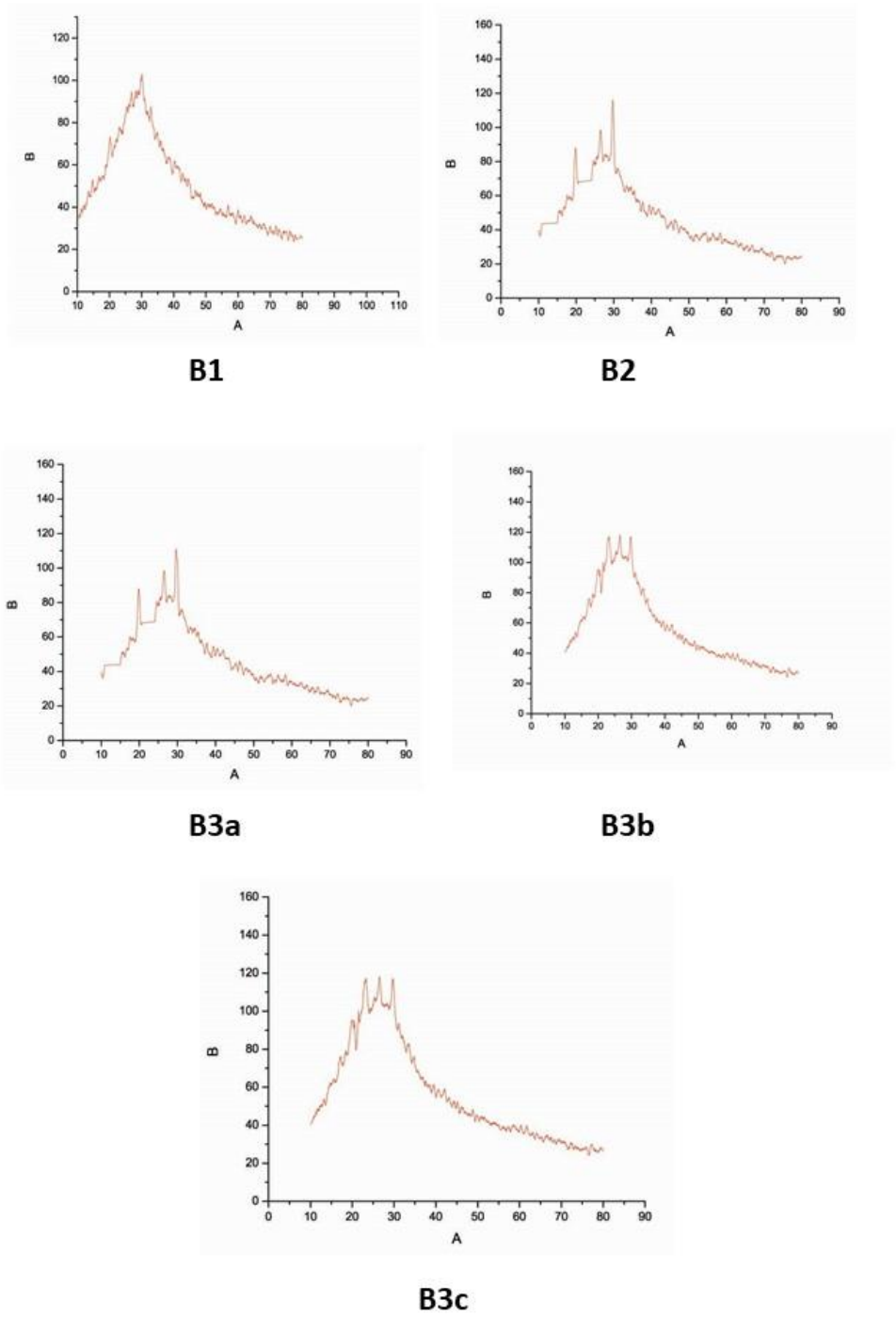


Figure 12: XRD profile of synthesized 1,3,5-Triazine derivatives

4.4 Antimicrobial sensitivity (properties) test of synthesized 1,3,5-Triazine derivatives against Bacteria, Fungus

The antibacterial, antifungal and antiviral (anticovid) effects of Newly synthesized 1,3,5-Triazine derivatives i.e. B1, B2, B3a, B3b and B3c has been also done (Table 2, Figure 13, Figure 14, Figure 15). On the basis of result/ antimicrobial testing, it is noted that all newly synthesized 1,3,5-Triazine derivatives i.e. B1, B2, B3a, B3b and B3c found to be Antimicrobial against *Staphalococcus aureus* (Gram posititive Bacteria) with zone of inhibitions 16 mm, 12 mm, 11 mm, 12 mm and 13 mm respectively (Table 4.3, Figure 13). No compound has shown antibacterial activity against a Gram positive Bacteria; *Diplococcus aureus* (Table 2, Figure 13).

On the basis of result/ antimicrobial testing, it is again noted that the Compound B1, B2 and B3c found to be Antibacterial against *Escherichia coli* (Gram negative Bacteria) with zone of inhibitions 16 mm, 12 mm and 11 mm respectively. Only B2 compound shown antibacterial effect against *Pseudomonas fluorescens* (Gram negative Bacteria) with zone of inhibition 11 mm. (Table 2, Figure 14).

The antifungal activity (testing) of newly synthesized 1,3,5-Triazine derivatives B1, B2, B3a, B3b and B3c has been also done. It has been found that compound B1 and B3b shows antifungal activity against Fungal species; *Candida albicans* with zone of inhibition 11 mm and 12 mm respectively. Compounds B1 and B2 shows antifungal activity against Fungal species; *Trichophyton rubrum* with zone of inhibition 12 mm and 11 mm respectively (Table 2, Figure 15).

Table 2: Antimicrobial sensitivity (properties) test of synthesized 1,3,5-Triazine derivatives (Scheme 2) against Bacteria, Fungus (After 24 Hrs at 37^0C temp). and Fungus at room temp. Zone of inhibition in mm

Test Compound	GM +VE BACTERIA		GM -VE BACTERIA		FUNGUS		Virus
	Staphalococcus aureus	*Diplococcus pneumonae*	*Escherichia coli*	*Pseudomonas fluorescens*	*Candida albicans*	*Trichophyton rubrum*	*Covid*
B1	16 mm	-----	11 mm	-----	11 mm	12 mm	14 mm
B2	12 mm	-----	12 mm	11 mm	-----	11 mm	12 mm
B3a	11 mm	-----	-----	-----	-----	-----	-----
B3b	12 mm	-----	-----	-----	12 mm	-----	-----
B3c	13 mm	-----	11 mm	-----	-----	-----	11 mm
Standard Ofloxacin (2 mcg) For Bacteria & Cotrimoxazole (25mcg) for Fungus and Doxycycline for Virus	20 mm	-----	11 mm	22 mm	11 mm	11 mm	12 mm

B1: 1-(4,6-dichloro-1,3,5-triazin-2-yl)-3-phenylthiourea

B2: 1,1'-(6-chloro-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

B3a: 1,1'-(6-((4-nitrophenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

B3b: 1,1'-(6-(p-tolylamino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

B3c:1,1'-(6-((4-hydroxyphenyl)amino)-1,3,5-triazine-2,4-diyl)bis(3-phenylthiourea)

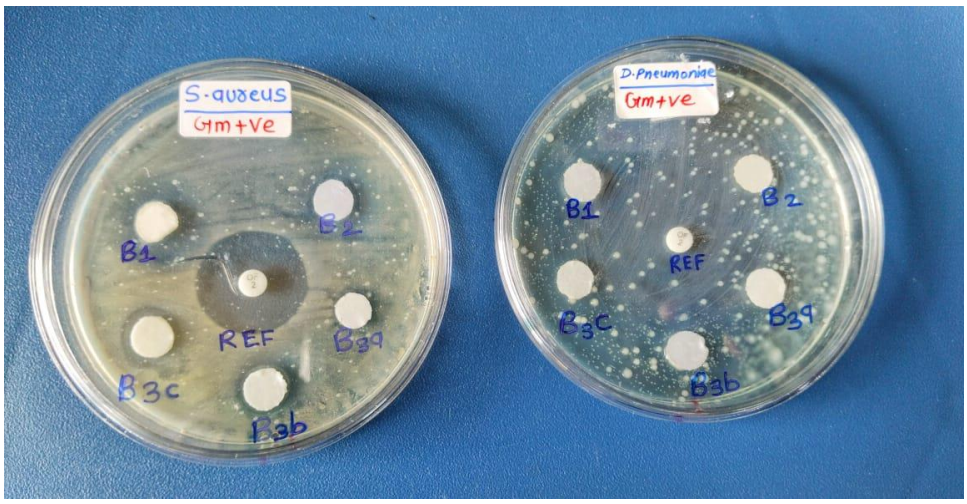


Figure 13: Plates showing Antibacterial (Gram + ve Bacteria) Sensitivity Test (properties) of synthesized 1,3,5-Triazine derivatives (Scheme 2)

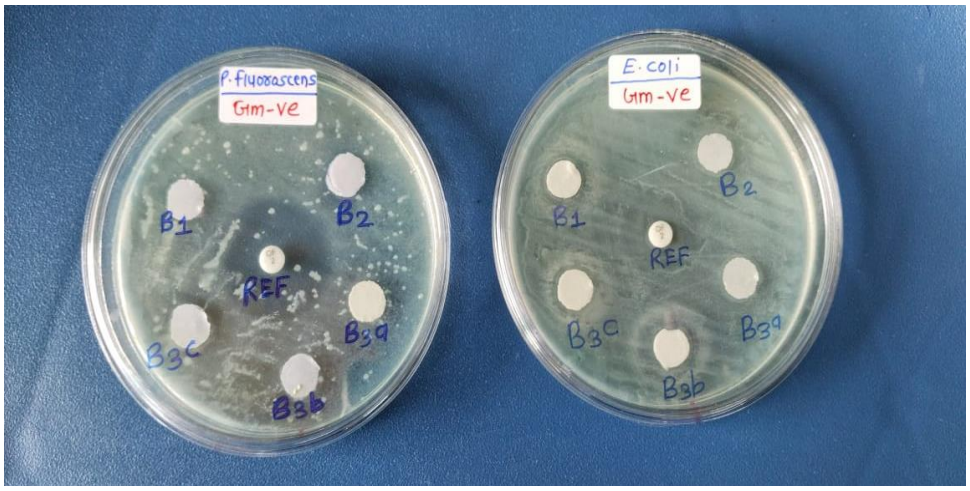


Figure 14: Plates showing Antibacterial (Gram - ve Bacteria) Sensitivity Test (properties) of synthesized 1,3,5-Triazine derivatives (Scheme 2)

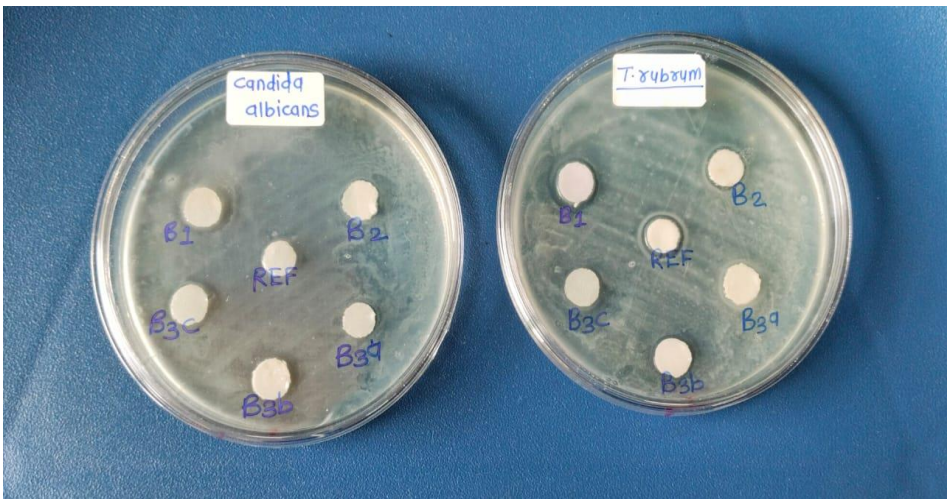


Figure 15: Plates showing Antifungal Sensitivity Test (properties) of synthesized 1,3,5-Triazine derivatives (Scheme 2)

Conflicts of interest: The author stated that no conflicts of interest.

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