ScienSage

Journal of Advanced Scientific Research

Available online through http://www.sciensage.info

ISSN
0976-9595
Research Article

SYNTHESIS, POLAROGRAPHIC AND ANTIMICROBIAL STUDIES OF BENZISOXAZOLYL-*N*-GLUCOSIDES

Rajendra K. Wanare*[1], Yogesh V. Punatkar[2], Ravin M. Jugade[2]

[1]*Department of Chemistry, Jawaharlal Nehru College, Wadi, Nagpur, India*

[2]*Department of Chemistry, Mahatma Jyotiba Phule, Educational Campus, Rashtrasant Tukadoji Maharaj, Nagpur University, Nagpur, India*

**Corresponding author:rajwanare@rediffmail.com*

ABSTRACT

The desired compounds 7-amino-3-methyl-5-(3′-aryl prop-2′-enoyl)-1,2-benzisoxazoles **2a-j** were prepared by the reaction of appropriate 5-acetyl-7-amino-3-methyl-1,2-benzisoxazole **1** with different aromatic aldehydes. The reaction of (**2a-j**) with hydroxylamine hydrochloride was done to form 7-amino-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**3a-**j). Condensation of tetra-*O*-acetyl-α-D-glucopyranosyl bromide (TAGBr) with 7-amino-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles furnishes 7-amino-(β-D-2,3,4,6-tetra-*O*-acetyl glucopyranosyl)-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**4a-j**) which on deprotection yielded 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**5a-j**). The identities of newly synthesized compounds were established on the basis of IR, ^{1}HNMR, ^{13}CNMR, Mass spectral, Elemental analysis, TLC, and Polarographic studies. All compounds have been evaluated for antimicrobial activities and some compounds show potent activities.

Keywords:1,2-Benzisoxazole, Amino compounds, *N*-Glucosides, Polarography.

1. INTRODUCTION

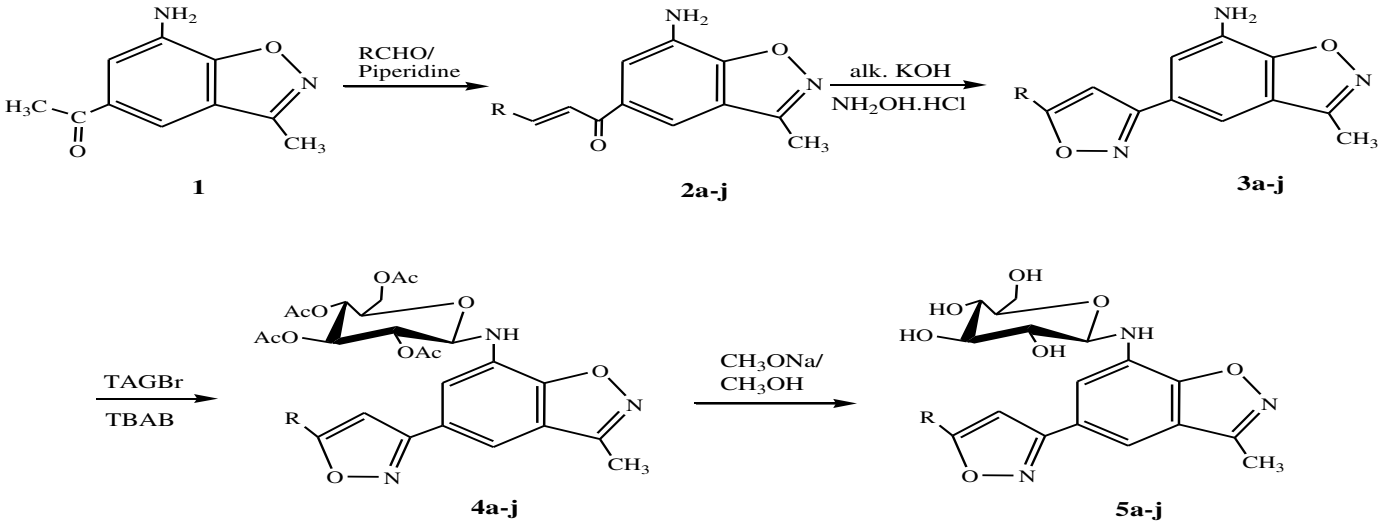
The study of heterocycles is an evergreen field in the branch of organic chemistry and always attracts the attention of scientists working not only in the area of natural products but also in the synthetic organic chemistry. Heterocyclic compounds play an important role in the metabolism of living organism due to their pharmacologically active heterocyclic ring. Heterocyclic ring exhibited chemotherapeutic, antituberculosis and other medicinal uses. Heterocyclic compounds isoxazole, pyrazoles, furans, pyrroles, thiazines, oxazines etc. exhibit diverse pharmacological activities such as anti-fungal, anti-bacterial, antiviral, anti-inflammatory, herbicidal, anticancer, cytotoxic, anaesthetics, and insecticidal [1-10]. Among the wide variety of heterocyclic compounds, isoxazoles are pharmaceutically important molecules and show therapeutic values in the field of medicinal chemistry. Isoxazoles are reported as potent anti-tuberculosis, anti-microbial and antihelmintic agents. Benzisoxazoles are important class of heterocyclic compounds in the field of drugs and widely used as analgesic, anticonvulsant**,** antipsychotic and antimicrobial agents [11-15]. They are present in large number of pharmaceutically important products with antitumor, antithrombotic and cholinesterase-inhibiting properties [16, 17]. 1,2-Benzisoxazole derivatives have been found to possess antidepressant, hypotensive, selective inhibitors of the enzyme acetyl cholinesterase, and evaluated as a potential antipsychotic D2/5-HT2 antagonists activities [18, 19]. Chalcones considered as precursors of flavonoids and isoflavonoids, are widely present in edible plants. The presence of α, β-keto functional group in chalcone is responsible for antimicrobial activities. Many chalcones exhibit diverse pharmacological activities like cytotoxic, anti-microbial, anti-viral, anti-inflammatory and anaesthetic properties [20-23]. Glucosylation plays an important role in various biological processes such as modification of protein, molecular recognition and immune responses. Addition of carbohydrates in synthetic drugs leads to formation of new hybrid molecule. High level of glucosylation imparts molecular changes that accompany malignant transformations which is a characteristic of cancer cells

[24, 25]. Glucosylation improves the solubility of various drugs without affecting their activities and attaching of the glucosidic moiety into the molecules which increases its hydrophilicity than respective aglycon. β-Glucosylation can improve the drug targeting to the cells due to their solubility in the membrane components. *N*-glucosylated heterocyclic compounds show biological and pharmacological activities [26]. The screening results indicate that glucosides showed moderate to excellent antibacterial activities against *E. coli* and *S. aureus* and antifungal activity against *C. albicans* and *A. niger* as compared to aglycon [27].

In the view of pronounced biological and pharmacological applications, it was planned to synthesize new chemical entities having active pharmacological functions namely benzisoxazoles, amine, isoxazoles and their *N*-glucosides moiety in a single molecular framework as new biological active compounds.

2. EXPERIMENTAL

Melting points were determined on a melting point apparatus in open capillaries and are uncorrected. IR spectra were recorded on Bruker infrared spectrometer, ^{1}HNMR, ^{13}CNMR spectra on Bruker Avance II 400 NMR spectrometer and MS spectra were recorded and polarograms were recorded on Elico CL-362 polarograph.



R= a) C_6H_5 e) 4-OHC_6H_4 i) 4-$CH_3OC_6H_4$
b) 4-ClC_6H_4 f) 2-OHC_6H_4 j) 6-$CH_3OC_6H_4$
c) 2-$NO_2C_6H_4$ g) 2-C_4H_3O
d) 4-$NO_2C_6H_4$ h) 2-$CH_3OC_6H_4$

Scheme: Synthesis of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles

2.1. Synthesis of 5-acetyl-7-amino-3-methyl-1,2-benzisoxazole (1)

It has been prepared by using starting compound *p*-hydroxyacetophenone followed by several steps as per reported literature [28]. (Yield 12.3g, 64.73%), m.p. 136°C.

IR:υ_{max}cm^{-1}:3323 (-NH_2), 3261 (-NH_2), 3054-2885 (C-H str. in benzene), 1637 (C=O), 1615 (bend N-H), 1568 (C=N). ^{1}H-NMR:The ^{1}H-NMR spectrum displayed signals at δ8.39-8.36 (t, 1H, Ar-H), δ8.18-8.11 (t, 1H, Ar-H), δ4.24 (s, 2H, -NH_2), δ2.64 (s, 3H, CH_3), δ2.56 (s, 3H, CH_3). ^{13}C-NMR:^{13}C-NMR spectrum displayed signals δ185.06 (C=O), δ161.78 (C-3a), δ149.50 (C-3), δ135.33 (C-5), δ131.53 (C-6), δ124.80 (C-4), δ120.93 (C-7a), δ108.10 (C-7), δ26.85 (CH_3), δ19.79 (CH_3). FAB-MS:The FAB-MS confirmed the molecular formula $C_{10}H_{10}N_2O_2$. It shows molecular ion peak at m/z 190.1 $[C_{10}H_{10}N_2O_2]^+$. The base peak appear at m/z 177.5 $[C_{10}H_{10}O_3]^+$.

2.2. Synthesis of 7-amino-3-methyl-5-(3′-phenyl prop-2′-enoyl)-1,2-benzisoxazole (2a)

The equimolar amount of 5-acetyl-7-amino-3-methyl-1,2-benzisoxazole (0.01M) and benzaldehyde (0.01M) were added in ethyl alcohol (25 mL) and few drops of piperidine. The reaction mixture was condensed foe

40min and cooled to 0°C, yellow solid compound formed was washed with water. (Yield 2.10g, 75.50%), m.p. 92°C and its alcoholic solution turned red with alkali and decolourised with bromine water and it gave dark red colour with conc. H_2SO_4. By following the same procedure, other chalcones 7-amino-3-methyl-5-(3′-aryl prop-2′-enoyl)-1,2-benzisoxazoles (**2b-j**) were prepared.

2.3. Synthesis of 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole (3a)

A mixture of 7-amino-3-methyl-5-(3′-phenyl prop-2′-enoyl)-1,2-benzisoxazole (2.78g, 0.01M), hydroxylamine hydrochloride (0.7g), ethyl alcohol (15mL) and KOH (0.4g) was refluxed on water bath for 4hr. It was cooled and acidified with glacial acetic acid (1.5mL) and was poured on ice-cold water (50mL), dried and crystallised with aqueous alcohol. (Yield 65.6%), m.p. 72°C. It did not give dark red colour with conc. H_2SO_4. IR:$\upsilon_{max}cm^{-1}$:3243 (-NH_2), 3064-2849 (C-H str. In benzene), 1693 (C=N stretching vibration aromatic). ^{1}H-NMR:The ^{1}H-NMR spectrum displayed signals at δ8.40-6.97 (7H, m, Ar-H), δ6.44 (s, 1H, Isoxazole ring), δ4.74 (s, 2H, NH_2), δ2.62 (s, 3H, CH_3). ^{13}C-NMR:The ^{13}C-NMR spectrum displayed signals δ166.68 (Isoxazole), δ164.1(Isoxazole), δ155.3 (C-3), δ148.1 (C-3a), δ135.9 (C-5), δ131.1(C-1′), δ130.9 (C-3′), δ128.2 (C-5′), δ128.0 (C-4′), δ126.6 (C-7), δ 125.9 (C-2′), δ123.9 (C-6′), δ122.1 (C-7a), δ113.1 (C-6), δ109.1 (C-4), δ102.4 (Isoxazole), δ18.51(CH_3). FAB-MS:FAB-MS confirmed the molecular formula $C_{17}H_{13}N_3O_2$. It shows molecular ion peak at m/z 292.8 $[C_{17}H_{13}N_3O_2]^+$. The base peak appear at m/z 133.8 $[C_8H_7NO]^+$. Following the above procedure, other 7-amino-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**3b-j**) were prepared. The characterization data of these compounds are summarised in Table 1.

Table 1; Characterization data of 7-amino-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (3a-j)

Comp	R	Molecular formula	Mol. Wt.	MP °C	Yield (%)	Calculated (Found) %		
						C	H	N
3a	C_6H_5	$C_{17}H_{13}N_3O_2$	291.1	128	64	70.09 (70.18)	4.50 (5.00)	14.42 (14.75)
3b	4-ClC_6H_4	$C_{17}H_{12}ClN_3O_2$	325.0	116	53	65.68 (65.35)	3.71 (4.11)	12.90 (13.45)
3c	2-$NO_2C_6H_4$	$C_{17}H_{12}N_4O_4$	336.0	136	48	60.71 (61.30)	3.60 (3.50)	16.66 (17.00)
3d	4-$NO_2C_6H_4$	$C_{17}H_{12}N_4O_4$	323.3	104	58	60.71 (60.65)	3.60 (3.68)	16.66 (16.35)
3e	4-OHC_6H_4	$C_{17}H_{13}N_3O_3$	307.1	146	52	66.44 (67.25)	4.26 (4.36)	13.67 (12.36)
3f	2-OHC_6H_4	$C_{17}H_{13}N_3O_3$	307.1	156	62	66.44 (66.80)	4.26 (4.55)	13.67 (12.56)
3g	2-C_4H_3O	$C_{15}H_{11}N_3O_3$	281.0	168	60	64.05 (64.52)	3.94 (4.58)	14.94 (16.00)
3h	2-$CH_3OC_6H_4$	$C_{18}H_{15}N_3O_3$	321.1	102	59	67.28 (68.25)	4.71 (4.24)	13.08 (14.63)
3i	4-$CH_3OC_6H_4$	$C_{18}H_{15}N_3O_3$	321.1	118	47	67.28 (66.52)	4.71 (5.30)	13.08 (12.65)
3j	6-$CH_3OC_6H_4$	$C_{18}H_{15}N_3O_3$	321.1	138	51	67.28 (68.21)	4.71 (4.80)	13.08 (14.20)

2.4. 2,3,4,6-Tetra-*O*-acetyl-α-D-glucopyranosyl bromide (TAGBr) or Glucosyl donor or α-Acetobromoglucose (ACBG)

The powdered glucose pent-acetate (21.6g) was added gradually in several instalments to the brominating agent (30mL). After the addition, the contents of the flask were kept at room temperature for 2hr. The reaction mixture was then mixed with chloroform and was shaken vigorously for 15min. It was poured on to ice cold distilled water. The chloroform layer was separated. It was washed several times with sodium bicarbonate solution to remove excess of bromine and finally 2-3 times with distilled water. The chloroform was dried over anhydrous calcium chloride. Afterword, the solvent was removed through vacuum distillation when a solid 2,3,4,6-tetra-*O*-acetyl-α-D-glucopyranosyl bromide was obtained, (yield 14.5 g, 67 %).

2.5. Synthesis of 7-amino-(β-D-glucopyranosyl) -3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazoles (5a)

It was prepared from 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole (2.91g, 0.01M) refluxed with tetra-*O*-acetyl glucuropyranosyl bromide (3.0g, 0.01M) in presence of tetra butyl ammonium bromide (PTC) using dichloromethane as a solvent. The deprotection of above obtained compound 7-amino-(β-D-2,3,4,6-tetra-*O*-acetyl glucopyranosyl)-3-methyl-5-

(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole (**4a**) was done by sodium methoxide in methanol and filtered from ion exchange resin (Amberlite IR 120, H^+, cation exchanger) to get target molecules (**5a**).

IR:υ_{max}cm^{-1}:3399 (str. OH), 3059 (NH), 2938 (str Ar-H), 1634 (C=N). ^{1}H-NMR:δ8.18-7.56 (m, 7H, Ar-H), δ6.83 (s, 1H, Isoxazole), δ5.57-5.53 (m, 1H in glucose), δ5.29 (s, 1H, NH), δ3.91-2.93 (m, 6H, glucose), δ2.60 (s, 3H, CH_3). Signals due to hydroxyl protons of the carbohydrate were not observed because of fast exchange of non-hydrogen bonded -OH groups and the acidic phenolic functions. ^{13}C-NMR:δ170.0 (Isoxazole), δ165.3 (Isoxazole), δ155.7 (C-3), δ148.8 (C-3a), δ131.6 (C-5), δ129.6 (C-1′), δ129.1 (C-3′), δ128.9 (C-5′), δ126.8 (C-4′), δ126.2 (C-7), δ 125.8 (C-2′), δ125.0 (C-6′), δ122.7 (C-7a), δ113.3 (C-6), δ109.9 (C-4), δ99.1 (Isoxazole), δ89.20 (glucose C-1″), δ83.45 (glucose C-5″), δ80.02 (glucose C-3″), δ74.63 (glucose C-4″), δ65.71 (glucose C-2″), δ61.45 (glucose C-6″), δ15.04 (CH_3). FAB-MS:FAB-MS confirmed the molecular formula $C_{23}H_{23}N_3O_7$. It shows molecular ion peak at m/z 452.7 $[C_{23}H_{23}N_3O_7]^+$. The base peak appear at m/z 291.2 $[C_{17}H_{13}N_3O_2]^+$ [29, 30].

By using above procedure, other *N*-glucosides 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**5b-j**) were prepared. The characterization data of these compounds are summarized in Table 2.

Table 2: Characterization data of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-arylisoxazol-5′-yl)-1,2-benzisoxazoles (5a-j)

Comp	R	Molecular formula	Mol. Wt.	$[\alpha]_D$ (°)	Calculated (Found) %		
					C	H	N
5a	C_6H_5	$C_{23}H_{23}N_3O_7$	453.1	+48.2	60.92 (61.90)	5.11 (5.46)	9.27 (7.95)
5b	4-ClC_6H_4	$C_{23}H_{22}ClN_3O_7$	487.1	+46.2	56.62 (58.60)	4.55 (4.75)	8.61 (8.20)
5c	2-$NO_2C_6H_4$	$C_{23}H_{22}N_4O_9$	498.1	+40.4	55.42 (55.80)	4.45 (4.90)	11.24 (11.90)
5d	4-$NO_2C_6H_4$	$C_{23}H_{22}N_4O_9$	498.1	+42.8	55.42 (54.98)	4.45 (4.86)	11.24 (12.36)
5e	4-OHC_6H_4	$C_{23}H_{24}N_2O_8$	469.1	+38.7	58.85 (59.32)	4.94 (5.36)	8.95 (9.57)
5f	2-OHC_6H_4	$C_{23}H_{24}N_2O_8$	469.1	+40.9	58.85 (59.55)	4.94 (4.80)	8.95 (9.00)
5g	2-C_4H_3O	$C_{21}H_{21}N_3O_8$	443.1	+32.6	56.88 (58.60)	4.77 (5.01)	9.48 (8.75)
5h	2-$CH_3OC_6H_4$	$C_{24}H_{25}N_3O_8$	483.1	+44.0	59.62 (60.25)	5.21 (5.76)	8.69 (7.98)
5i	4-$CH_3OC_6H_4$	$C_{24}H_{25}N_3O_8$	483.1	+51.1	59.62 (60.25)	5.21 (5.12)	8.69 (9.00)
5j	6-$CH_3OC_6H_4$	$C_{24}H_{25}N_3O_8$	483.1	+45.3	59.62 (59.21)	5.21 (5.65)	8.69 (9.24)

2.6. Antimicrobial Activity

The compounds **5a-j** were screened for their antibacterial activity against *Escherichia coli* and *Staphylococcus aureus* by disc diffusion method. The standard Ciprofloxacin was used for the comparison of results.

3. RESULTS AND DISCUSSIONS

The obtained compound 5-acetyl-7-amino-3-methyl-1,2-benzisoxazole **1** was confirmed by IR spectra and shown two peaks at 3359 cm^{-1} and 3253 cm^{-1}, ^{1}HNMR spectra indicates the peak of two protons at δ4.24 ppm and MS shows molecular ion peak at m/z 190. The compound 7-amino-3-methyl-5-(3′-phenyl prop-2′-enoyl)-1,2-benzisoxazole showed IR spectrum absorption band at 1734 cm^{-1} for >C=O group in chalcone. In ^{13}CNMR spectra two peaks observed at δ141ppm and δ123ppm for ethylenic (-CH) and for >C=O the peak appears at δ198ppm. The obtained compound 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole observed the molecular ion peak in MS at m/z 292.8. After glucosylation obtained target molecule 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazoles showed IR spectra strong band in the range of 3399 cm^{-1} due to glucosyl-OH [31-33]. The ^{1}HNMR spectra show a multiplet due to the glucosyl ring protons in the ranges of δ3.91-2.93 ppm and the doublet of anomeric proton of the glucose moiety within the region of δ5.57-5.53 ppm. The aromatic proton appears in the region δ8.18-7.56 ppm. The ^{13}CNMR spectra show the signal for β-anomeric carbon is observed at δ89.20 ppm.

3.1. Antimicrobial Activity

The screening result showed the entire compound active against both the bacteria tested at concentration of 800μg/mL. Compounds **5d-j** were active and **5a-c** showed moderately active against bacteria *E. coli* and

5b, 5e, 5h and **5j** were active and **5a, 5c-d, 5f** and **5i** showed less activity against bacteria *S. aureus*. Similarly, antifungal screening of compounds **5a-j** were carried out against two fungi viz., *Candida albicans* and *Aspergillus niger* adopting the disc diffusion method. The comparison of results was done by using clotrimazole as a standard. The compounds **5a-h** and **5j** were active and **5i** was less active against fungi *C. albicans*. The compounds **5b-c, 5f-h** were active and **5a, 5d-e** and **5i-j** were moderately active against *A. niger* at concentration of 800µg/mL. The antimicrobial activity data of these compounds are shown in Table 3.

3.2. Polarographic Studies

Polarographic studies of 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole and 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole were carried out using Elico CL-362 polarograph based on microprocessor operation. The electrode system consisted of dropping mercury electrode as working electrode, platinum wire as auxiliary electrode and saturated calomel electrode as reference electrode. The supporting electrolyte used was 0.1M KCl solution. The supporting electrolyte solution was deareated with nitrogen for 15min and polarograms were recorded in diffusion current (DC) and differential pulse polarogram (DPP) modes. To this solution, various concentrations of ethanolic solutions of 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole were added and polarograms were recorded for each addition. The DC polarograms have been shown in fig. 1a while DP polarograms have been shown in fig. 1b.

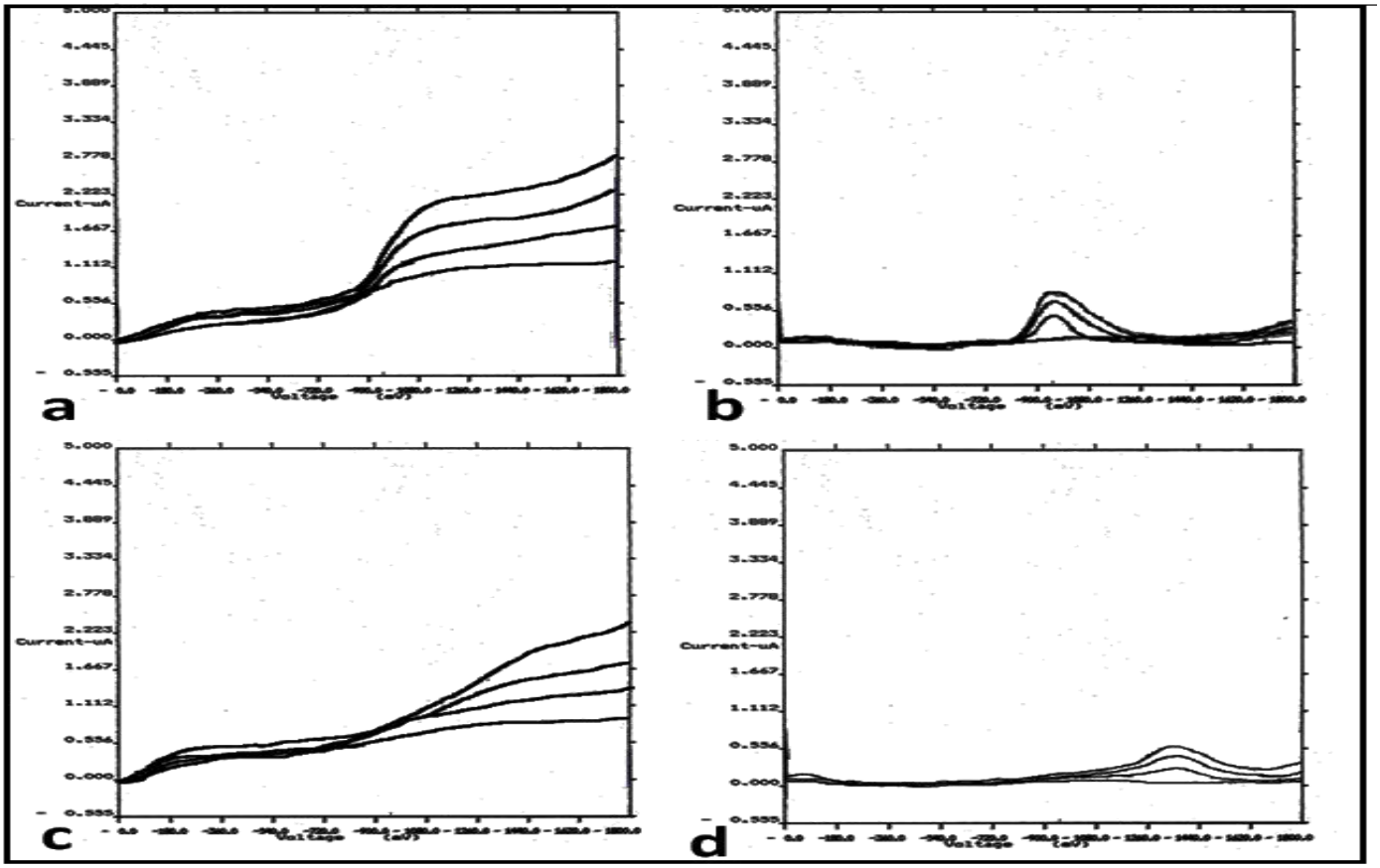


Fig. 1:(a) DC polarograms of 0.1 M KCl and with four additions of 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole, (b) DP polarograms of 0.1 M KCl and with four additions of 7-amino-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole, (c) DC polarograms of 0.1 M KCl and with four additions of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole, (d) DP polarograms of 0.1 M KCl and with four additions of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole.

The diffusion current (DC) polarogram shows a distinct polarographic wave with half wave potential ($E_{1/2}$)-0.960V which matches with the literature value for methyl-α,β-unsaturated aryl ketone group [34]. The differential pulse polarogram shows a distinct peak with peak potential -0.951V. The supporting electrolyte solution was deareated with nitrogen for 15min and polarograms were recorded in DC and DPP modes. To this solution, various concentrations of ethanolic solutions of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-phenyl isoxazol-5′-yl)-1,2-benzisoxazole were added and polarograms were recorded for each addition. The DC polarograms have been shown in fig. 1c while DP polarograms have been shown in fig. 1d. The diffusion current (DC) polarogram shows a distinct polarographic wave with half wave potential ($E_{1/2}$) -1.300V which matches with the literature value for sugar group [35]. The differential pulse polarogram shows a distinct peak with peak potential -1.350V.

Table 3: Antimicrobial activity of 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-arylisoxazol-5′-yl)-1,2-benzisoxazoles (5a-j)

Products	Diameter of Inhibition Zone (in mm) Against (conc. in µg/mL)			
	Bacterial Strains		Fungal Strain	
	E. Coli	*S. aureus*	*A. niger*	*C. albicans*
5a	9.2	11.0	9.8	8.9
5b	11.2	12.2	10.4	12.0
5c	11.9	10.4	11.1	10.7
5d	11.2	12.0	11.2	8.3
5e	9.0	10.4	8.8	8.6
5f	10.9	8.2	9.1	11.3
5g	10.0	12.3	11.8	10.6
5h	11.5	9.2	11.3	9.2
5i	10.9	11.9	8.9	11.2
5j	11.4	9.2	10.8	9.6
Standard	32	28	24	23
Ciprofloxacin (100µg/mL)			Clotrimazole (100µg/mL)	
Zone of Inhibition in mm ± 0.3			Blank 6.3mm	

4. CONCLUSION

Synthesized compounds 7-amino-(β-D-glucopyranosyl)-3-methyl-5-(3′-aryl isoxazol-5′-yl)-1,2-benzisoxazoles (**5a-j**) are confirmed by FT-IR, ^{1}H-NMR, FAB-MS, optical activity and elemental analysis. These compounds were evaluated for in vitro antibacterial activity against *E. coli* and *S. aureus* strains as well as for antifungal activity against *A. niger* and *C. albicans* strains using cup-plate technique. Some compounds showed excellent results against bacterial and fungal strain.

5. ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to Head, Department of Chemistry, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur and Principal, Jawaharlal Nehru College, Wadi, Nagpur, for granting Laboratory facility for carrying the proposed research work.

Conflict of interest

None declared

6. REFERENCES

1. Chen Q, Zhu XL, Jiang LL, *Eur. J. Med. Chem.,* 2008; **43(3):**595-603.
2. Srinivas K, Bhanuprakash K, Harikishore K, *Eur. J. Med. Chem.,* 2006; **41:**1240-1246.
3. Starcevic K, Kralj M, Ester K, Sabol I, *Bioorg. Med. Chem.,* 2007; **15:**4419-4426.
4. Chandra T, Garg N, Suman L, Saxena SS, *Eur. J. Med. Chem.,* 2010; **45:**1772-1776.
5. Ramla MM, Omar MA, Tokuda H, Diwani H, *Bioorg. Med. Chem.,* 2007; **15:**6489-6496.
6. Kalirajan R, Sivakumar SU, Jubie S, Gowramma B, *Int. J. Chemtech. Res.*, 2009; **1(1):**27-34.
7. Aitawade MM, Sambavekar PP, Anbhule PV, *Indian J. Chem. Sec. B.*, 2014; **53B:**754-762.
8. Cali P, Naerum L, Mukhija S, Hjelmencrantz A, *Bioorg. Med. Chem. Lett.,* 2004; **14:**5997-6000.
9. Diana GD, Mckinlay AM, Otto MJ, Akullian V, Oglesby C, *J. Med. Chem.,* 1985; **28:**1906-1910.
10. Na X, Zhou Y, Wang G, Miao W, Qu J, *J. Heterocycl. Chem.,* 2010; **47:**15-21.

11. Tangallapally RP, Sun D, Budha N, Lee,RE, *Bioorg. Med. Chem. Lett.,* 2007; **17:**6638-6642.
12. Kumbhare RM, Ingle VN, *Indian J. Chem. Sec. B.,* 2009; **48B:**996-1000.
13. Carr JB, Durham HG, Hass DK, *J. Med. Chem.,* 1977; **20(7):**934-939.
14. Sharma A, Gupta S, Upmanyu N, Jain S, Garg G, *Der. Phama. Chemica.,* 2011; **3(3):**253-264.
15. Thakar KA, Bhawal BM, *Curr. Sci.*, 1978; **47:**950-952.
16. Shastri RA, Varudkar JS, *Indian J. Chem. Sec. B.*, 2009; **48B:**1156-1160.
17. Dubrovskiy AV, Lorak RC, *Organic Letters.*, 2010; 12(6):1180-1183.
18. Uno H, Kurokawa M, Mishimura H, *J. Med. Chem.*, 1979; **22:**180-183.
19. Villalobes A, Blake JA, *J. Med. Chem.*, 1994; **37:**2721-2734.
20. Suvitha S, Abdelwahab SI, *Molecules.*, 2012; **17:**6179-6195.
21. Choudhary AN, Juyal V, *Int. J. Pharm. and Pharma. Sci.*, 2011; 3**(3):**125-128.
22. Elarfi MJ, Al-difar HA, *Sci. Revs. Chem. Comm.*, 2012; **2(2):**103-107.
23. Patil S, Utale P, *Asian J. Biomed. Pharm. Res.*, 2013; **3(2):**114-122.
24. Jayapal MR, Shreedhar NY, *Int. J. Curr. Pharm. Res.*, 2010; 2(4):60-62.
25. Inaba Y, Kawakami T, Aimoto S, Ikegami T, Takeuchi T, Nakazawa T, Yano S, Mikata Y, *Carbohydr. Res.*, 2009; **344:**613-626.
26. Pratviel G, Bernadou J, Meunie B, *Angew. Chem. Int. Ed.*, 1995; **34:**746-769.
27. Chavan SA, Ulhe AG, Berad BN, *Heterocycl. Commun.*, 2015; 1-4.
28. Umare VD, Ingle VN, Wanare RK, *Int. J. ChemTech. Res.*, 2009; **1(2):**314-317.
29. Punatkar YV, Wanare RK, Jugade RK, *Research Journal of Chemical Sciences.*, 2016; **6(1):**61-68.
30. Wanare RK, *J. Pharm. Biomed. Sci.*, 2012; **24(24):**97-101.
31. Ingle VN, Upadhyay UG, Kharche ST, *Indian J. Chem. Sec. B.*, 2004; **43:**1743-1747.
32. Silverstein RM, Webster FX, Kiemle DJ, *7th ed. Wiley, New York*, 2005.
33. Hatzade KM, Taile VS, Gaidhane PK, Ingle VN, *Indian J. Chem. Sec. B.*, 2008; **47:**1260-1270.
34. Zuman P, *Academic Press, New York.*, 1969.
    Kapoor RC, Aggarwal BS, *Principles of Polarography*, *Wiley Eastern Limited, New York.*, 1991; **1257:**96-115.