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In vitro Antidiabetic and Anticancer Activity of Some Novel Diazenyl Benzene Sulphonamide Derivatives

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A series of novel 2-[(5-phenyl-1,3,4-thiadiazole-2-imino)substituted benzene]diazenyl benzene sulphonamide derivatives **(VII)$_{6\text{-}10}$** were synthesized and FT-IR, ^{1}H NMR, ^{13}C NMR and GC-MS spectral data were used to investigate the structures of the synthesized sulphonamide derivatives. The antioxidant activity of 2-[(5-phenyl-1,3,4-thiadiazole-2-imino)substituted benzene]diazenyl benzene sulphonamide derivatives **(VII)$_{6\text{-}10}$** was done using DPPH technique. Compounds **(VII)$_7$** and **(VII)$_9$** displayed excellent antioxidant activity when compared to standard ascorbic acid. The *in vitro* antidiabetic activity on α-amylase and α-glucosidase studies indicated compound **(VII)$_7$** as promising inhibitor of α-amylase and α-glucosidase. The cytotoxic activity of the synthesized compound **(VII)$_9$** was tested against human colon (HCT-116), lung (A549), breast (MCF-7) cancer cell lines and fibroblast (L929) normal mouse lines. The results showed that compound **(VII)$_9$** has good cytotoxic activity.

Keywords: Sulphonamide Derivatives, Antidiabetic activity, α-Glucosidase activity, Antioxidant activity, Cytotoxic activity.

INTRODUCTION

Sulphonamides are an essential class of compounds in the study of medicine and pharmaceuticals, because of their wide range of applications in biology [1]. Antimicrobial, antihypertensive, antiviral, antithyroid, hypoglycaemia and diuretic qualities are all possessed by sulphonamides are the members of a large pharmaceutical family. Sulphonamides also have anticancer activities [2-5]. Furthermore, sulphonamides are recognized as inhibitors of the carbonate dehydratases enzyme, which is being employed in therapeutic medicine for the treatment of glaucoma [6-9]. 1,3,4-Thiadiazoles have more interest of researchers due to the vast number of different synthesis methods that have been described in the literature. The biological effects of these compounds are quite diverse [10-12] and include, amongst other things, antifungal, anti-inflammatory, antibacterial, antiparasitic, antioxidant, antidepressant, anticonvulsant, diuretic and antitumoral agents [13-21]. Three nitrogen heteroatoms in five-membered rings defined a new class of chemicals [22].

In recent studies, researchers have incorporated the azomethine C=N linkage, a pivotal component for organic reactivity, into the N-contributing molecule within Schiff base investigations. One of the factors contributing to the significant attention received by the N-containin molecule is its prominence [23]. An extensive number of heterocyclic frameworks with azomethine derivatives have been explained to possess cytotoxic, antibacterial, anticancer and antifungal activities [24-26]. Azo molecules have been linked to the inhibition of deoxyribonucleic acid and ribonucleic acid synthesis, cancer and protein amalgamation, among other things [27]. The interaction between the dynamic site of proteins and azo compounds is facilitated by the presence of -N=N- moiety in their molecular structure [28]. It was shown that halogen substituents in azo atoms had a comparable effect on the inhibition of receptor protein expression [29].

For a long time now, it has been asserted that a significant scope of sulfonamide subordinates have demonstrated significant measurable protease inhibitory activities [30]. Sulfonamides are designed antimicrobial resistance that act as potent inhibitors

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of the H_2-pteroate synthase enzyme, which is responsible for the production of dihydropteroate (DHPS). Different organic fiery combinations contain the important sulfonamide establishment, $–SO_2NH–$, which is used as an antibacterial container, antithyroid specialist, antitumor, antitoxin and carbonic anhydrase inhibitor, among other things [31,32]. Sulfonamides are often used in clinical practice to treat a variety of urinary tract disorders and gastrointestinal contaminations. Aromatic and/or heteroaromatic sulfonamides are used as anticancer agents because they inhibit CAS (carbonic anhydrase) [33] and also helpful in combating inflammation and viruses [34,35]. The motivation behind this study is to synthesize five new diazenyl compounds based on the structural characteristics and diverse biological activities exhibited by azo-imine compounds and sulphonamide derivatives. These compounds were specifically examined for their antioxidant, antidiabetic and cytotoxic activities.

EXPERIMENTAL

The chemicals and solvents were of laboratory grade and procured from Aldrich-Sigma, USA. The melting points were measured using open capillaries and are uncorrected. The completion of the reactions and assessment of compound purity were conducted using thin-layer chromatography (TLC) on the precoated silica gel-aluminum plates ($60F_{254}$ plates Merck). The visualization was achieved by subjecting the plates to UV-light exposure at 254 nm or by briefly exposing them to iodine vapour. The infrared spectra of the compounds were obtained using a Fourier-transform infrared spectrophotometer (IRAfinity-1, Shimadzu) using KBr pallets. The compounds were also analyzed using ^{1}H NMR spectroscopy using a multinuclear Fourier transform (FT) NMR spectrometer, namely the Advance-II model manufactured by Bruker. The NMR spectra were acquired at a frequency of 400 MHz using TMS as internal standard.

General procedure

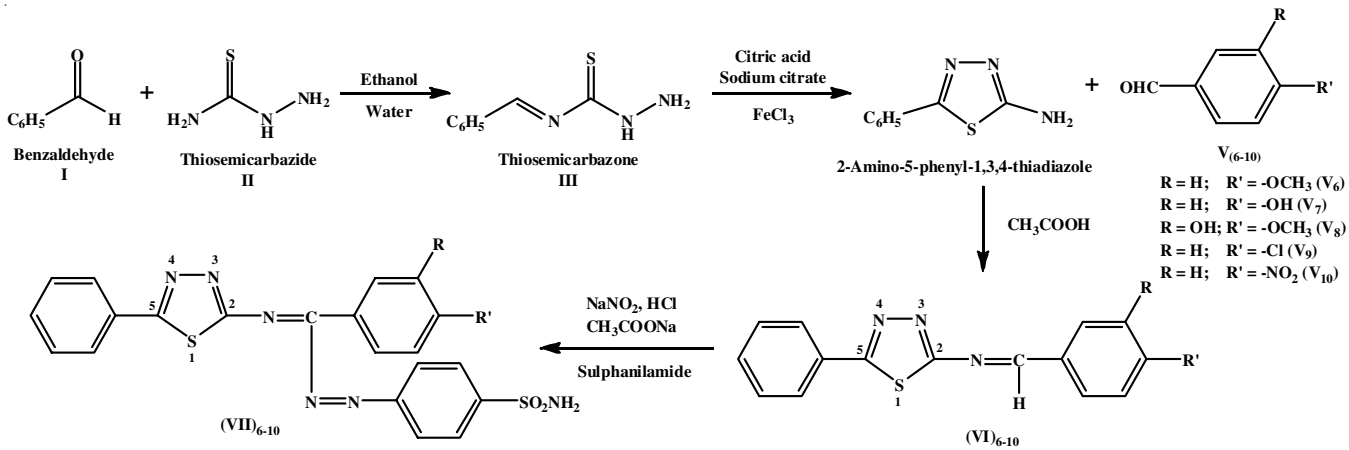
Synthesis of thiosemicarbazones (III): Benzaldehyde (**I**) (0.2 mol) dissolved in 300 mL of hot alcohol was added with 300 mL of dilute ethanolic solution of thiosemicarbazide (**II**, 0.2 mol) with constant stirring. The final product was made by recrystallizing ethanol, drying it, and filtering it under vacuum pressure after it had cooled to room temperature [36].

Synthesis of 2-amino-5-aryl-1,3,4-thiadiazole (IV): At room temperature, 0.05 mol of compound **III** dissolved in 300 mL of warmed water was added to 300 mL of $FeCl_3$ (0.15 mol) solution, stirred gradually and heated the mixture for 45 min at 80-90 ºC. After performing filtration on the solution while it was still hot, 0.11 mol of citric acid and 0.05 mol of sodium citrate were added. The resultant mixture was separated into four equal parts and then each quarter was treated with a 10% NH_3. Compound IV, the specified thiadiazole, was synthesized through the usage of an appropriate solvent. Following that, it was allowed to recrystallize before being filtered in a vacuum.

Synthesis of 2-[5-phenyl-1,3,4-thiadiazole-2-imino]-substituted benzene $(VI)_{6-10}$: 2-Amino-5-aryl-1,3,4-thiadiazole (0.01 mol, **IV)** dissolved in heated glacial acetic acid (30 mL) was added to 0.01 mol of ethanolic solution of aromatic aldehyde and then refluxed for 6 h. After being cooled to room temperature, it was placed on crushed ice and left overnight to settle. Following the separation process, solid benzylidene imine was washed with petroleum ether and filtered to remove any remaining impurities. The solid benzylidene imine $(VI)_{6-10}$ was dried and recrystallized from hot ethanol [36].

General method for the synthesis of 2-[(5-phenyl-1,3,4-thiadiazole-2-imino) substituted benzene]diazenyl benzene sulfonamide $(VII)_{6-10}$: Under the steady stirring of benzylidene imines $(VI)_{6-10}$ (0.02 mol), imines were dissolved in a solution of ethanolic sodium acetate (5 g). A solution containing sodium nitrate (0.02 mol) in water was added to with a cooled solution of sulphanilamide (0.02 mol) that had been dissolved in 3 N HCl (25 mL). The contents were allowed to settle for 2 h at room temperature in order to obtain thick precipitate, which was filtered, washed with water, dried and recrystallized (**Scheme-I**).

2-[(5-Phenyl-1,3,4-thiadiazole-2-ylimino)-4-methoxy-benzene]diazenylbenzene sulfonamide $(VII)_6$: Yield: 81%; m.p.: 208-210 ºC; IR (KBr, ν_{max}, cm^{-1}): 3097 (C-H arom.), 1648 (C=N), 1383, 1039 (SO_2), 1278 (C-N), 2853 (-OCH_3), 1540 (N=N), 3207 (NH_2); ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm:



Scheme-I: Synthesis of 2-[(5-phenyl-1,3,4-thiadiazole-2-imino) substituted benzene]diazenyl benzene sulphonamide $(VII)_{6-10}$

3.828 (s, 3H, -OCH_3), 4.816 (s, 2H, -NH_2), 7.285-7.783 (m, 13H, Ar-H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: 122.68-140.52 (Ar C-H), 166.29 (C=N), 65.29 (-OCH_3); Mass: Obs. (*m/z*) 479.9, calcd. (*m/z*) 478.5; Elemental analysis of $C_{22}H_{18}N_6O_3S_2$ calcd. (found) %: C, 55.22 (55.20); H, 3.79 (3.72); N, 17.56 (17.51).

2-[(5-Phenyl-1,3,4-thiadiazole-2-ylimino)-4-hydroxybenzene]diazenyl benzene sulfonamide (VII)$_7$: Yield: 76%; m.p.: 142-144 ºC, IR (KBr, ν_{max}, cm^{-1}): 3088 (C-H arom.), 1648 (C=N), 1383, 1040 (SO_2), 1278 (C-N), 3736 (OH), 1540 (N=N); ^{1}H NMR (400, MHz, DMSO-d_6) δ ppm: 4.977 (s, 2H, NH_2), 10.168 (s, 1H, OH), 7.281-8.419 (m, 13H, Ar-H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: 127.04-131.33 (Ar-CH), 156.61 (C-OH), 169.28 (C=N); Mass: Obs. (*m/z*) 465.4, calcd. (*m/z*) 464.5; Elemental analysis of $C_{21}H_{16}N_6O_3S_2$ calcd. (found) %: C, 54.30 (54.26); H, 3.47 (3.44); N, 18.09 (18.01).

2-[(5-Phenyl-1,3,4-thiadiazole-2-ylimino)-3-hydroxy-4-methoxybenzene]diazenyl benzene sulfonamide (VII)$_8$: Yield: 80.0%; m.p.: 178-180 ºC, IR (KBr, ν_{max}, cm^{-1}): 3096 (C-H aromatic), 1649 (C=N), 1383, 1040 (SO_2), 1278 (C-N), 3735 (OH), 2864 (-OCH_3), 1540 (N=N); ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: 3.835 (s, 3H, -OCH_3), 5.093 (s, 2H, NH_2), 7.328-8.418 (m, 12H, Ar-H), 10.169 (s, 1H, OH); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: 124.22-140.52 (Ar-CH), 156.61 (C=N), 169.32 (C-OH), 56.49 (-OCH_3); Mass: Obs. (*m/z*) 495.5, calcd. (*m/z*) 494.5; Elemental analysis of $C_{22}H_{19}N_6O_4S_2$ calcd. (found) %: C, 53.43 (53.44); H, 3.67 (3.64); N, 16.99 (16.93).

2-[(5-Phenyl-1,3,4-thiadiazole-2-ylimino)-4-chlorobenzene]diazenyl benzene sulfonamide (VII)$_9$: Yield: 82%; m.p.: 176-178 ºC; IR (KBr, ν_{max}, cm^{-1}): 3093 (C-H arom.), 1669 (C=N), 1383, 1040 (SO_2), 1278 (C-N), 3206 (NH_2), 1540 (N=N), 763 (C-Cl); ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: 4.100 (s, 2H, NH_2), 7.007-7.837 (m, 13H, Ar-H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: 56.49 (C-Cl), 127.14-131.81 (Ar-CH), 169.46 (C=N); Mass: Obs. (*m/z*) 496.1, calcd. (*m/z*) 495; Elemental analysis $C_{21}H_{15}N_6O_2S_2Cl$, calcd. (found) %: C, 52.22 (52.21); H, 3.13 (3.13); N, 17.40 (17.41).

2-[(5-Phenyl-1,3,4-thiadiazole-2-ylimino)-4-nitrobenzene]diazenyl benzene sulfonamide (VII)$_{10}$: Yield: 88%; m.p.: 156-158 ºC; IR (KBr, ν_{max}, cm^{-1}): 3105 (C-H arom.), 1648 (C=N), 1383, 1040 (SO_2), 1285 (C-N), 3241 (NH_2), 1525 (N=N), 1346 (C-NO_2); ^{1}H NMR (400 MHz, DMSO-d_6) δ ppm: 4.899 (s, 2H, NH_2), 7.166-7.816 (m, 13H, Ar-H); ^{13}C NMR (100 MHz, DMSO-d_6) δ ppm: 122.77-132.41 (Ar-CH), 168.11 (C=N); Mass: Obs. (*m/z*) 506.0, calcd. (*m/z*) 505.5; Elemental analysis of $C_{21}H_{15}N_7O_4S_2$, calcd. (found) %: C, 51.11 (51.10); H, 3.06 (3.04); N, 19.87 (19.86).

Antioxidant activity: A 1 mL of DPPH$^•$ solution (0.1 mM) prepared in ethanol was added to 3 mL of DMSO containing sample solutions at varying concentrations (50-250 µg/mL). The mixture was vigorously shaken after having been allowed to stand for 30 min at room temperature [37]. The free radical scavenging activity was measured by observing a decrease in the absorbance of the reaction mixture by measuring the absorbance at 517 nm.

$$\text{Inhibition (\%)} = \frac{\text{Control} - \text{Test}}{\text{Control}} \times 100$$

***In vitro* α-amylase inhibitory assay:** Bernfeld's approach [37] was used to examine amylase inhibition *in vitro*. In brief, the test extract (100 µL) was mixed with 200 µL of amylase enzyme (Hi medium Rm 638) and 100 µL of 2 mM phosphate buffer (pH-6.9) follwed by the addition of 100 µL of 1% starch after 20 min incubation. Control experiment was also carried out by following an identical procedure except that buffer was used in place of enzyme (200 µL). Both the control and test samples were incubated for 5 min before 500 µL of dinitrosalicylic acid reagent was added. A bath of boiling water was used to hold them for 5 min. Percentage inhibition of α-amylase enzyme was determined by measuring absorbance at 540 nm by using the formula.

$$\text{Inhibition (\%)} = \frac{\text{Control} - \text{Test}}{\text{Control}} \times 100$$

***In vitro* α-glucosidase inhibition assay:** In the present experiment, glucopyranoside was introduced into the phosphate buffer solution. Different concentrations of the synthesized compounds, specifically 500, 250, 125, 62.5, and 31.25 µg/mL, were employed in the preparation of the sample solutions. The aforementioned mixture was added in 0.5 µg/mL of glucosidase and then incubated at 37 ºC for 20 min [36]. Following the incubation period, the reaction mixture was halted by introducing HCl. The determination of colour intensity was conducted at a wavelength of 510 nm and then percentage inhibition of α-glucosidase was calculated by using the following formula.

$$\text{Inhibition (\%)} = \frac{\text{Control} - \text{Test}}{\text{Control}} \times 100$$

Anticancer and cytotoxic activity: The reagents DMEM (AL111, Himedia, Sigma), Mc-Coy's 5A-(AL057-H, Himedia, Sigma) fetal bovine serum (RM-10432, Himedia) and the human cell lines, HCT116, A549, MCF-7 and L929 were obtained from NCCS, Pune, India. The synthesized compounds **(VII)$_{6\text{-}10}$** dissolved in DMSO as solvent and subsequently diluted to provide working concentrations of 100, 50, 25, 12.5 and 6.25 µg/mL. The cells were cultured in 96-well plates with a cell density of 5×10^4 cells per well. Following a 4 h incubation period, the cells were subjected to various quantities of samples and subsequently incubated for 72 h. Then, 25 mL of MTT solution (5 mg/mL) was introduced into each well, followed by a further incubation period of 4 h. The medium was then removed and 100 mL of DMSO was introduced to dissolve the formazan crystals. Absorbance at 492 nm was measured using a microplate spectrophotometer (Awareness Technology Inc Stat fax 2100) in order to determine the amount of formazan crystal. The experiments were conducted in triplicate as described earlier [38,39].

RESULTS AND DISCUSSION

Thiosemicarbazone (**III**) was cyclized to 2-amino-5-aryl-1,3,4-thiadiazole (**IV**) by reacting with citric acid and sodium citrate using $FeCl_3$ as oxidizing agent. 2-Amino-5-aryl-1,3,4-thiadiazole (**IV**) were further reacted with substituted aromatic aldehydes **(V)$_{6\text{-}10}$** in presence of ethanol results in the formation

TABLE-1
ANTIOXIDANT ACTIVITY OF DIAZENYL BENZENE SULPHONAMIDE DERIVATIVES **(VII)$_{6-10}$**

Compound	Concentration (μg/mL)			IC_{50} value (μM)
	100	200	300	
(VII)$_6$	22.052 ± 0.023	22.534 ± 0.016	25.337 ± 0.011	398.304
(VII)$_7$	21.952 ± 0.018	44.257 ± 0.010	64.333 ± 0.017	230.608
(VII)$_8$	17.103 ± 0.011	22.942 ± 0.026	61.586 ± 0.015	271.491
(VII)$_9$	27.424 ± 0.050	35.549 ± 0.005	74.070 ± 0.025	118.518
(VII)$_{10}$	20.699 ± 0.202	21.839 ± 0.030	22.604 ± 0.234	340.049
Ascorbic acid	24.746 ± 0.020	33.291 ± 0.011	41.971 ± 0.029	393.480

of benzylideneimines **(VI)$_{6-10}$**. The imines were reacted with $NaNO_2$, HCl, CH_3COONa and benzene sulphonamide to obtain diazenyl benzene sulphonamide derivatives **(VII)$_{6-10}$**. All the synthesized diazenyl sulphanilamide were characterized by FT-IR, ^1H NMR, ^{13}C NMR and mass spectroscopy. The FT-IR spectrum of diazenyl benzene sulphonamide **(VII)$_6$** showed characteristic vibrations at 1648 cm^{-1} for the -C=N- (imine), the stretching vibration appeared at 2853 cm^{-1} for the $-OCH_3$ group. The azo compound gave the sharp peak at 1540 cm^{-1}, which is attributed for the –N=N- linkage. The asymmetric and symmetric vibration due to SO_2 group was observed at 1383 and 1039 cm^{-1} confirmed the formation of the sulphones. Presence of these bands thus, confirmed the formation of the benzylidene imines with the diazotized solution of sulphanilamide. Band at 1278 cm^{-1} was also visible, which was due to the C-N bending. The C-H stretching vibration was observed at 3097 cm^{-1} and NH_2 stretching vibration at 3207cm^{-1}. The ^{1}HNMR spectrum of compound **(VII)$_6$** showed a multiplet for thirteen aromatic protons in the range of δ 7.285-7.783 ppm. The downfield signal as singlet at δ 4.816 ppm for the protons of the NH_2 group and another singlet was observed at δ 3.828 ppm for three protons of the methoxy group at C_{15}. The ^{13}C NMR spectra of the synthesized compound **(VII)$_6$** showed signal for imine carbon at δ 165.29 ppm and the signal for other 20 aromatic carbon seen between the region δ 122.68-140.52 ppm. The methoxy carbon at C_{15} appeared at δ 65.29 ppm. The mass spectrum of synthesized compound **(VII)$_6$** showed a molecular ion peak at *m/z* = 479.9 (32%) and base peak at 177.1 (100%), with its molecular formula $C_{22}H_{18}N_6O_3S_2$. Other derivatives in these series were characterized in the similar way.

Antioxidant activity: Diazenyl benzene sulphonamides **(VII)$_7$** and **(VII)$_9$** having low IC_{50} value (230.608 μM, 118.518 μM, respectively) showed efficient radical scavenging activity as compared to compound **(VII)$_6$**, which has IC_{50} value 398.304 μM. The compound **(VII)$_8$**, showed IC_{50} value 271.491 μM and **(VII)$_{10}$**, showed IC_{50} value of 340.049 μM. The antioxidant activity of compound **(VII)$_{10}$** was found to be very good when compared to standard ascorbic acid (393.48 μM). The structure activity relationship of the tested diazenyl benzene sulphonamide showed the synthesized compound **(VII)$_9$** bearing *p*-Cl (halo substitution) showed dominant DPPH activity with IC_{50} value of 118.518 μM. Compounds **(VII)$_7$** and **(VII)$_8$** containing 4-OH and 3-OH-4-OCH_3 groups showed good activity with IC_{50} value of 230.608 μM and 271.491 μM, respectively (Table-1). The presence of 4-OCH_3 and 4-NO_2 groups in the same position exhibits good activity compared to standard ascorbic acid.

Antidiabetic activity on α-amylase and α-glucosidase studies: All the synthesized diazenyl benzene sulphonamides showed a gradual increase in inhibition, when the concentration increased from 10 to 50 μg/mL. In both *in vitro* techniques, compound **(VII)$_7$** showed the maximum IC_{50} value (2.12 and -12.1 μg/mL). A stronger percentage of inhibition was produced by adding a hydroxyl to the aryl ring's *para* position because it interacted more favourably with the enzymes' active sites. Compounds **(VII)$_8$** and **(VII)$_6$** showed the IC_{50} = 3.2, 43 μg/mL and 4.3, 111 μg/mL), respectively (Table-2). The QSAR studies showed that substitution at *para* position $–OCH_3$ and 4-OCH_3-3–OH on the aromatic ring showed better inhibitory activity. Similarly, compound **(VII)$_{10}$**, with IC_{50} value = 2.8, 54 μg/mL containing electron withdrawing $–NO_2$ at *para* position on 1,3,4-thiadiazole based imino ring skeleton showed significant inhibitory activity and was found to be the most efficient α-glucosidase inhibitory activity. Additionally, diazenyl benzene sulphonamide **(VII)$_9$** with maximum IC_{50} = 11.4, 271 μg/mL containing electron withdrawing chlorine group at *para* position exhibiting the better activity. All these diazenyl benzene sulphonamide derivatives showed a very good inhibitory activity against α-glucosidase and α-amylase enzymes when compared to standard acarbose (IC_{50} values α-glucosidase 4.9 and α-amylase 173 μg/mL).

TABLE-2
IC_{50} VALUE OF α-GLUCOSIDASE AND α-AMYLASE INHIBITION FOR DIAZENYL BENZENE SULPHONAMIDE **(VII)$_{6-10}$**

Compound	IC_{50} value (μg/mL)	
	α-Glucosidase	α-Amylase
(VII)$_6$	4.3	111
(VII)$_7$	2.12	-12.1
(VII)$_8$	3.2	43
(VII)$_9$	11.4	271
(VII)$_{10}$	2.8	54
Acarbose	4.9	173

Anticancer activity: *In vitro* anticancer activity of diazenyl benzene sulphonamide **(VII)$_9$** showed the highest antioxidant activity. Therefore, it was screened for its anticancer activity against three cancer cells *viz.* colon, lungs and breast, cancer cell lines *in vitro* by MTT assay method. Three cancer cell lines were tested for anticancer activity at 6.25, 12.5, 25, 50 and 100 μg/mL. Doxorubicin was used as standard drug.

The breast cancer cell line (MCF7) was more sensitive to compound **(VII)$_9$** with the low IC_{50} value of 49.93 μg/mL

TABLE-3
ANTICANCER AND CYTOTOXIC STUDIES OF DIAZENYL BENZENE SULPHONAMIDE **(VII)$_9$**

Cell lines	Percentage (%) of viability					IC_{50} value (µg/mL)
	6.25 µg/mL	12.5 µg/mL	25 µg/mL	50 µg/mL	100 µg/mL	
Colon (HCT116)	97.96	93.87	87.19	72.41	41.34	69.82
Lung (A549)	96.42	93.15	88.66	73.80	45.91	86.48
Breast (MCF-7)	88.61	80.35	63.12	50.07	30.15	49.93
Fibroblast (L929)	95.61	93.11	91.11	87.47	81.29	625.59

followed by a colon cancer cell line (HCT 116) with an IC_{50} value = 69.82 µg/mL and lung cancer cell line (A549) with an IC_{50} value = 86.49 µg/mL (Table-3). The antiproliferative effect was determined as dose dependent. Compound **(VII)$_9$** showed a moderate anti-proliferative activity when compared to standard doxorubicin (IC_{50} value = 47.96 µg/mL). The cytotoxic effect of normal fibroblast cell line (L929) has an IC_{50} value 625.59 µg/mL. The cell morphology observed under phase contrast inverted microscope showed membrane blebbing and nuclear condensation.

Conclusion

In this work, a series of diazenyl benzene sulphonamides derivatives **(VII)$_{6\text{-}10}$** were synthesized and characterized. The structure of these diazenyl benzene sulphonamides were elucidated on the basis of IR, ^{1}H, ^{13}C NMR, MS spectral and elemental analyses. Among the synthesized compounds, the antioxidant activity of newly synthesized diazenyl benzene sulphonamides **(VII)$_9$** had the higher radical scavenging activity due to the presence of chloro substituent at *para* when compared with standard drug ascorbic acid. Antidiabetic studies indicated that compound **(VII)$_7$** will be an investigation and development of a prospective chemical that might lead to the creation of selective inhibition of α-amylase and α-glucosidase. The *in vitro* anticancer studies revealed that compound **(VII)$_9$** had the moderate anticancer activity against MCF7 (breast) and HCT116 (colon) cells. The results of cytotoxicity study performed by MTT assay suggest that the compound **(VII)$_9$** is non-toxic in nature when tested on the normal mouse fibroblast cell.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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