Nigerian Research Journal of Chemical Sciences (ISSN: 2682-6054)
Volume 11, Issue 1, 2023

Influence of solvents on the ^{1}H-NMR chemical shifts of 4-(4-acetyl-5-methyl-1H-1,2,3-triazol-1-yl)-N-(6-chloropyridazin-3-yl)benzenesulfonamide

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ABSTRACT

A heterocyclic compound 4-(4-acetyl-5-methyl-1H-1,2,3-triazol-1-yl)-N-(6-chloropyridazin-3-yl)benzene sulfonamide (M2) was prepared by 1, 3-dipolar cycloaddition of 4-Azido-N-(6-chloro-3-pyridazinyl)benzene sulfonamide to acetylacetone. Mass spectrometry (MS), Fourier-transform infrared (FTIR) spectroscopy, and 1H NMR spectroscopy were used for structure characterization of the compound. The effects of several solvents (DMSO-d$_6$, CD_3OD and $CDCl_3$) on the experimental ^{1}H-NMR chemical shifts of the title molecule are explored. Significant change in chemical shifts values $|\Delta\delta|> 0.2$ ppm was observed when converted from low polar solvent ($CDCl_3$) to high polar solvent (DMSO-d$_6$). The ^{1}H- NMR of the title molecule was computed using GIAO/B3PW91/6-311++G(d,p), and GIAO/B3PW91/6-311++G(d,p) levels with IEFPCM in DMSO,CH_3OH and $CHCl_3$. Study of the correlation between experimental 1H-NMR chemical shifts and theoretical values suggests that GIAO/B3PW91/6-311++G(d,p) results gave lower RMSE values compared with results which were obtained from GIAO/B3PW91/6-311++G(d,p). The relationship between experimental ^{1}H-NMR chemical shifts and solvatochromic parameters, as well as dielectric constant of DMSO, CH_3OH, and $CHCl_3$ solvents, values were observed. Many experimental ^{1}H-NMR chemical shifts of title molecule have strong negative correlation (R= -0.90 to -1) with solvatochromic parameters, and dielectric constant of solvents under study.

Key words: DFT, NMR, solvatochromic, triazole

INTRODUCTION

Nuclear magnetic resonance (NMR) is an effective tool in structural analysis of organic compounds. The proton NMR experiment is the most widely used NMR technique. Many factors influence on ^{1}H chemical shifts in NMR including temperature [1, 2], concentration [1, 3], anisotropies , steric effects[4], substituents [5], and solvent effects [3, 6]. Solvent selection has an influence on the chemical shift, and coupling pattern [6]. The effects of solvents in proton resonances are caused by four interactions: van der Waals interactions, solvent anisotropy, hydrogen bonding, and polar effects [7].

Many investigations on the ^{1}H and ^{13}C NMR chemical shifts of a variety of molecules in various solvents have been reported. Hashimoto and Sakata have given the proton chemical shifts for six compounds in twelve solvents. They observed that in C_7D_8 and C_6D_6 solutions, every proton signal is transferred to higher fields than in cyclohexane-d_{12} solution [8]. The ^{1}H and ^{13}C shifts of 14 aldopyranoses in D_2O and DMSO solutions, as well as an algorithm for calculating the shifts, were reported by Hobley *et al.* Analysis of results showed small effects of solvent on chemical shifts [9]. In seven common solvents, Gottlieb *et al.* investigated the ^{1}H and ^{13}C chemical shifts of 36 common impurities [10]. Jones *et al* measured the ^{1}H and ^{13}C shifts of 60 various solvents in CD_3OD, DMSO-d_6, D_2O, and $CDCl_3$[11]. Abraham *et al* reported the ^{1}H shifts of a series of alcohols, diols, and inositols in $CDCl_3$, D_2O, and DMSO-*d_6* solutions**.** The ethers and alcohols under study have consistent ^{1}H chemical shifts, suggesting that the molecules are present in the same conformation in both $CDCl_3$ and D_2O solution. Contrarily, DMSO-*d6* causes distinct and significant solvation shifts [12]. Using DMSO-d_6 and $CDCl_3$ as solvents, Abraham *et al* recorded the ^{1}H chemical shifts of 124 compounds that contain various functional groups, non-polar, and polar aprotic compounds which exhibited slight changes in chemical shifts ($\Delta\delta$). Otherwise, very considerable variations in chemical shifts are seen for protic molecules such as alcohols, and carboxylic acids [13]. Standara *et al* reported the ^{1}H, ^{13}C, and ^{15}N shifts of some 6-halopurines in $CDCl_3$, DMF-$d_7$and DMSO-*d_6* solutions. In comparison to DMF-*d7* and DMSO-*d6*, the signal of hydrogen H-8 is about 0.8 ppm lesser in CDCl3. The other hydrogens' chemical shifts are not remarkably different from one another.[14]. In the NMR spectra of codergocrinemesilate and flupentixol dihydrochloride, Holzgrabe *et al* studied the effect of the type of solvent on the signal separation of key resonances. The study showed that due to unique solute-solvent effects, considerable differences in the chemical shift may occur by utilizing a mixture of solvents or by switching solvents with various chemical characteristics regarding polarity and aromaticity.[15].

Recently, Landge *et al* synthesized (2-(4-(naphthalen-2-yl)-1H-1,2,3-triazol-1-yl)phenol and characterized by ^{1}H-NMR in CD_3CN, DMSO-*d_6*, and $(CD_3)_2CO$. They noticed that the phenyl ring proton in the ortho site is most influenced when the solvent is changed. It is clearly shifting much downfield by using acetone as a solvent.[16]. Gerothanassis *et al* used $CDCl_3$, $(CD_3)_2CO$, and DMSO-*d_6* to investigate the effects of solvents on ^{1}H-NMR chemical shifts of chrysophanol, emodin, and physcion [17]. More recently, Chavelas-Hernández *et al* based on aromatic-solvent-induced shifts (ASISs) studied varying ^{1}H NMR chemical shifts of series beta-lactams while changing the solvent used from $CDCl_3$ to C_6H_6.They found that the protons of the beta-lactam ring are the most affected when solvent change from C_6D_6 to $CDCl_3$[18].

The electronic surrounding of the nuclei of a molecule influences the chemical shift [19, 20]. The solvation process in various solvents includes various molecular interactions, all of which are electrostatic in origin. These interactions affect the electronic behavior of molecules as well as the behavior of the atoms that compose these molecules. As a result, the ^{1}H -NMR spectra in various solvents would be sensitive to solvation characteristics [21].

In the present work, 4-(4-acetyl-5-methyl-1H-1,2,3-triazol-1-yl)-N-(6-chloropyridazin-3-yl)benzenesulfonamide (M2) was synthesized and characterized it by IR, ^{1}H-NMR, and ESI massmeasurements. The influence of the solvent on the ^{1}H-NMR chemical shifts has been examined. DFT calculations were used to provide a satisfactory prediction of the chemical shifts in DMSO, CD_3OD and $CDCl_3$.

EXPERIMENTAL

All chemicals used in the synthesis were purchased from Sigma Aldrich and utilized without further purification. Melting points were measured with thermal scientific melting point instrument. The FTIR-ATR method was used on a Bruker FTIR spectrometer to record infrared spectra. ^{1}H-NMR spectra of M2 were measured in DMSO-d_6, $CDCl_3$ and CD_3OD as solvents by Varian-INOVA 500 MHz spectrometer at Central Laboratory, Tehran University, Iran. Chemical shifts have been recorded relative to tetramethylsilane (TMS) as an internal reference. Mass spectra were recorded by Electrospray ionization (ESI) technique in positive ion mode using LCQ instrument LC/MS electrospray ion-trap mass spectrometer at Laboratories Research Institute of Medicinal Plants and Raw Materials, Shahid Beheshti University, Iran.

The DFT calculations included full geometric optimization of the structure of M2 molecule in gas phase at the B3PW91/6-311+G(d,p) level of theory [22, 23]. The vibrational frequencies were calculated to check for imaginary frequencies. ^{1}H-NMR absolute shielding constants were calculated at the levels B3PW91/6-311++G(d,p), and B3PW91/6-311++G(2d,p) with gauge independent atomic orbital (GIAO) method [24]. The chemical shifts were calculated relative to shielding constants of TMS as reference which were calculated at the corresponding theoretical levels. The integral equation formalism polarizable continuum model (IEFPCM) approach [25] was used to represent the solvation model in calculations of^{1}H shielding constants in DMSO, $CHCl_3$ and CH_3OH. Gaussian 09 was used to perform all calculations [26].

*Synthesis of 4-Azido-N-(6-chloro-3-pyridazinyl)benzenesulfonamide (*M1)

M1 was synthesized based on literature [27]. $NaNO_2$ (2.0 mmol) dissolved in water (10 mL) was added dropwise at 0 °C to a solution of sulfachloropyridazine (2.0 mmol), conc. HCl (0.7 mL), and water (10 mL). NaN_3 (2.0 mmol) dissolved in water (10 mL) was gradually added to the above mentioned solution, and the resultant mixture was stirred at 0 °C until a yellow solid formed. The precipitate was filtered, dried, and re-crystallized from $CHCl_3$ to obtain a pale yellow powder.

Synthesis of 4-(4-acetyl-5-methyl-1H-1,2,3-triazol-1-yl)-N-(6-chloropyridazin-3-yl)benzenesulfonamide (M2)

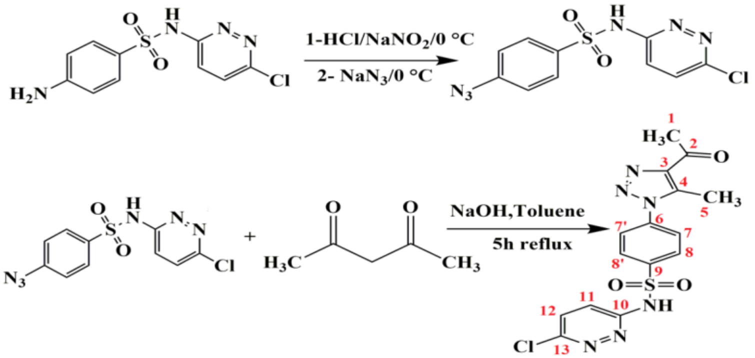
M2 was synthesized using a modified method based on literature [28]. Acetylacetone (0.02mol)) was added to a solution of the azide derivative *(*M1) 0.003 mol in 25ml toluene, then 2 mmol base NaOH was added to the reaction mixture. The reaction mixture was sonicated with refluxed for 5 h, hence the reaction mixture was cooled, filtered, washed with warm water, dried, and re-crystallized from ethyl acetate to obtain a pale yellow powder.

RESULTS AND DISCUSSION

M1: Yield, 82%, pale yellow powder, m.p. = 123–124 °C; molecular formula $C_{10}H_7ClN_6O_2S$; FT-IR: 3170 cm^{-1} (N-H), 3080 cm^{-1} (C-HArom.), 2118 cm^{-1} (N_3), 1581 cm^{-1} (C=C). ^{1}H-NMR(500MHz, DMSO-D_6, ppm): 8.29 (s, 1H,NH), 7.91 (d, 2H, N3-C-CH=CH-C-SO_2), 7.77 (s, 1H, ClC-CH=CH-C-NH), 7.58 (s, 1H, ClC-CH=CH-C-NH), 7.28 (d, 2H, N3-C-CH=CH-C-SO2) ; MS(ESI): m/z 311.80 $(M+H)^+$.

M2: Yield, 30%, pale yellow powder, mp 268–270 °C; molecular formula $C_{21}H_{18}ClN_7O_4S$; FT-IR: 3271 cm^{-1} (N-H), 3093 cm^{-1} (C-HArom.), 2973 cm^{-1} (CH_3asym.), 2927 cm^{-1} (CH_3 sym.), 1672 cm^{-1} (C=O), 1622 cm^{-1} (C=C). ^{1}H-NMR chemical shifts displayed in Table 1. MS(ESI): m/z 392.05$(M+2H)^{2+}$.

Synthesis of **M2** involves two steps as explained in scheme 1. The first step involved the preparation of azide derivative **M1**. Very strong band at 2118 cm^{-1} was observed in the FT-IR spectra owing to asymmetric stretching of the -N_3 group [29]. This was joined by the disappearance of the asymmetric and symmetric stretching vibration bands at 3493 and 3392 cm^{-1} respectively, which belong to -NH_2 group. The proton signal attributed to -NH_2 group at 6.08 ppm is not observed in the ^{1}H-NMR spectra of **M1**. The last evidence supports the form **M1**. The second step involved 1,3-dipolar cycloaddition of azide to acetylacetone in the presence of a base. The IR spectrum of M2 exhibits changes compared to a spectrum of M1 suggesting the synthesis of triazole ring. One of the most significant of these changes was the disappearance of the stretching vibration band of the -N_3 group at 2118 cm^{-1}. Moreover, at 1672 cm^{-1}, a strong stretching vibration band occurs, which is distinctive of the carbonyl group [28]. In comparing the ^{1}H-NMR spectra of the M1 and M2, the ^{1}H-NMR spectrum of the M2 displays additional proton bands characteristic of methyl groups in positions 1 and 5 (Table 1), which can be seen in the 2.5-2.8 ppm range [30, 31]. This finding supports the formation of a triazole ring by 1, 3-dipolar cycloaddition reaction of M1, and acetylacetone.



Scheme 1: Synthesis of M2.

Table 1:M2 data from ^{1}H NMR in DMSO-d_6, CD_3OD, and $CDCl_3$ (chemical shifts δ, and Δδ in ppm).

Position	δ DMSO-d_6	δ CD_3OD	δ $CDCl_3$	Δδ (δ CD_3OD -δ $CDCl_3$)	Δδ (δ DMSO-d_6 -δ CD_3OD	Δδ (δDMSO-d_6- δ $CDCl_3$
1	2.63	2.69	2.75	-0.06	-0.06	-0.12
5	2.528	2.60	2.64	-0.04	-0.08	-0.12
7,7'	7.64	7.65	7.63	0.02	-0.01	0.01
8,8'	8.00	8.23	8.17	0.06	-0.23	-0.17
11	6.88	7.09	7.30	-0.21	-0.21	-0.42
12	7.21	7.31	7.37	-0.06	-0.1	-0.16

From Table 1, the chemical shift attributed to protons resonance at the sites 7 and 7' in all solvents (DMSO-d_6, CD_3OD, and $CDCl_3$) was found in the range 7.63 - 7.65 ppm. The chemical shift caused by protons at sites 8 and 8' appear at low field area 8-8.23 ppm. This result is consistent with previous studies [32, 33]. The proton at position 11 has signal at higher field region 6.8-7.30 ppm compared with proton at position 12. The proton at position 12 is deshielded by electronic withdrawal effect of chlorine atom at C-13. Due to the fast exchange with the water residual in the sample, the resonant signal of the -NH group did not exist in any of the cases (DMSO-d_6, CD_3OD, and $CDCl_3$).

From Table 1, it can be seen that deshielding effect caused by the solvent is greater in $CDCl_3$ and CD_3OD than in DMSO-d_6 for most protons present in M2. This is an indication that the interactions between M2 and the solvents are greater in $CDCl_3$ and CD_3OD than in DMSO-d$_6$ at the molecular level [21].

Table 1 reviews differences in chemical shifts recorded in DMSO-d_6, CD_3OD, and $CDCl_3$. The chemical shift of protons at site 1 shows a very small change with the polarity change of the solvent. The Δδ(DMSO-d_6 - $CDCl_3$) value for protons at site 1 is found at -0.01 ppm. Abraham *et al* [13] reported Δδ = -0.08, and -0.02 ppm as corresponding to methyl protons in acetone, and acetophenone respectively. On the other hand, the chemical shift of protons at site 5 has larger change when moving from DMSO-d_6 to $CDCl_3$ (-0.11 ppm) compared with change of signal of protons at position 1 (-0.01 ppm).

Concerning the effect of solvent polarity on the chemical shifts of phenyl ring protons, the following is noted. With the change of the solvent, the chemical shift of protons at sites 7, and 7' exhibits a very small change. However, there is increase in the shielding in the chemical shift of protons at sites 8, and 8' going from CD_3OD and $CDCl_3$ to DMSO-*d*$_6$ (Tables 1). This suggests weak electronic interactions between the aromatic protons at positions 8,8' and DMSO-*d*$_6$ solvent compared with CD_3OD and $CDCl_3$.

The protons at sites 7, and 7' show positive shift with Δδ(DMSO-*d*$_6$ - $CDCl_3$) equal 0.01 ppm. The aromatic protons in halobenzene derivatives show positive shift Δδ(DMSO-*d*$_6$ - $CDCl_3$) from 0.04 ppm to 0.14 ppm [13].The Δδ(DMSO-*d*$_6$ - CDCl3) is negative for the protons at sites 8, and 8'.The aromatic protons in phenol show negative shift with Δδ(DMSO-*d*$_6$ - $CDCl_3$) -0.17, -0.09 and -0.08 ppm for the para, meta and ortho protons, respectively [3].

From Table 1, it is clear that the chemical shifts of protons at sites 11 and 12 are systematically affected as the solvents polarity decreases. The chemical shift of the signal is increased as the solvent polarity decreases from DMSO-*d*$_6$ to $CDCl_3$. The chemical shift of proton at site 11 changed substantially as the solvent polarity changes, with maximum value when moving from DMSO-d_6 to chloroform (-0.42 ppm) [34]. The π-shift on this proton is caused by a large differential π-shift excess, which leads to a change in chemical shift (-0.42 ppm) [3]. On the other hand, the chemical shift of proton at site 12 slightly changed with the solvent polarity compared to the changes shown by the chemical shift of proton at site 11. The changes in ^{1}H-NMR chemical shifts with change of solvent obtained for M2 are in agreement with previous studies based on Δδ values and recorded from |0.01| to |0.4| for H-C-C protons [13, 17].

Table 2 presents the DFT-calculated ^{1}H NMR chemical shifts (δ calcd.) of M2 with IEFPCM in DMSO, CH_3OH, and $CHCl_3$ at the B3PW91/6-311++G(d,P) and B3PW91/6-311++G(2d,P) levels of theory. For the two levels of theory utilized, excellent correlation coefficients (R) and coefficient of determination (R^2) with experimental ^{1}H-NMR chemical shifts were observed (Table 3). It also notes that the calculations are at the B3PW91/6-31++G(d,p) level slightly outperformed those at the B3PW91/6-31++G(2d,p) level in terms of correlation coefficient, and root-mean-square error RMSE. This is in line with earlier research, which has shown that expanding the basis set and computation cost does not always result in further accurate chemical shifts [35, 36].

Based on RMSE values Table 3 shows that DFT calculations using chloroform and methanol provided a slightly better agreement for the entire molecule than DMSO. Calculated ^{1}H-NMR chemical shifts (at /B3PW91/6-311++G(d,p) level with IEFPCM in DMSO and CH_3OH, respectively) *vs.* experimental 1H-NMR chemical shifts of M2 can be seen in Figures 1 and 2.

Table 2: Calculated chemical shifts (ppm) using B3PW91/6-311++(d,p),and B3PW91/6-311++(2d,p) levels of M2 with IEFPCM in DMSO, CH_3OH, and $CHCl_3$.

Solvent	DMSO		CH_3OH		$CHCl_3$	
Position	$\delta_{Calcd.}$ B3PW91/6-311++G(d,p)	$\delta_{Calcd.}$ B3PW91/6-311++G(2d,p)	$\delta_{Calcd.}$ B3PW91/6-311++G(d,p)	$\delta_{Calcd.}$ B3PW91/6-311++G(2d,p)	$\delta_{Calcd.}$ B3PW91/6-311++G(d,p)	$\delta_{Calcd.}$ B3PW91/6-311++G(2d,p)
1	2.81	2.78	2.8	2.78	2.79	2.77
5	2.8	2.76	2.79	2.76	2.76	2.73
7,7'	8.15	8.18	8.15	8.18	8.1	8.13
8,8'	8.86	8.93	8.86	8.93	8.87	8.93
11	7.09	7.12	7.08	7.11	6.88	6.93
12	7.65	7.75	7.64	7.74	7.52	7.62

Table 3: Results of correlation between calculated and experimental ^{1}H-NMR chemical shifts

Level of theory	Solvent	R	R^2	RMSE
B3PW91/6-311++(d,p)	DMSO	0.99757	0.9951	0.474
	CH_3OH	0.99723	0.9944	0.368
	$CHCl_3$	0.99067	0.9814	0.392
B3PW91/6-311++(2d,p)	DMSO	0.99754	0.9950	0.514
	CH_3OH	0.99722	0.9944	0.409
	$CHCl_3$	0.99124	0.9825	0.415

The correlation between the solvatochromic parameters, and dielectric constant of DMSO, CH_3OH and $CHCl_3$ solvents, and experimental ^{1}H-NMR chemical shifts of M2 in three deuterated solvents was investigated. The solvatochromic parameters were as follows: solvent basicity (SB), solvent acidity (SA), acceptor number scale (AN), donor number scale (DN), solvent dipolarity and polarizability scale (SPP), scale of solvent hydrogen-bond acceptor basicities (β).

Table 4 lists the values of solvatochromic parameters and dielectric constant of the solvents examined.

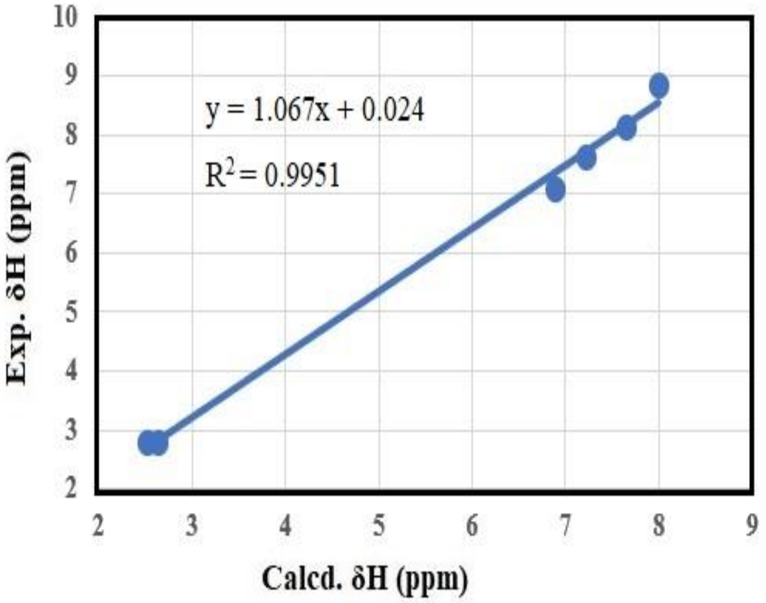


Figure 1: Experimental 1H-NMR chemical shifts of M2 vs. Calculated 1H-NMR chemical shifts (at the GIAO/B3PW91/6-311++G(d,p) level with IEFPCM in DMSO).

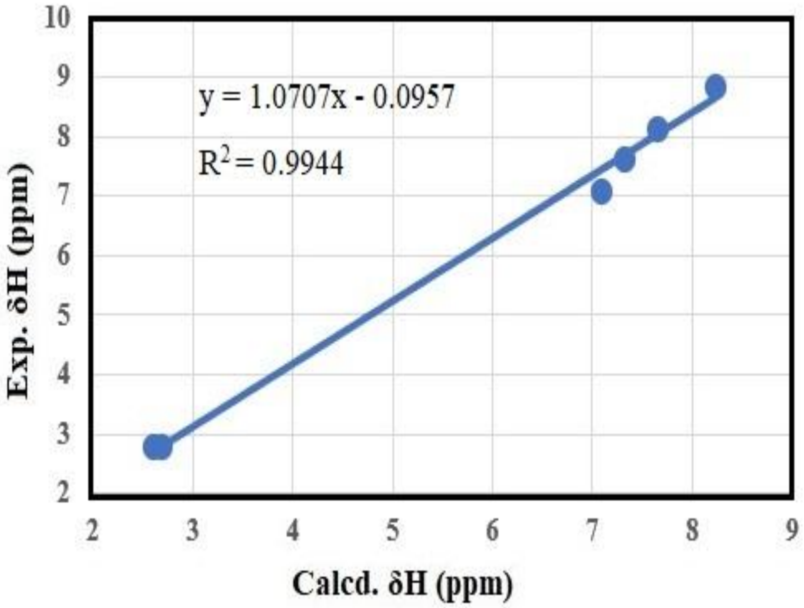


Figure 2: Experimental ^{1}H-NMR chemical shifts of M2 *vs.* Calculated ^{1}H-NMR chemical shifts (at the GIAO/B3PW91/6-311++G(d,p) level with IEFPCM in CH_3OH).

Table 4: dielectric constant, and solvatochromic parameters of DMSO, CH_3OH and $CHCl_3$ solvents.

Parameter / Position	ε[a]	SA[b]	SB[c]	AN[d]	DN[e]	B[f]	SPP[g]
DMSO	47.24	0.072	0.647	19.3	29.8	0.76	1
CH_3OH	33.00	0.605	0.545	41.3	19	0.66	0.857
$CHCl_3$	4.80	0.047	0.071	4	4	0.1	0.786

Sources: a values [37], b and c[38], dand e [39, 40], f[41], and g [41]

The correlation coefficient of the solvents parameters and the ^{1}H-NMR chemical shift values obtained are listed in Table 5. The poor correlation coefficient ($r \leq |0.7|$) was noticed in Table 5. It cannot be enhanced by implicitly allowing for many distinct interaction mechanisms between the solute and the solvent(the multi-solvent parameter approach) because there is a few solvents evaluated in this work [42]. The ^{1}H-NMR chemical shifts of protons at positions 1, 5,11 and 12 have a strong negative correlation with the values of the dielectric constant of the solvents. This suggests that the ^{1}H-NMR chemical shifts of these protons are inversely affected by the polarity of solvents, which are represented by their dielectric constants.

Table 5: Correlation coefficient values for relation between experimental 1H-NMR chemical shifts of M2 and some parameters values of three solvents under studied.

Parameter / Position	ε	SA	SB	AN	DN	β	SPP
1	-0.982	-0.039	-0.936	-0.408	-0.995	-0.927	-0.981
5	-0.929	0.149	-0.854	-0.228	-0.959	-0.840	-1.00
7, 7'	0.652	0.885	0.771	0.994	0.578	0.787	0.325
8, 8'	-0.569	0.672	-0.422	0.349	-0.643	-0.399	-0.833
11	-0.982	-0.039	-0.936	-0.408	-0.995	-0.927	-0.981
12	-0.945	0.103	-0.877	-0.273	-0.972	-0.864	-0.998

From Table 5, the ^{1}H-NMR chemical shifts of protons at positions 1,5,11 and 12 exhibit weak correlation with SA while the ^{1}H-NMR chemical shift of protons at positions of 7, and 7' has a strong positive correlation (R= 0. 885).

The ^{1}H-NMR chemical shifts of protons at positions 1,5,11 and 12 have excellent negative correlation with DN values. Hanna [42] found a fair linear correlation between the chemical shifts of the N-H proton of morpholine and the solvent DN values (n=9, R=0.72).

Figure 4 shows the correlation between DN values and ^{1}H NMR chemical shift of proton at position 11. AN values exhibit weak correlation with the ^{1}H-NMR chemical shifts of protons at positions 5, 12, 8 and8'. In contrast, AN values exhibit very strong positive correlation with the ^{1}H-NMR chemical shifts of protons at positions 7, and 7' (Figure 3). This demonstrates the high dependence of this signal on AN value.

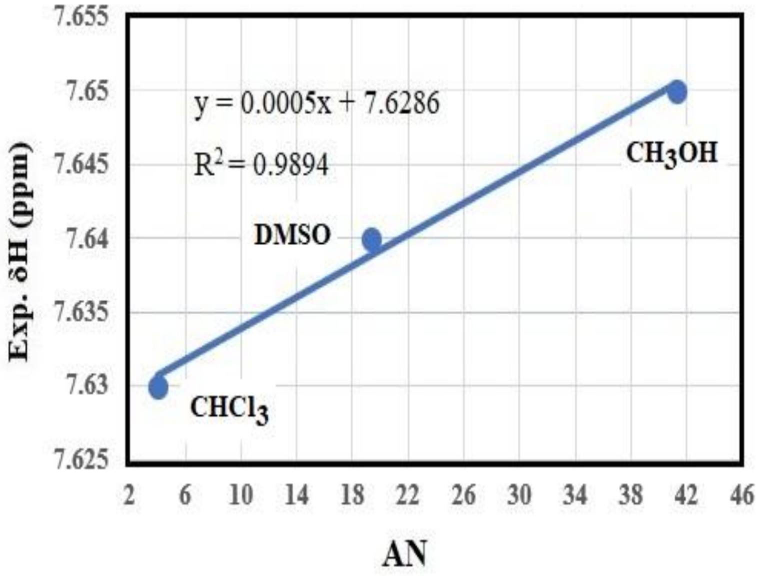


Figure 3: Graphical representation of the relationship between AN values and experimental ^{1}H-NMR chemical shifts of protons at positions 7,7".

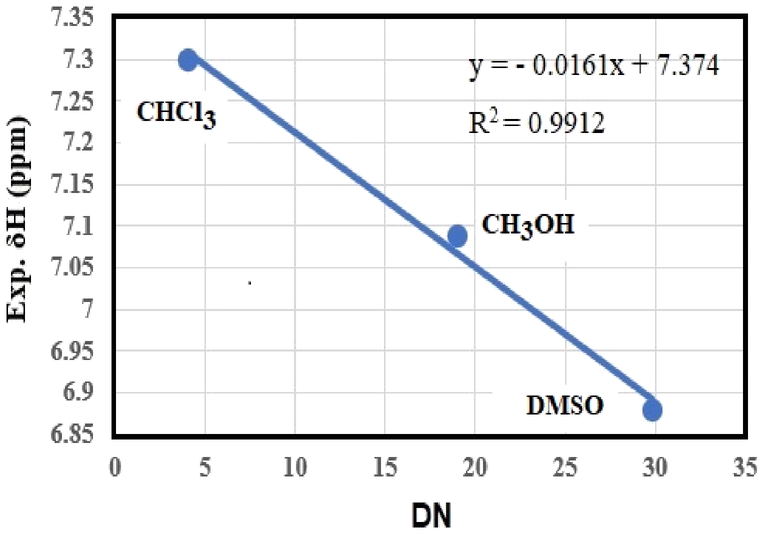


Figure 4: Graphical representation of the relationship between DN values and experimental ^{1}H-NMR chemical shifts of proton at position 11.

The last solvatochromic parameters studied are β and SPP. The β values give weaker correlations with signal of protons at positions 8, and 8'. It has an excellent negative correlation with the ^{1}H-NMR chemical shifts of protons at positions 1,and 11. Lapuka and co-workers got excellent correlation (n =10, R = 0.996) for solvent β values with ^{1}H-NMR signal of acetylenic proton in 2- methylbut-l-ene-3-yne [43].

On the other hand, the SPP values give strong correlations with most signals, except for the resonant signal of protons at positions 7, and 7'. It gives excellent negative correlation with the ^{1}H-NMR chemical shifts of protons at positions 1,11, and 12 (R= -0.981, -0.981, and -0.998 respectively). More than that, it gives a perfect negative relationship with the ^{1}H-NMR chemical shift of protons at position 5 (Figure 5). It can be observed that all of the data is arranged in a straight line, and as SPP values increase, chemical shift decreases.

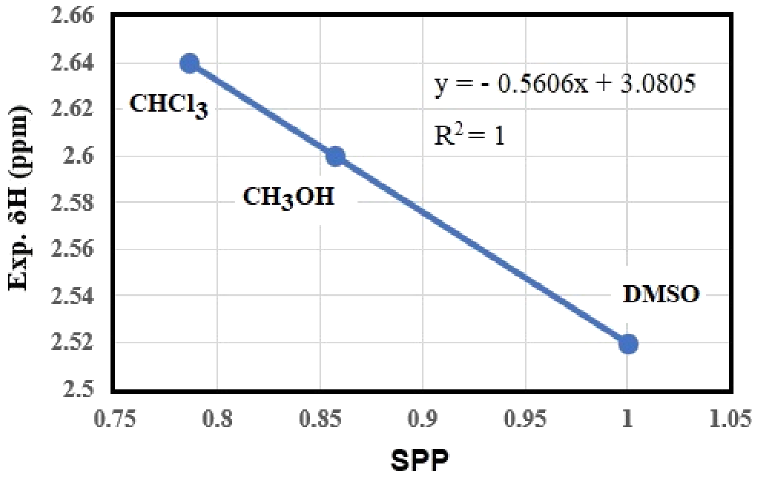


Figure 5: Graphical representation of the relationship between SPP values and experimental ^{1}H-NMR chemical shifts of protons at position 5.

CONCLUSIONS

The study shows a small effect of solvent polarity change on experimental ^{1}H-NMR chemical shifts of the molecule under research, except the substantial change for chemical shift of proton in position 11, Δδ(DMSO-*d6* - CDCl3) reaches -0.42 ppm . Changes in ^{1}H-NMR chemical shifts were in agreement with the results available from previous studies. In addition, the correlation between ^{1}H-NMR chemical shifts and solvatochromic parameters gave many excellent negative correlations. The correlation between ^{1}H-NMR chemical shift of methyl group that attached to triazole ring with solvent dipolarity and polarizability scale (SPP) values give perfect negative correlation (R= -1).

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