Prediction study by ab initio / HF and DFT / B3LYP methods of modes Vibration molecular frequencies by IR spectroscopy with structure Architecture and substituting reactivity effect from microscopic scale

of Thiohydantoin molecular to medicine

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Abstract—The Molecular geometry, vibrational frequencies, energy gaps, net charges, dipole moments and heats of formation for ThioHydantoin at the ground state, in present work, we have been calculated and performed by using the Molecular Mechanics, Quantum mechanics methods by different basis set in order to obtain optimized geometrical parameters are in good agreement with experimental values. Comparison of the obtained fundamental vibration frequencies of ThioHydantoin result by Density Functional Theory developed by Becke, Lee, Yang, and Parr method with simple regression, are in a close agreement with the experimental data. ab initio/ Hartree-Fock with three basis set was used to investigate the effects of a variety of substituants (methyl ,dimethyl, trimethyl ,and chloride ,dichloride ,trichloride) on the electronic properties of ThioHydantoin derivatives. Detailed vibrational wave number shifts and vibrational mode analyses were reported.

Keywords—*ThioHydantoin; Vibrational frequencies; Substituent effect; DFT; ab initio.*

I- Introduction

From the microscopic scale in molecular to medicine, molecules of Thiohydantoins,2-thioHydantoins are the most notable with a large number of medicinal and industrial applications, Among the known these molecules are most due of their wide applications as hypolipidemic,antithyroidal [1,15], anticarcinogenic, antimutagenic [2,28], antiviral (e.g., against herpes simplex virus, HSV) [16], human immunodeficiency virus (HIV) [16] and tuberculosis[23], antimicrobial(antifungal and antibacterial) [27], anti-ulcer and anti-inflammatory agents [11], as well as pesticides [5]. Additionally, 2-Thiohydantoins have been used as reference standards for the development of C-terminal protein sequencing [31,6], as reagents for the development of dyes [20] preparative methods for 2-Thiohydantoins include the reactions between thiourea and benzyl [24,28], amino amide and diimidazolethiocarbonate [4,7], and others [21].However, the above methods often suffer from one or more synthetic limitations for large-scale preparation of 2-Thiohydantoin derivatives due to their use of expensive, moisture sensitive and/or highly toxic starting materials and reagents. Moreover, the methods developed for combinatorial synthesis and used to prepare 2-Thiohydantoin derivatives in small quantities for purposes

like biological testing may not be feasible when operated on a large scale [9,19].

In recent years, the theoretical study of geometry and electronic structures has proved to be very efficient to predict the physical-chemistry properties of large systems [5,31]. The theoretical calculation of vibrational properties is used to understand the spectra's of large number of donor-acceptor systems [29,24]. Consequently, these calculations can be performed at different accuracy levels depending on the aim of the theoretical study. The substituants attached to the molecular framework can enhance or diminish the reactivity.

In this study the Molecular geometry optimization, vibrational frequencies, energy gaps, net charges, dipole moments and heats of formation.ThioHydantoin at the ground state, in present work, we have been calculated and performed by using the Molecular Mechanics, PM3, ab initio/HF and DFT/B3LYP methods basis set in order to obtain optimized geometrical parameters are in good agreement with experimental values. Comparison of the obtained fundamental vibrational frequencies of ThioHydantoin result by DFT/B3LYP (6-311G++ (d, p)) method, are in a close agreement with the experimental data. Ab initio/HF with 6-31G basis set was used to investigate the effects of a variety of substituants (methyl ,dimethyl, trimethyl ,and chloride ,dichloride ,trichloride) on the electronic properties of ThioHydantoin derivatives. Detailed vibrational wave number shifts and vibrational mode analyses were reported.Thiohydantoins are sulfur analogs of ThioHydantoin and derivatives with one or both carbonyl groups replaced by thiocarbonyl groups [30].

1. COMPUTATIONAL DETAILS

Initial calculations were optimized using HyperChem 8.03 software [20,31]. The geometries of ThioHydantoin and its derivatives; were first fully optimized by molecular mechanics, with MM+ force-field (rms = 0.001 Kcal/Å). Further, geometries were fully re-optimized by using PM3 method [19,25,24]. In the next step, a parallel study has been made using Gaussian 09 program package [30,8], at various computational levels, HF/6-31G+, 6-31G++ (d,p), 6-311G++ (d,p),and B3LYP/6-31G+, 6-31G++ (d,p), 6-311G++ (d,p). The calculated results have been reported in the present work.

2. RESULTS AND DISCUSSION

2.1. Molecular geometry of ThioHydantoin

The molecular structure of Thiohydantoinis shown in (Figure 1). With this structural model, Thiohydantoin [24,12,20].

The optimized geometrical parameters of Thiohydantoin by ab initio/HF and DFT method have been depicted and compared with experimental parameters [13] obtained from the crystal structure analyses of Thiohydantoin in (Table 1).

(S6-C2)and 1,396A° (C2–N1) at B3LYP/DFT, 1,37A°(C2–N3) and 1,205A°(C4-O7) at ab initio/HF,and 1,37A°(N3-C2)at B3LYP/DFT or ab initio/HF for the bond lengths and 131,5°(S6-C2-N1),122,8°(S6-C4-N3) at ab initio/HF also 125,5°(O7-C4-N3)or 128,2°(O7-C4-N3)basis sets for the bond angles.On the other hand, dihedral angles 174, 8° (O4-C4-C5-N1) which is close to the currently accepted experimental values this confirms our structure has a flat geometry.
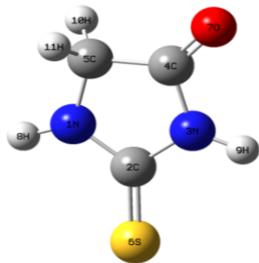
Fig. 1: Conformation 3D of molecular structure and atom numbering adopted in this study for ThioHydantoin (GaussView 09)

Thus, in this work was revealed good between the experimentally obtained values data are in good agreement with the theoretical calculations for bond lengths, bond angles and dihedral angles. The nearly of the calculated geometries from the experimental parameters are 1,633A°

Table 1: Comparison of the experimental and calculated values of bond lengths and bond angles of ThioHydantoin

Parameters	Exp.[34]	ab initio/HF			DFT(B3LYP)		
		6-31G+(d,p)	6-31G++(d,p)	6-311G++(d,p)	6-31G+(d,p)	6-31G++(d,p)	6-311G++(d,p)
Bond Length(A°)							
S6-C2	1,633	1,62136	1,62136	1,62136	1,62136	1,62135	1,62136
N1-C2	1,396	1,39612	1,39612	1,39612	1,39612	1,39606	1,39612
O7-C4	1,205	1,21096	1,21096	1,21096	1,21096	1,2109	1,21096
N3-C2	1,37	1,41999	1,41999	1,41999	1,41999	1,41999	1,43513
Bond angle (°)							
S6-C2-N1	131,5	127,430	127,430	127,430	127,430	127,433	127,430
S6-C2-N3	122,8	127,297	127,297	127,297	127,292	127,292	127,297
O7-C4-N3	125,5	122,529	122,529	122,529	122,529	122,530	122,529
O7-C4-C5	128,2	130,847	130,847	130,847	130,847	130,849	130,847
Dihedral angles (°)							
C4-N3-C2-S6	174,80	179,989	179,989	179,994	179,994	179,994	179,994

2.2. Vibration frequencies of ThioHydantoin

IR spectroscopy can give a great deal of information on small ring heterocyclic, because of the effects of ring strain on the frequencies of vibration of substituent's attached to the ring, and because the ring vibrations fall into a readily accessible region of the IR spectrum [13, 15, 28].Experimental and theoretical (HF/6-31G+ (d, p)) vibration wave numbers of ThioHydantoin were given in Table 2.ThioHydantoin consists of 11 atoms, which has 27 normal modes. These normal modes of the title molecule have been assigned according to the detailed motion of the individual atoms. All normal modes assigned to one of 13 types of motion(C–H, C=O,C=S, C–H, and stretching's; HCH, CCN, CCH, NC=S,NC=O, CC=O, NCN, CNC, CNH, and NCH bindings, and HNC=O, OCCH, HCNH, NCNH, CNC=S, NCCN, CNCC,NCNC and NH twisting, C-H,C=O,C=S Scissoring, C=O,C=S wagging, C-H rocking The asymmetric C-H stretching frequency decreases with increasing ring size, predicted by a calculation analysis. The results obtained from the calculations show that, while the harmonic corrections of wave numbers are closer to the experimental ones rather than wave numbers of forms gave the best fit to the experimental ones. The vibration wave numbers of the forms of ThioHydantoin obtained from the HF calculations are almost the most the same.

Table 2: Comparison of the experimental and calculated vibration spectra of ThioHydantoin.

Symmetry	EXP. IR [30]	ab- initio/HF			DFT(B3LYP)			assignment
		6-31G+(d,p)	6-31G++ (d,p)	6-311G++ (d,p)	6-31G+ (d,p)	6-31G++ (d,p)	6-311G++ (d,p)	
A		128,42	128,16	114,48	107,42	107,42	98,78	υ C4-H
A		162,84	164,31	136,91	148,54	149,20	137,76	υ C4-H
A		299,88	299,88	300,27	277,16	277,10	278,35	υ C4-H, ω C=O, ω C=S, ωN1-H,
A		469,35	470,59	440,08	402,13	404,46	391,51	υ C4-H
A	530	528,64	528,61	530,41	491,75	491,66	494,68	υC4-H, ωN1-H, υ C=O, υ C=S
A		552,68	552,56	554,92	513,70	513,65	515,83	υ C4-H, ω C=O, ω C=S, ωN1-H,
A		603,64	602,13	592,14	548,53	547,70	546,58	υ C4-H, ω C=O, ω C=S, ωN1-H,
A	631	656,44	656,08	637,00	600,44	600,43	592,88	υC4-H, υ N1-H, δ C5-H
A		718,22	717,32	718,28	648,53	647,87	651,20	υ C4-H, ω C=O, ω C=S, ωN1-H,
A		732,38	732,38	731,76	673,82	673,79	674,37	υ C5-H
A	964	950,96	950,80	947,32	875,24	875,11	871,93	υ C4-H, ω C=O, ω C=S, ωN1-H,
A	1045	1053,96	1053,86	1051,94	970,52	970,46	969,51	ω C5-H, ωN1-H, ω C=S, ω C=O, ωN3-H,
A		1113,50	1113,36	1110,39	1008,64	1008,35	1006,43	ω C=S, ω C=O ,ω C5-H, ωN1-H,
A	1156	1142,30	1142,24	1140,31	1061,44	1061,58	1058,49	υ C-H, ωN1-H, ωN3-H
A	1223	1248,86	1248,69	1245,90	1166,46	1166,31	1163,48	υ C4-H, ω C=O, ω C=S, ωN1-H,
A	1298	1299,82	1299,58	1298,12	1186,83	1186,23	1189,33	υ C4-H, ω C=O, ω C=S, ωN1-H,
A	1381	1316,72	1316,52	1304,73	1210,35	1210,38	1199,55	υ C5-H, ωN1-H, ωN3-H,
A		1457.14	1457,33	1451,19	1307,34	1307,39	1302,38	ω C=O ,ω C5-H, ωN1-H,
A	1528	1505,97	1505,74	1499,23	1368,16	1368,03	1363,98	υ C4-H, ω C=O, ω C=S, ωN1-H, υ N3-H
A		1550,84	1550,81	1544,17	1396,32	1396,24	1390,58	υ C4-H, ω C=O, ω C=S, ωN1-H
A		1621.02	1621,45	1615,67	1487,46	1487,18	1483,30	υ C4-H, ω C=O, ω C=S, ωN1-H
A	1716	1690,13	1689,85	1682,77	1546,89	1546,71	1541,20	υ C4-H, ω C=O, ω C=S, ωN1-H, , ωN3-
A		2033,29	2033,25	2025,92	1835,64	1835,56	1830,66	δ C=S,δ C=O , υ C4-H, υ N1-H
A	3197	3228. 19	3228,25	3210,85	3052,36	3052,13	3039,31	ω C5-H, ω N3-H
A	3283	3892.6359	3276,78	3255,66	3093,82	3093,57	3076,47	υ C4-H, ω N3-H, τ N3-H, ρ C5-H
A		3888,39	3888,32	3871,52	3651,94	3651,92	3638,27	δ N3-H
A		3916.92	3916,69	3898,72	3677,89	3677,70	3664,92	δ N3-H

IR$_{exp}$: Experimental Infrared; asym: asymmetric; sym: symmetric; ν: bond stretching δ: scissoring; τ: twisting; ω: wagging; ρ: rocking;

**Fig. 2:** Different figures of 27 modes with bond of ThioHydantoin ring
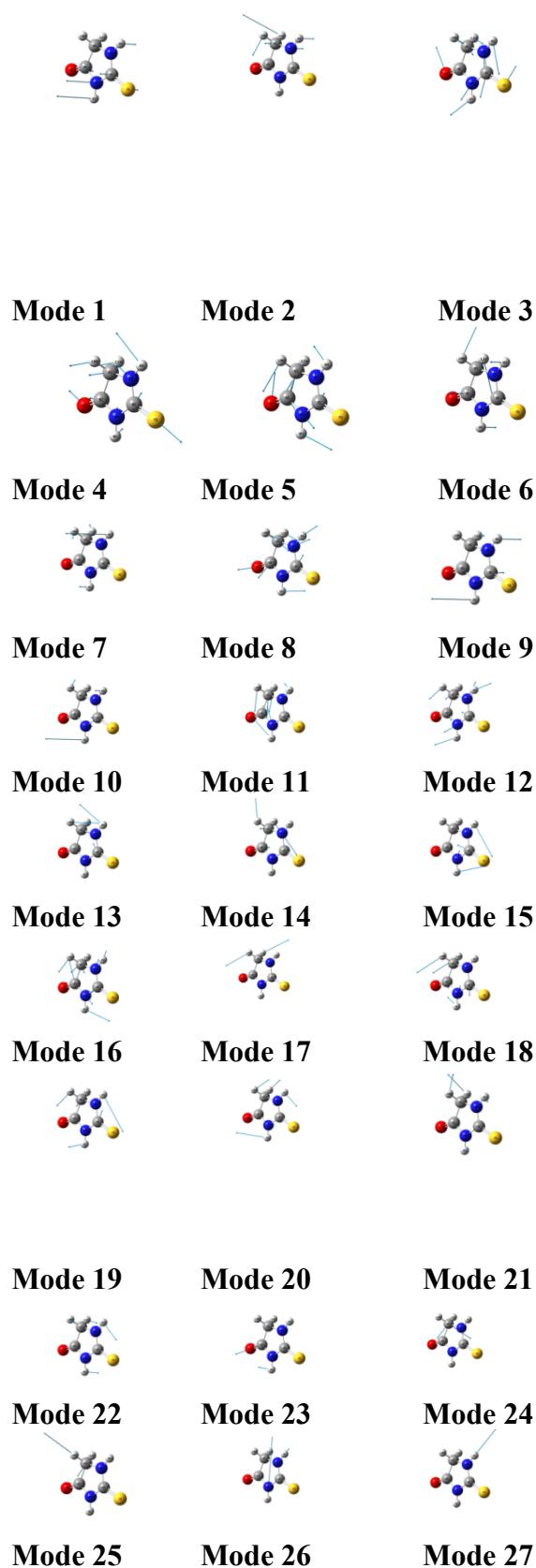
The diatomic molecules have only one link, which can stretched. The more complex molecules have m connections, and vibration maybe combined, leading to infrared absorption at the characteristic frequencies wh can be linked to chemical groups. For example, atoms CH_2, which is commonly found in organic compounds, vibrate in six different ways: stretching and skew symmet scissoring, and rocking, agitation outside plane wagg and twistingv_1 (NH) stretching mode for monomer observed at (moderate intensity) $(3283–3197 cm^{-1})$, absorption in the large $428 Cm^{-1}$, $429,743428 C...$,$429,7797428 Cm^{-1}$ and $433,4412428 Cm^{-1}$ experimental values in good agreement with that obtained from ab-initio/HF theory using basis6-31G+(d,p)set and6-311G++(d,p) .v_3 C2=S6 and v C4=O7 stretching modes were observed with I-R intensity at 200, $371623 Cm^{-1}$ and frequency $1864,9723 Cm^{-1}$These considerations thus provide additional support. Cyclic imides represent an important class of compounds in medicinal chemistry due to its large spectrum of biological activities [12, 6].

Relation between experimental and predict

frequency by simple regression is obtained

Fig.3: Simple linear regression between the experimental frequencies and predict

v experimental frequency = 9.253 + 1.002 v predicted frequency [23]
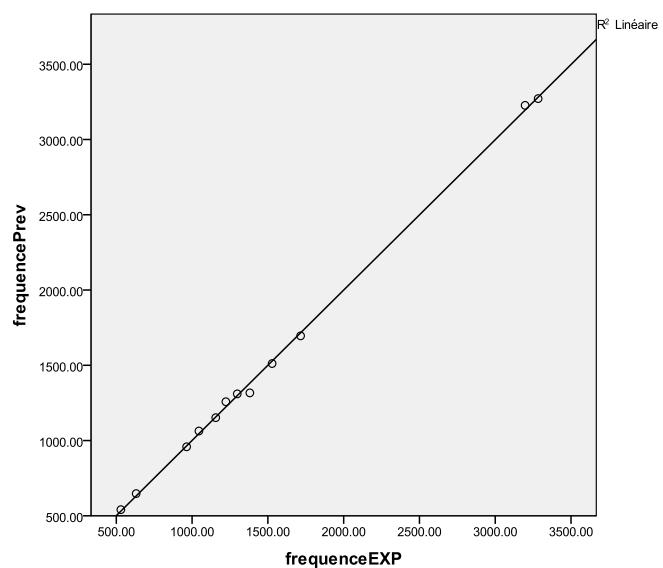
2.3. Electronic properties of ThioHydantoin
Highest occupied molecular orbital (HOMO and lowest unoccupied molecular orbita (LUMO) are very important parameters fo quantum chemistry. We can determine the wa the molecule interacts with other species hence, they are called the frontier orbital' [29]. Energies of the HOMO and the LUMO are very popular quantum chemica descriptors. The HOMO represents the abilit to donate an electron; their energy is directl related to the ionization potential an characterizes the susceptibility of the molecul to attack by electrophiles. On the other hand the LUMO as an electron acceptor; thei energy is directly related to the electro affinity and characterizes the susceptibility o the molecule to attack by nucleophiles [29] HOMO and LUMO energies, energy gap $(|\Delta E| = |EHOMO-ELUMO|)$ and dipol moments of Hydantoin calculated at al

initio/HF and B3LYP/DFT in 6-31G+ basis set is given in (Figure 2).The value of energy gap (ΔE) the low gap between HOMO and LUMO energies is for ThioHydantoin0,01375a.u. obtained at DFT/B3LYP (6-311G++(d,p)) whereas the (ΔE) for B1 is 0,2759a.u. and C1 0,25991 a.u Obtained at HF/ab initio (6-31G+) .Atomic charges of hydantoin, which have been calculated by Mullikan method at the ab initio/HF (6–31G+), and DFT/ B3LYP (6–31G+) levels of calculation are shown in below (Fig 4).

Atomic charges of ThioHydantoin, which have been calculated by Mullikan method at the ab initio/HF (6–31G+) and DFT/ B3LYP (6–31G+ levels of calculation are shown in below

ab initio/HF(6-31G+(d,p))

HOMO   LUMO

ΔE

LUMO

-0,05477

-0,23678

HOMO

E

|ΔE| = |EHOMO-ELUMO|
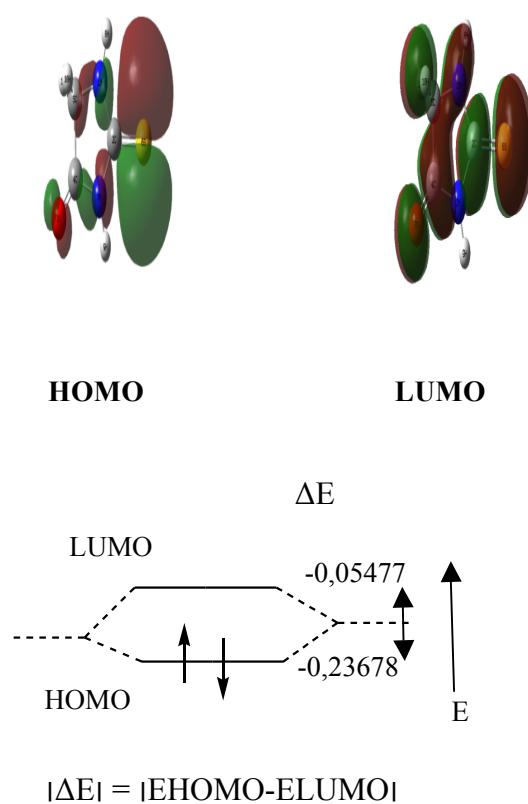
Fig.4: 3D plot of (a) HOMO and (b) LUMO
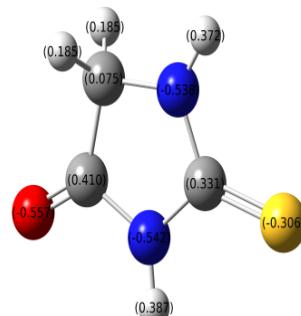
of the ThioHydantoin (DFT/B3LYP(6-311G++ (d,p))
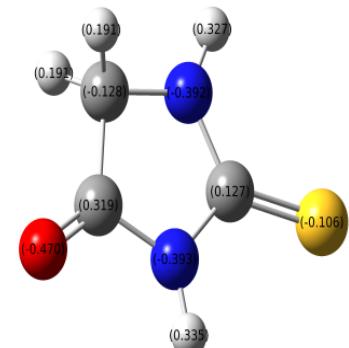
DFT/B3LYP(6-31G+(d,p))

Fig. 5: The Mulliken charges (Q$_M$) of Thiohydantoin

Shows that the atoms N1, N2, C5 and S6,O7 have negative Mullikan charges which leads to electrophilic substitution, whereas at the atom C2,C3 have positive Mullikan charge which lead to preferential site nucleophilic attack.

2.4. Substituent effects on the electronic structure in ThioHydantoin and derivatives

Substituent effects play a fundamental role in a variety of observed physical and chemical phenomena. For example, substituent effects influence the rates of nucleophilic substitutions and the molecule's reactivity, [25] vibration specter, [22] acid-base properties, [13] the conformations of molecules, and so forth.

The calculated values of (methyl, chloride) substituted ThioHydantoin are given in Table 4, Table 5, Table 6, Table 7, Table 8 and Table 9. The chemical structures of the compounds studied of ThioHydantoin and derivatives are shown in (Figure 4)/ (Table 3).

In (Table 4), Table 6 and Table 8, HOMO and LUMO energies, energy gaps ΔE, heat of formation and dipole moments are reported for ThioHydantoin and its derivatives. In Table 5, Table 7 and Table 9 net atomic charges are also reported.
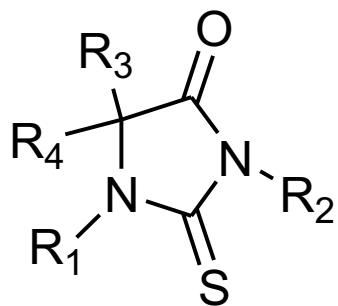
Fig. 6: Structure of ThioHydantoin derivatives

Table 3: Series 1 of ThioHydantoin and group's substituted ThioHydantoin

Compound	R_1	R_2	R_3	R_4
	Series 1			
A1	CH_3	H	H	H
A2	H	CH_3	H	H
A3	H	H	CH_3	H
A4	H	H	H	CH_3
A5	CH_3	CH_3	H	H
A6	CH_3	H	CH_3	H
A7	H	CH_3	CH_3	H
A8	H	CH_3	H	CH_3
A9	H	H	CH_3	CH_3
A10	CH_3	H	H	CH_3
A11	CH_3	CH_3	CH_3	H
A12	CH_3	H	CH_3	CH_3
A13	H	CH_3	CH_3	CH_3
A14	CH_3	CH_3	H	CH_3

Table 4: Series 2 of ThioHydantoin and group's substituted ThioHydantoin

Compound	R_1	R_2	R_3	R_4
	Series 2			
B1	Cl	H	H	H
B2	H	Cl	H	H
B3	H	H	Cl	H
B4	H	H	H	Cl
B5	Cl	Cl	H	H
B6	Cl	H	Cl	H
B7	Cl	H	H	Cl
B8	H	Cl	Cl	H
B9	H	H	Cl	Cl
B10	H	Cl	H	Cl
B11	Cl	Cl	Cl	H
B12	H	Cl	Cl	Cl
B13	Cl	H	Cl	Cl
B14	Cl	Cl	H	Cl

Table 5: Series 3 of ThioHydantoin and group's substituted ThioHydantoin

Compound	R_1	R_2	R_3	R_4
	Series 3			
C1	CH_3	Cl	H	H
C2	Cl	CH_3	H	H
C3	CH_3	H	Cl	H
C4	CH_3	H	H	Cl
C5	Cl	Cl	CH_3	CH_3
C6	Cl	Cl	Cl	CH_3
C7	CH_3	CH_3	CH_3	Cl
C8	CH_3	CH_3	Cl	Cl
C9	CH_3	Cl	Cl	Cl
C10	Cl	CH_3	CH_3	CH_3
C11	CH_3	CH_3	CH_3	Cl
C12	Cl	Cl	Cl	CH_3
C13	CH_3	Cl	CH_3	CH_3
C14	Cl	CH_3	Cl	Cl

Table 6: Energies of ThioHydantoin and derivatives (series1)

Compound	System	Heat of formation Kcal/mol	HOMO (a.u)	LUMO (a.u)	ΔE (a.u)	μ (D)
	ThioHydantoin	-9,7056357	-0,02152	-0,00777	0,01375	4,081
A1	1-methyl Thiohydantoin	-11,0051321	-0,33477	-0,2551	0,07967	4,356
A2	2-methylThiohydantoin	-9,7558576	-0,33567	-002599	0,30968	3,687
A3	3-methyl Thiohydantoin	-17,2585353	-0,33989	-0,03450	0,30539	3,929
A4	4-methyl Thiohydantoin	-17,2585376	-0,33988	-0,00391	0,33597	3,929
A5	1-2dimethyl Thiohydantoin	-10,8404679	-0,32984	-0,0209	0,30894	3,890
A6	1-3dimethylThio hydantoin	-17,0902209	-0,33244	-0,02498	0,30746	4,56
A7	2-3dimethyl Thiohydantoin	-17,2786109	-0,33457	-0,02962	0,30495	3,594
A8	2-4dimethylThiohydantoin	-17,2786110	-0,33455	-0,02961	0,30494	3,594
A9	3-4dimethyl Thiohydantoin	-23,2439497	-0,33613	-0,02803	0,3081	4,523
A10	1-4dimethyl Thiohydantoin	-17,0919723	-0,33243	-0,02499	0,30744	4,560
A11	1-2-3 trimethylThiohydantoin	-17,5728890	-0,32763	-0,02072	0,30691	3,742
A12	1-3-4 trimethylThiohydantoin	-23,3603744	-0,33062	-0,02351	0,30711	4,757
A13	2-3-4 trimethylThiohydantoin	-23,1685720	-0,33125	-0,02355	0,3077	4,13
A14	1-2-4 trimethylThiohydantoin	-16,8703291	-0,32763	-0,02068	0,30695	4,091

Heat of formation by PM3/HOMO, LUMO, ΔE and μ by ab initio/HF (6-31G+ (d,p)

Table 7: Mullikan charges of Thiohydantoin andderivatives (series1)

omp.	ThioH.	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A12	A11	A13	A14
N	0,0567	0,04399	0,05202	0,04182	004184	0,04107	0,041	0,0382	0,05413	0,0382	0,0410	0,046	0,030	0,050	0,038
C	-0,106	-0,00951	-0,0930	-0,1124	-0,1124	-0,0832	-0,118	-0,1002	-0,0989	-0,100	-0,066	-0,09	-0,12	-0,06	-0,082
N	0,0274	0,02363	0,013990	0,03356	0,03354	0,01137	0,025	0,02165	0,02565	0,0217	0,025	-0,03	0,019	0,013	0,013
C	0,2360	0,023544	0,251951	0,23492	0,2349	0,25155	0,231	0,25058	0,23508	0,2506	0,231	0,231	0,249	0,251	0,248
C	-0,1214	-0,10760	-0,12515	-0,1022	-0,1022	-0,1119	-0,075	-0,106	-0,058	-0,106	-0,094	-0,07	-0,08	-0,08	-0,080
O	-0,3012	-0,30499	-0,30271	0,29759	-0,2976	-0,3062	-0,304	-0,2988	-0,2990	-0,299	-0,304	-0,30	-0,30	-0,30	-0,30
S	-0,2448	-0,25017	-0,25434	-0,2167	-0,2167	-0,2596	-0,254	-0,2279	-0,2528	-0,228	-0,254	-0,26	-0,25	-0,26	-0,262
C		-0,00638	-0,06444	-0,1122	-0,1203	-0,0636	-0,066	-0,1198	-0,1164	-0,068	-0,118	-0,12	-0,08	-0,12	-0066
C									-0,1164	-0,119	-0,118	-0,12	-0,08	-0,12	-0,065
OC												-0,04		-0,06	-0,118

Net charge calculated by ab initio/HF (6-31G+ (d, p))

We note that the heat of formation decrease approximately 1,135 kcal/mole at addition of methyl group, 7,5 Kcal/mole at addition dimethyl/mole group and 13,54 Kcal/mole at addition trimethyl.

In the mono-substituted alkyl group category, the ThioHydantoin showing maximum positive charge on 2th position carbon (0, 415) which leads to nucleophile substitution (Table 5).The compound A1 is further supported by the smaller HOMO-LUMO energy gap (0.33789a.u) (Table 5) which depicts the chemical reactivity of the compound;

ThioHydantoin the C-2 position compound (A8) shows, smaller HOMO-LUMO energy gap (0,30494a.u) (Table 5). We also note that the methyl substituent (donor effect) has the effect of increasing the energy of the HOMO, with little change in the LUMO (Table 5).

higher is the HOMO-LUMO energy gap, lesser is the flow of electrons to the higher energy state, making the molecule hard and less reactive. On the other hand in smaller HOMO-LUMO gap, there is easy flow of electrons to the higher energy state making it softer and more reactive (HSAB principle: hard and soft acids and bases). Hard bases have highest-occupied molecular orbitals (HOMO) of low energy, and hard acids have lowest-unoccupied molecular orbitals (LUMO) of high energy [12, 20, and 8]. In the case of dimethyl substituted of

The presence of a donor groups in the C2 and C4 positions causes the decrease in dipole moment (compound A1), the compound (A12) shows maximum dipole moment value (4,757D) (Table 5) In the present work, we have studied chloride of substituted ThioHydantoin long the same line of methyl substituted ThioHydantoin for a comparative study.

Table 8: Energies of ThioHydantoin and derivatives (series2)

Compound	System	Heat of formation (Kcal/mol)	HOMO (a.u)	LUMO (a.u)	ΔE (a.u)	μ (D)
B1	1ChloroThiohydantoin	-5,0913502	-034474	-0,06876	0,27598	3,682
B2	2-Chloro Thiohydantoin	-4,2813065	-0,33811	-0,003955	0,29856	4,114
B3	3-Chloro Thiohydantoin	-13,3314574	-0,34549	-0,05722	0,28827	2,595
B4	4-Chloro Thiohydantoin	-13,3318167	-0,34549	-0,05720	0,28829	2,593
B5	1-2-DichloroThiohydantoin	-0,2862087	-0,34244	-0,04919	0,29325	3,701
B6	1-3-Dichloro Thiohydantoin	-8,4940204	-0,35491	-0,07461	-0,2803	2,513
B7	1-4-DichloroThiohydantoin	-8,4944630	-0,35017	-0,06420	0,28597	2,513
B8	2-3 DichloroThiohydantoin	-7,8540813	-0,34757	-0,05751	0,29006	2,638
B9	3-4 DichloroThiohydantoin	-16,9145623	-034847	-0,05974	0,28873	2,166
B10	2-4 DichloroThiohydantoin	-7,8546230	-0,34755	-0,05747	0,29008	2,640
B11	1-2-3 Trichlorothiohydantoin	-3,0955890	-0,35233	-0,06480	0,28753	2,417
B12	2-3-4 Trichlorothiohydantoin	-11,4288866	-0,35018	-0,05942	0,35018	2,176
B13	1-3-4 Trichlorothiohydantoin	-10,9667999	-0,35102	-0,06068	0,29034	1,998
B14	1-2-4 Trichlorothiohydantoin	-3,0955890	-0,35230	-0,06476	0,28754	2,417

Heat of formation by PM3/HOMO, LUMO, ΔE and μ by ab initio /HF (6-31G+ (d, p)

Table 9: Mullikan charges of ThioHydantoin and derivatives (series 2)

Comp.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
1N	-0,1095	0,0549	0,0347	0,0346	-0,1109	-0,0955	-0,0957	0,0369	0,0359	0,0370		0,03466	-0,1315	-0,0
2C	-0,0639	-0,0664	-0,1149	-0,1149	-0,0253	-0,0903	-0,0389	-0,0796	-0,1003	-0,0794	-0,0977	-0,0608	-0,0615	-0,0
3N	0,0255	-0,1398	0,0396	0,0396	-0,1418	0,0389	-0,0957	-0,1282	-0,0368	-0,1284	-0,1321	0,0370	0,0370	-0,1
4C	0,2384	0,2770	0,2268	0,2269	0,2792	0,2272	0,2272	0,2652	0,0226	0,2652	0,2654	0,2264	0,2260	0,26
5C	-0,0787	-0,1179	-0,1303	-01303	-0,0756	-0,1139	-0,0389	-0,1279	-0,1592	-0,1283	-0,1321	-0,1574	-0,1235	-0,1
6C														
6O	-0,2978	-0,2851	-0,2743	-0,2742	-0,2820	-0,2713	-0,2712	-0,2572	-0,2571	-0,2573	-0,2538	-0,2426	-0,2567	-0,2
7S	-0,2058	-0,2209	0,0156	-0,0182	-0,0756	-0,1349	-0,1345	-0,1560	-0,1863	-0,1563	-0,1033	-0,1640	-0,1578	-0,1
8Cl	0,1604	0,1788	0,0156	0,0156	0,1789	0,1330	0,1328	0.1799	0,0648	0,1800	0,1798	0,1877	0,1874	0,17
9Cl					0,1603	0,0512	0,0513	0,0163	0,06475	0,0169	0,1343	0,1382	0,0723	0,13
10Cl											0,0515	0,0662	0,0722	0,05

Net charge calculated by ab initio/HF(6-31G+(d,p))

The heat of formation is increased approximately 8, 24 Kcal/mol for each addition of chloride group. In mono-substituted chloride derivatives, 2chloro ThioHydantoin (compound B6) is predicted to be more chemically reactive on the basis of least HOMO-LUMO energy gap (0.2803a.u) (Table 6) and shows maximum positive charge (0,42) in carbon C-2 leading to favored site for nucleophilic attack (Table 7).

In di-substituted chloride derivatives, the carbon C-2 in 3-4-dichloro-ThioHydantoin (compound B9) shows maximum positive charge (0,225) leading to favored site for nucleophilic attack (Table 7). The compound3-4 -dichloro ThioHydantoin (B9) is more reactive than2 chloro ThioHydantoin (B6), this is due to smaller HOMO-LUMO energy gap (0.2805) which reflects a chemical stability (Table 6). The tri

substituted ThioHydantoin (compound B14) is predicted to be the most reactive with smaller HOMO-LUMO energy gap (0.28754a.u) (Table 6) and these considerations thus Provide additional support maximum positive charge (0,265) in carbon C-2 leading to favored site for nucleophilic attack (Table 6) of all Thiohydantoin systems.

We note also that the chloride substituen (attractor effect) lowers the energies of HOMC and LUMO, his influence on the energy of the LUMO is more important. The compound B shows the maximum dipole moment valu (4,114D), it would be originate from an attracto effect in position C2.

Table 10: Energies of ThioHydantoin and derivatives (series3)

Comp.	System	Heat of formation (Kcal/mol)	HOMO (a.u)	LUMO (a.u)	ΔE (a.u)	μ (D)
C1	2Chloro1methyl ThioHydantoin	-5,5776164	-0,33473	-0,03741	0,25991	4,409
C2	1Chloro2methylThio Hydantoin	-5,1253669	-0,33672	-0,04035	0,29637	3,302
C3	3Chloro1methylThio Hydantoin	-13,766805	-0,34182	-0,05388	0,28794	2,986
C4	4Chloro1methylThio Hydantoin	-13,7683732	-0,34186	-0,05386	0,288	2,982
C5	1-2-Dichloro3-4dimethyl Thiohydantoin	-12,5109731	-0,33984	-0,04546	0,29438	4,203
C6	1-2-3Trichloro4methylThiohydantoin	-11,2389458	-0,35013	-0,066175	0,28838	2,864
C7	4Chloro1-2-3trimethylThiohydantoin	-21,3245754	-0,33475	-0,04521	0,28954	3,211
C8	3-4Dichloro1-2dimethylThiohydantoin	-17,2638813	-0,34114	-0,05440	0,28674	1,96
C9	1Methyl2-3-4Trichloro Thiohydantoin	0,0963718	-0,34650	-0,0563	0,28957	2,522
C10	1Chloro 2-3-4 TrimethylThiohydantoin	-17,820059	-0,33419	-0,03802	0,29617	4,157
C11	2Chloro1-3-4Trimethyl Thiohydantoin	-17,9623619	-0,33217	-0,03514	0,29703	4,830
C12	2Methyl1-3-4 TrichloroThiohydantoin	-11,1959304	-034727	-0,05770	0,28957	1,614

Heat formation by PM3/HOMO, LUMO, ΔE and μ by ab initio/HF (6-31G+ (d, p))

Table 11: Mullikan charges of ThioHydantoin and derivatives (series3) Net charge calculated by ab- initio/HF (6-31G+(d,p))

Comp.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1N	0,0425	-0,112	-0,100	0,026	-0,109	-0,099	0,033	0,026	0,028	-0,037	0,044	-0,135
2C	-0,056	0,052	-0,076	-0,100	0,021	-0,050	-0,065	-0,079	-0,068	-0,010	-0,054	-0050
3N	-0,142	0,013	0,0349	0,035	-0,140	-0,131	0,017	0,021	-0,137	-0,051	-0,138	0,024
4C	0,2763	0,255	0,226	0,226	0,276	0,268	0,243	0,239	-0,051	-0,184	0,272	0,242
5C	0,1042	-0,083	-0,113	-0,114	-0,008	-0,063	-0,072	-0,144	-0,141	-0,116	-0,036	-0,125
6C	-0,065	-0,066	0,0261	-0,124	-0,124	-0,139	-0,128	-0,066	0,265	-0,075	-0,070	-0,068
6O	-0,289	-0,299	-0,278	-0,278	-0,280	-0,254	-0,281	-0,262	-0,246	-0,070	-0.287	-0,258
7S	-0,226	-0,215	-0,197	-0,196	-0,189	-0,116	0,066	-0,205	-0,172	0,059	-0,233	-0167
8C										0,0115	-0,069	
8Cl	0,1772	0,159	0,0130	0,013	0,175	0,141	0,0137	0,0592	0,187	0,0072	0,174	0,187
9C										0,0124	-0,120	
9Cl					0,154	0,177		0,0591	0,064			0,069
10Cl						0,041			0,064			0,069
11Cl												
10C										-0,120		
11C												

The heat of formation is decreased for each addition of methyl group and increased for each addition of chloride group.

In the mono-substituted methyl group, the (compound C3 and C4) showing positive charge on 2th position carbon (0, 226) and in the mono-substituted chloride group, the (compound C2) showing positive charge on 2th position carbon (0,227) which leads to nucleophilic substitution (Table 9). In mono-substituted chloride derivatives the compound (C1) are predicted to be more chemically reactive on the basis of least HOMO-LUMO energy gap (0,25991a.u) and maximum dipole moment value (4,830D)(Table 8).The di-substituted ThioHydantoin (compound C8) is predicted to be the most reactive with smaller HOMO-LUMO energy gap (0,28674a.u)

(Table 8) and positive charge (0,240) in carbon C-2 leading to favored site for nucleophilic attack (Table 9). In tri-substituted chloride derivatives the compounds (C9,C12) are more reactive due to smaller HOMO-LUMO energy gap (0,28957a.u) which reflects a chemical stability of all tri-substituted ThioHydantoin system (Table 8),the compound (C11) with the maximum dipole moment value (4,8301D) and more less smaller HOMO-LUMO energy gap (0,29703a.u) table (8).The different substitutions shown the best small energy(0,27219a.u) compared with al compound C1 is predicted to be most reactive and the maximum dipole moment value(4,409D) is 2Chloro1 methyl ThioHydantoin involve asymmetric compound and positive charge to best favored site for nucleophilic attack is compound 1chloroThioHydantoin.

3. CONCLUSION

The present study has that the aim qualitative; we are trying to clarify the proprieties of ThioHydantoin, throw computational methods. Bond lengths and angles have been calculated by using HF/6-31(G+), 6-31G++(d,p) and 6-311G++(d,p) and B3LYP/6-31(G+), 6-31G++(d,p) and 6-311G++(d,p)methods and compared with experimental values.

All compared data have been shown to have a good agreement with each other. We have carried out ab initio and density functional theory calculation on the vibrational spectrum of ThioHydantoin. The vibrational frequencies of infrared intensities with the stretching wave numbers calculated by HF/(6-31+G(d, p)) method agree satisfactorily with experimental results. On the basis of agreement between the calculated and experimental results, assignments of all the fundamental vibrational modes of ThioHydantoinwere examined and proposed in this investigation. This study demonstrates that scaled HF/(6-31+G(d, p)) calculations are powerful approach for understanding the vibrational spectra of medium sized organic compounds.

Resulting in well with the equation of simple linear regression

$$\upsilon_{\text{experimental frequency}} = 9.253 + 1.002\ \upsilon_{\text{predicted frequency}}$$

In the substituted Methyl, Chloride and with the combination of two groups, 1-Methy ThioHydantoin, 1-3DichloroThiohydantoin and 2ChloroMethylThioHydantoin are predicted to be the most reactive with leas HOMO-LUMO energy gap of al Thiohydantoin derivatives. The tri-chloroo ThioHydantoinis predicted to be the mos reactive with all chloro and methy derivatives. The presence of acceptor in B1(1ChloroThioHydantoin),

B6(1-3Dichloro ThioHydantoin) group position causes the decrease in energy gaps which reflects a chemical stability and show the maximum dipole moment value in B2(2-Chloro Thiohydantoin) derivatives ThioHydantoins constitute an importan class of heterocyclic and offer interesting activity biological in medicinal chemistry.

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