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Nano Theoretical Study of NMR Shielding Tensors on Ginger Plant

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ABSTRACT

In this research, the Magnetite nanoparticles (Fe_3O_4) were prepared by coprecipitation of Fe^{3+} and Ginger is a well known spice and flavoring agent which has also been used in traditional medicine in many countries. Ginger contains essential oils including gingerol and zingiberene. It also contains pungent principles such as zingerone, and shogaol. In the paper six theoretical methods were used to calculation of physical parameters for gingerol and zingiberene. Used to Gaussian 98, NMR and NBO calculations by using HF method with 6-31G, 6-31G* and 6-31+G basis set and B3LYP, BLYP and B3PW91 methods with 6-31G basis set. Chemical shift was drown curve for all of the atoms in each molecule. The thermochemical parameters including Thermal Energy(ΔE), Atomic charges, Chemical Shift Anisotropy(δ), Asymmetry parameter(η), Chemical Shift anisotropy(Δσ), Dipole orientation, Isotropic, anisotropic and NMR determinant for gingerol and zingiberene. Also the natural bond orbital (NBO) analysis has been performed which seem edquite informative to show some important atomic and structural features. Also we obtained Shielding value for the each atom with GaussView program (GIAO Magnetic shielding).

Keywords: Ginger; gingerol; zingiberene; zingerone; shagaol; NBO analysis; Nano physical parameters; GIAO

INTRODUCTION

Ginger (*Zingier officinale* Roscoe; family Zingiberaceae) is a well known spice and flavoring agent.

(a) Classification:
Kingdom: Plantae
Division: Angiosperma
Class: Monocotyledoneae
Order: Scitaminaea
Family: Zingiberaceae
Genus : *Zingiber*
Species : *officinale*

(b) Vernacular names:
Sanskrit : Adrakam, Ardraka
Hindi : Adrak,Sunthi,Sonth
Kannada : Sunthi
Marathi: Nisam
Gujarati: Sunt
English: Ginger

(c) Part used: Rhizome

(d) Botanical description: An herbaceous rhizomatous perennial, reaching up to 90 cm in height under cultivation. Rhizomes are aromatic, thick lobed, pale yellowish, bearing simple alternate distichous narrow oblong lanceolate leaves. The herb develops several lateral shoots in clumps, which begin to dry when the plant matures. Leaves are long and 2-3 cm broad with sheathing bases, the blade gradually tapering to a point. Inflorescence solitary, lateral radical pedunculate oblongcylindrical spikes. Flowers

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are rare, rather small, calyx superior, gamosepalous, three toothed, open splitting on one side, corolla of three subequal oblong to lanceolate connate greenish segments [1].

(e) Geographical distribution: The plant is widely cultivated all over India, Bangladesh, Taiwan, Jamaica and Nigeria. This perennial grows in warm climates [2].

(f) Traditional use: Ginger is carminative, pungent, stimulant, used widely for indigestion, stomachache, malaria and fevers. It is chiefly used to cure diseases due to morbidity of Kapha and Vata. Ginger with lime juice and rock salt increases appetite and stimulates the secretion of gastric juices. It is said to be used for abdominal pain, anorexia, arthritis, atonic dyspepsia, bleeding, cancer, chest congestion, chicken pox, cholera, chronic bronchitis, cold extremities, colic, colitis, common cold, cough, cystic fibrosis, diarrhoea, difficulty in breathing, dropsy, fever, flatulent, indigestion, disorders of gallbladder, hyperacidity, hypercholesterolemia, hyperglycemia, indigestion, morning sickness, nausea, rheumatism, sore throat, throat ache, stomach ache and vomiting. Ginger forms an important constituent of many pharmacopoeial Ayurvedic formulations [3, 4].

(g) Anatomy of the Rhizome: Scraped rhizome with buff external surface showing longitudinal striations and occasional loose fibers, outer surface dark brown and more or less covered with cork which shows conspicuous, narrow, longitudinal and transverse ridges; the cork readily exfoliates from lateral surfaces but persists between branches. Smoothed transversely cut surface exhibiting a narrow cortex separated by an endodermis from a much wider stele, numerous widely scattered fibrovascular bundles, abundant scattered oleoresin cells with yellow contents. Starch abundant in the thin-walled ground tissue, as flattened, ovate to subrectangular, transversely straited, simple granules, each with the hilum in a projection towards one end. Pigments cells with dark reddishbrown contents occurring either singly in the ground tissue or in axial rows accompanying the vascular bundles. Vessels with spiral or reticulate thickening in the scattered vascular bundles are found. Irregularly shaped thin-walled fibers with delicate, transverse septa, yielding only slightly the reaction characteristic of lignin. Sclereids and calcium oxalate crystals absent [5, 6].

(h) Pharmacology and Clinical Studies

Anti-emetic Activity: Early animal studies had demonstrated the anti-emetic property of fresh ginger [7], but it was the clinical work of Mowrey and Clayson which generated a wider interest in this use of ginger [8]. They compared the effects of 1.88g of dried powdered ginger, 100mg dimenhydrinate (Dramamine) and placebo on the symptoms of motion sickness in 36 healthy subjects who reported very high susceptibility to motion sickness. Motion sickness was induced by placing the blind folded subject in a tilted rotating chair. Ginger was found to be superior to dimenhydrinate and placebo in preventing the gastrointestinal symptoms of motion sickness and the authors postulated a local effort in the gastrointestinal tract for ginger. This was particularly likely since it was given as a powder only 25 minutes before the test. The gingerols and shogaols were subsequently identified as the main anti-emetic compounds in ginger [9].

Improvement of digestive function

Early Chinese and Japanese research found that oral and intragastric application of fresh ginger decoction produced a stimulant action on gastric secretion1. German scientists found that chewing 9g of crystallised ginger had a profound effect on saliva production [10]. Amylase activity was also increased and the saliva was not more watery, although it contained slightly less mucroprotein. Intraduodenal doses of ginger extract increased bile secretion in rats. Total secretion of bile solids was also increased, but not to the same extent as bile flow. 6-gingerol and 10-gingerol were identified as the active components [11]. Fresh ginger also contains a proteolytic enzyme [12]. Ginger, in conjunction with other pungent Ayurvedic herbs, increased the bioavailability of a number of drugs by promoting their absorption and/or protecting them from being metabolized in their first passage through the liver [7]. Oral doses of 6-shogaol accelerated intestinal transit in rats [13]. Also an extract of ginger, and isolated 6-shogaol and gingerols, enhanced gastrointestinal motility in mice after oral doses [14].

Anti-ulcer Activity

Ginger and 6-gingerol inhibited experimental gastric ulcers in rats [15, 16]. Fresh ginger decocted in water resulted in symptomatic improvement in 10 patients with peptic ulcers [7].

Antiplatelet Activity

Srivastava and co-workers found that aqueous extract of ginger inhibited platelet aggregation induced by ADP, epinephrine, collagen and arachidonic acid in vitro [17]. Ginger acted by inhibiting thromboxane synthesis [18, 19]. It also inhibited prostacyclin synthesis in rat aorta [17]. The antiplatelet action of 6-gingerol was also mainly due to the inhibition of thromboxane formation [20].

Anti-inflammatory Activity

Ginger extract inhibited carrageenan-induced paw swelling and was as active as aspirin [21]. Essential oil of ginger inhibited chronic adjuvant arthritis in rats [22].

Ginger and its pungent components are dual inhibitors of arachiodonic acid metabolism. That is, they inhibit both cyclooxygenase (prostaglandin synthetase) and lipoxygenase enzymes of the prostaglandin and leukotriene biosynthetic pathways [21, 23-28].

Antipyretic Activity

Ginger extract given orally reduced fever in rats by 38%, while the same dose of aspirin was effective by 44% [21]. The antipyretic activity of 6-shogaol and 6-gingerol has also been observed [13].

Cardiovascular Effects

Ginger exerted a powerful positive inotropic effect on isolated guinea pigs left atria [29]. Gingerols were identified as the active components [29, 30].

Antioxidant Activity

Extracts of ginger have pronounced antioxidant activity comparable to that of synthetic antioxidant preservatives [31].

Other Effects

Ginger extract exhibited a prolonged hypoglycaemic activity in rabbits [21]. Antihepatotoxic activities of gingerols and shogaols were observed using carbon tetrachloride and galactosamine induced cytotoxicity in cultured rat hepatocytes [32]. Injection of 6-shogaol showed an intense antitussive action in comparison with dihydrocodeine phosphate [13].

Pharmacokinetics

After injection, 90% of 6-gingerol was bound to serum protein and elimination was mainly via the liver [33]. Oral or intraperitoneal dosage of zingerone resulted in the urinary excretion of metabolites within [30] hours, mainly as glucuronide and/or sulphate conjugates. Appreciable biliary excretion (40% in 12 hours) also occurred [34].

(i) Toxicity and Adverse Reactions

The mutagenic activity of ginger extracts has been observed in several strains [28, 35]. As a result of component fractionation of ginger juice, it was found that 6- gingerol was a potent mutagen [36]. When mutagenicity of gingerol or shogaol was tested in the presence of zingerone, it was observed that zingerone suppressed the mutagenic activity of bothcompounds [28, 37].

Ginger extract caused no mortality at doses of up to 2.5g/kg in mice (equivalent to about 75g/kg of fresh rhizome) [21]. This low acute toxicity was confirmed in a separate study, which also found that ginger extract at 100mg/kg per day for three months caused no signs of chronic toxicity [38]. Topical application of ginger may cause contact dermatitis in sensitive patients [39].

(j) Phytochemistry

Ginger has been reported to contain usually 1-3% of volatile oil, pungent principles viz., gingerols and shogaols and about 6-8 lipids and others. Ginger oil contains Zingibereneand bisaboline as major constituents along with other sesqui and monoterpenes. Ginger oleoresin contains mainly the pungent principles gingerols and shogaols as well as zingiberone. Shogaols have recently been found to be twice as pungent as gingerols [7-10].

(k) Active principles

Gingerols, Shogaols.

Figures 1 and 2 show Zingiber officinal Plant and Zingiber officinal rhizome. Also Figure 3 show general structure of Gingerols and Figure 4 show Structure of Zingiberene.

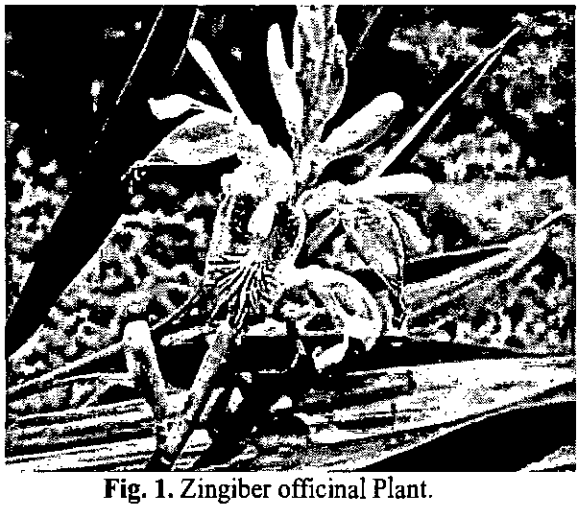


Fig. 1. Zingiber officinal Plant.

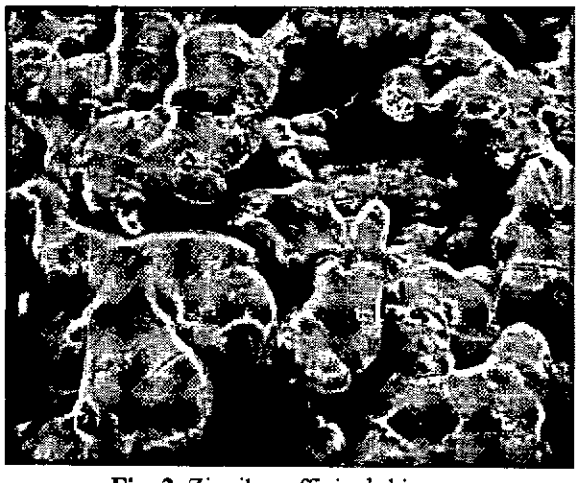


Fig. 2. Zingiber officinal rhizome.

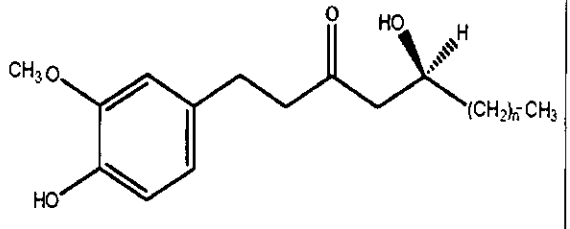


Fig. 3. General structure of Gingerols [(n=1, 2, 3, 4, 6, 8, 10) for specific compounds].

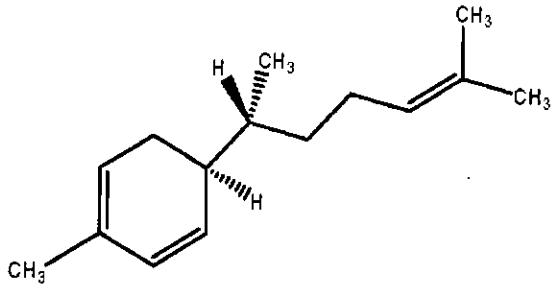


Fig. 4. Structure of Zingiberene.

METHODS

Stage 1: Start ChemDraw and construct molecules. Save the results as a ChemDraw file.

Stage 2: Reopen this file using Chem3D and perform an energy minimization. Then save the results as a gjc file.

Stage 3: Reopen this file using Gaussian98 and the calculations were performed using the *Gaussian® 98* program suite. Gaussian is one of the most widely used quantum chemical program packages for molecular applications, and is used both in industry and in many scientific areas in academia. we have calculated the geometric parameters of the compounds in the ground state the using the Hartree-Fock (HF) [40], Becke's three-parameter hybrid method [41] with the Lee, Yang, and Parr correlation functional methods [42] (B3LYP), Becke's exchange functional in combination with the Lee, Yang and Parr correlation functional methods (BLYP) [42,43], Becke's three parameter exchange functional combined with gradient corrected correlation functional of Predew and Wang's 1991 (B3PW91) [43,44], and 6-31G, 6-31G* and 6-31+G basis set.

The calculation that you ask Gaussian to perform is distributed between many processors to get the answer faster. If you want to optimize a geometry, it means that you want Gaussian to adjust the bond lengths, angles, and dihegrals to find the lowest energy conformation of the molecule. The command to tell Gaussian to optimize the molecular geometry is "opt".

The Gaussian program does semi-empirical and *ab initio* calculations. In *ab initio* calculations the important integrals are done directly from first principles. First principles means that the integrals are done either using closed formulas or by doing the integrals numerically. The particular *ab initio* method that works best for calculating NMR properties. Finding a good geometry is called geometry optimization, so "OPT" are used as the keyword.

The calculation will generate an output file called *filename.out*. The output file (*filename.out*) contains a lot of information about the calculation and the results. The content depends on what type of calculation that has been performed and on what print options that was specified. The units are usually Hartree (atomic unit) for energy and Angstrom for distance. There are several different pieces of data that

you may need from this. The important information is the Hartree Fock energy (ΔE), the Mulliken charges, Distance matrix (angstroms), Dipole moment (Debye) and Atomic charge. Distance matrix value is determined the using Matlab program.

We used Gaussian98 at the NMR shift calculation using the HF, B3LYP, BLYP, B3PW91 methods and 6-31G, 6-31G* and 6-31+G basis set [45]. There for "NMR" are used as the keyword. The calculation will generate an output file called *NMR.out*.The output file (*NMR.out*) contains a lot of information about the NMR shift calculation and are listed in the "GIAO Magnetic shielding tensor (ppm)", such as σ Isotropic(ppm) and σ Anisotropic(ppm). As the usig the X, Y and z with Matlab program is solved determinant 3*3 and σ is calculated. Molecular orbital calculations can be used to get good estimates for chemical shifts. In this exercise we calculated the chemical shifts for each of the atom, then using the Excel program draw the diagrams which shows chemical shifts for each of the atom.

In the part of "GIAO Magnetic shielding tensor (ppm)" the using the σ Isotropic(ppm), σ Anisotropic(ppm) and Eigen values(σ_{11}, σ_{22}, σ_{33}) are calculated parameters such as δ, η and Δσ [46].

A full NBO analysis is obtained in *Gaussian* when using the POP=NBO keyword. NBO analysis did using the HF, B3LYP, BLYP, B3PW91 methods and 6-31G, 6-31G* and 6-31+G basis set and the output is obtained for each of the molecule. The main listing of NBOs, displaying the form and occupancy of the complete set of NBOs that span the input AO space and for each orbital gives the type of orbital and the occupancy. We were extaracted just BD for 2-center bond and BD* for 2-center antibond from NBO.output [47].

We obtained Shielding value for the each atom with GaussView program (GIAO Magnetic shielding).

DISCUSSION

In this work, we calculated parameters such as atomic charges, energy (ΔE), chemical shift anisotropy (δ), asymmetry parameter (η), chemical shift anisotropy (Δσ), dipole orientation , isotropic , anisotropic , NMR determinant, distance matrix determinant, NBO calculations and magnetic shielding (GIAO) for zingiberene and gingerol using the HF method with 6-31G,6-31G* and 6-31+G basis set and B3LYP, BLYP and B3PW91 methods with 6-31G basis set. At in work, in molecule (1) (Figure 5). HF/6-31G method and in molecule (2) (Figure 6) with B3LYP/6-31G, BLYP/6-31G and B3PW91/6-31G any response is obtained.

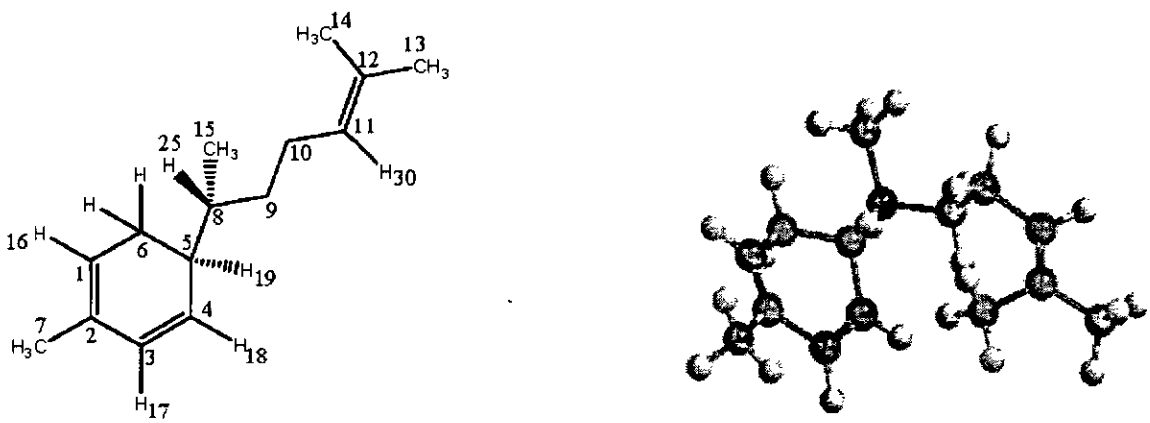


Fig. 5. Molecule 1[Zingiberene] or [(S)-2-methyl-5((R)-6-methylhept-5-en-2-yl) cyclohexa-1, 3-diene)].

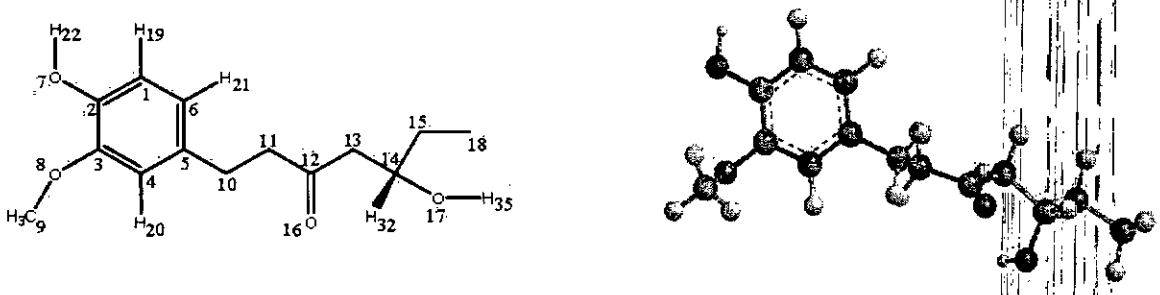


Fig. 6. Molecule 2[gingerol [n=1]] or [(S)-5-hydroxy-1-(4-hydroxy-3-methoxyphenyl) heptan-3-one].

These parameters are shown in Table 1 and 2. At present, in this section, we considered these parameters.

As shown in Table 1, in molecule (1) (zingiberene), with HF/6-31G and HF/6-31G*, C_{14} has greatest negative Atomic charge value and H_{17} has greatest positive Atomic charge value. With B3LYP/6-31G, C_{14} has greatest negative Atomic charge value and H_{25} has greatest positive Atomic charge value. With BLYP/6-31G, C_7 has greatest negative Atomic charge value and C_{12} has greatest positive Atomic charge value and with B3LPW91/6-31G, C_7 has greatest negative Atomic charge value and H_{25} has greatest positive Atomic charge value. In molecule (2), with HF/6-31G, HF/6-31+G and HF/6-31G*, C_{12} has greatest positive Atomic charge value and O_7 has greatest negative Atomic charge value.

As pointed in Table 1, for molecule(1), with HF/6-31G and HF/6-31G*, C_2 has greatest negative Chemical shift anisotropy (δ) value and C_{13} has greatest positive Chemical shift anisotropy (δ) value. While with B3LYP/6-31G, BLYP/6-31G and B3LPW91/6-31G, C_3 has greatest negative Chemical shift anisotropy (δ) value and C_2 has greatest positive Chemical shift anisotropy (δ) value. For molecule (2) with HF/6-31G, HF/6-31+G and HF/6-31G*, O_7 has greatest negative Chemical shift anisotropy (δ) value and O_{16} has greatest positive Chemical shift anisotropy (δ) value.

As pointed in Table 1, in molecule (1), for the atoms is shown in table η has the positive amounts. With HF/6-31G and HF/6-31G* Asymmetry parameter (η) value for C_4 is the greatest value and for H_{17} is the smallest value. With B3LYP/6-31G, η for C_4 is the greatest value and for H_{18} is the smallest value. Also BLYP/6-31G and B3LPW91/6-31G, η for C_{12} is the greatest value and for H_{18} is the smallest value. In molecule(2), with HF/6-31G, η for C_{14} is the greatest value and for C_9 is the smallest value, while with HF/6-31+G, η for O_8 is the greatest value and for C_9 is the smallest value. Also with HF/6-31G* η for C_{14} is the greatest value and for H_{21} is the smallest value.

The results from Table 1 indicate that in molecule (1) HF/6-31G and HF/6-31G*, Chemical shift anisotropy (Δσ) value for C_{13} is greatest positive value and for C_2 is greatest negative value. With others methods, C_2 has greatest positive value for Chemical shift anisotropy (Δσ) and C_3 has greatest negative value for Chemical shift anisotropy (Δσ).

Dipole orientation (Dipole moment) that reported in Table 1, at the molecule (1) for B3PW91/6-31G level is the greatest value and for HF/6-31G* level is the smallest value. While at the molecule (2), Dipole orientation (Dipole moment) for HF/6-31+G level is the greatest value and for HF/6-31G* level is the smallest value.

ΔE (kcal/mol) that reported in Table 1, for two molecules at HF/6-31G is zero. ΔE for molecule (1) with B3LYP method and for molecule (2) with HF/6-31G* has greatest negative value.

As shown in Tahle 2, in molecule (1) with HF/6-31G, B3LYP/6-31G and BLYP/6-31G σ_{iso}(σ Isotropic(ppm)) for carbon atoms, C_{14} is greatest value and whit HF/6-31G* and B3PW91/6-31G C_{15} is greatest value, but for hydrogen atoms in all methods H_{19} has greatest value. In molecule (2) with HF/6-31G, HF/6-31+G and HF/6-31G*, σ_{iso} for carbon atoms C_{13} has greatest value, for hydrogen atoms H_{35} has greatest value and for oxygen atoms O_{16} has negative greatest value.

Table 1. Values of parameters like atomic charges, ΔE (kcal/mol), chemical shift (δ), asymmetry parameter (η), chemical shift anisotropy (Δσ), dipole moment for active site of studied moleculars obtained using different methods

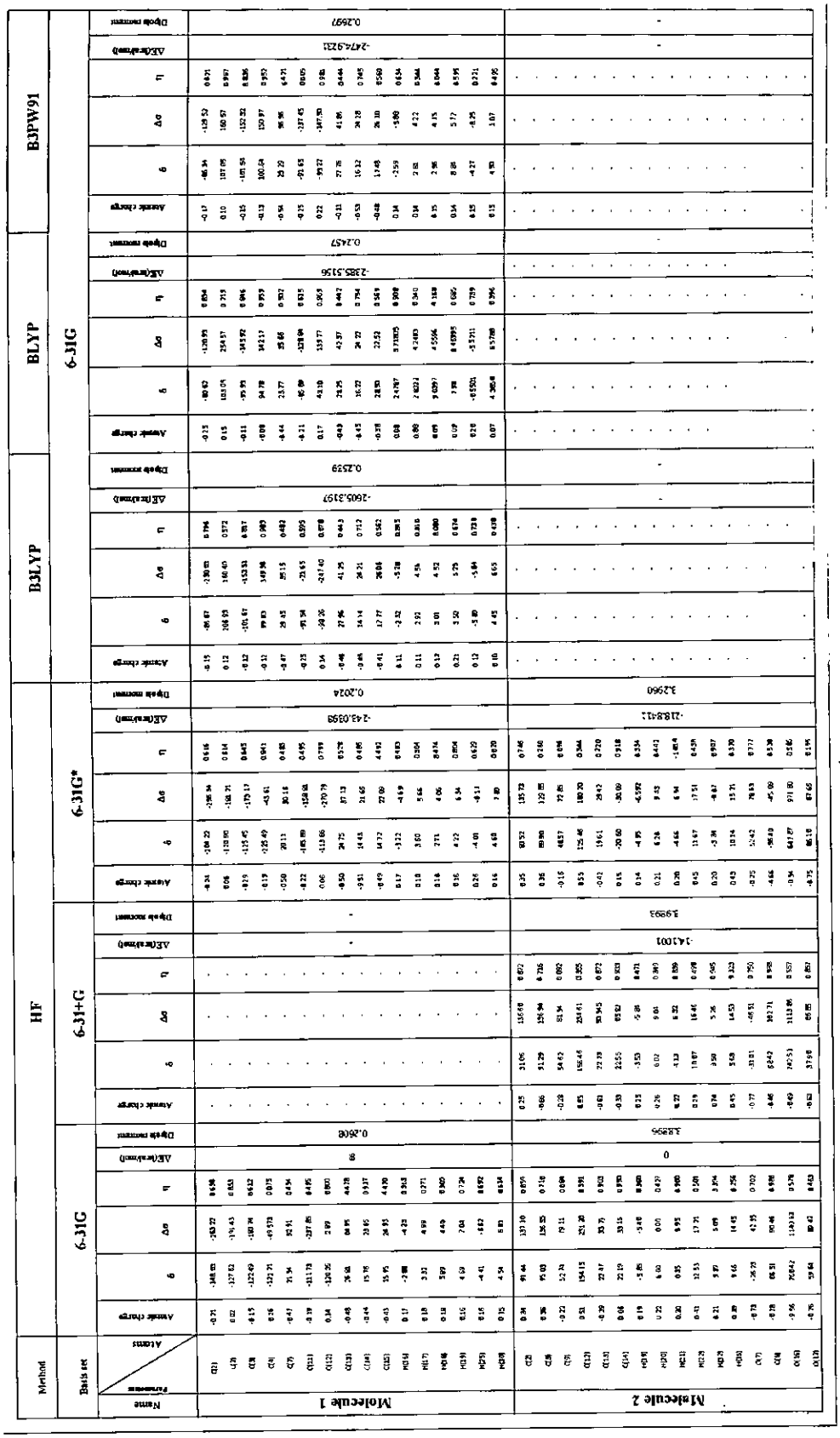


Table 2 .Values of parameters like isotropic (σ_{iso}), anisotropic (σ_{aniso}) shielding and NMR determinan for active site of studied molecular obtained using different methods

Method		HF								B3LYP			BLYP			B3PW91		
Basis set		6-31G			6-31+G			6-31G*					6-31G					
Name	Parameters / Atoms	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)	σ Isotropic (ppm)	σ Anisotropy (ppm)	σ (ppm)
	C(1)	85.53	133.80	-4.21e+05	-	-	-	83.99	126.30	-3.47e+05	76.02	116.81	-1.30e+05	72.18	110.89	-8.83e+04	78.71	118.24	-9.41e+04
	C(2)	73.27	175.43	-8.63e+05	-	-	-	73.03	164.54	-7.32e+05	64.21	160.40	-4.41e+05	60.11	154.57	-3.52e+05	67.61	160.57	-4.32e+05
	C(3)	77.93	172.56	-7.84e+05	-	-	-	77.78	142.32	-6.34e+05	70.00	138.59	-4.01e+05	66.77	132.88	-3.30e+05	72.64	139.85	-3.81e+05
	C(4)	72.15	171.00	-7.35e+05	-	-	-	71.88	159.43	-6.28e+05	66.63	149.90	-3.54e+05	63.90	142.17	-2.82e+05	69.37	150.97	-3.27e+05
	C(7)	186.84	32.91	6.45e+06	-	-	-	181.00	30.16	5.87e+05	171.99	35.15	5.01e+06	165.91	35.66	4.49e+06	175.03	34.93	5.20e+06
	C(11)	79.08	125.33	-5.70e+05	-	-	-	78.27	118.74	-4.56e+05	69.89	109.54	-2.73e+05	66.31	104.06	-2.20e+05	72.62	110.94	-2.52e+05
	C(12)	78.07	162.53	-7.20e+05	-	-	-	75.10	153.64	-5.92e+05	65.98	145.78	-3.50e+05	61.60	139.77	-2.78e+05	69.57	145.94	-3.34e+05
	C(13)	132.50	39.95	5.58e+06	-	-	-	176.80	37.13	5.44e+06	167.73	41.95	4.60e+06	161.73	42.37	4.13e+06	170.76	41.64	4.68e+06
	C(14)	190.74	23.65	6.90e+06	-	-	-	148.66	21.65	6.26e+06	176.75	24.21	5.48e+06	171.05	24.33	4.96e+06	179.50	24.18	5.24e+06
	C(15)	190.93	23.93	6.65e+06	-	-	-	184.18	22.00	6.21e+06	176.56	26.66	5.45e+06	170.43	27.52	4.90e+06	179.98	26.10	5.70e+06
	H(16)	27.76	2.95	2.12e+04	-	-	-	27.35	3.47	2.02e+04	27.25	9.48	2.01e+04	27.06	3.71	1.96e+04	27.15	3.17	1.98e+04
	H(17)	27.20	4.99	1.99e+04	-	-	-	27.00	5.40	1.94e+04	26.65	4.36	1.87e+04	26.48	4.24	1.84e+04	26.52	4.22	1.85e+04
	H(18)	26.95	4.40	1.94e+04	-	-	-	26.66	4.05	1.88e+04	26.55	4.52	1.85e+04	26.38	4.55	1.81e+04	26.44	4.35	1.83e+04
	H(19)	32.36	7.04	3.33e+04	-	-	-	31.69	6.34	3.13e+04	31.10	5.25	2.98e+04	30.67	4.47	2.86e+04	31.05	2.77	2.95e+04
	H(25)	32.30	5.49	3.31e+04	-	-	-	31.53	5.15	3.09e+04	30.72	5.08	2.85e+04	30.24	4.63	2.73e+04	30.66	5.54	2.83e+04
	H(30)	27.99	6.81	2.13e+04	-	-	-	27.61	7.03	2.05e+04	27.23	6.65	1.97e+04	26.99	6.57	1.92e+04	27.14	6.51	1.96e+04
Molecule 2	C(2)	59.74	137.10	-1.87e+05	60.31	136.60	-1.88e+05	58.13	135.70	-1.49e+05	-	-	-	-	-	-	-	-	-
	C(3)	58.49	136.55	-1.18e+05	58.10	136.94	-1.20e+05	59.78	125.86	-8.59e+04	-	-	-	-	-	-	-	-	-
	C(9)	159.04	79.11	9.30e+06	152.89	81.94	9.27e+06	147.98	72.86	8.00e+06	-	-	-	-	-	-	-	-	-
	C(12)	-17.03	231.20	1.08e+06	-18.20	234.61	1.17e+06	2.18	188.20	4.07e+05	-	-	-	-	-	-	-	-	-
	C(13)	159.86	93.71	8.94e+06	158.71	93.94	9.07e+06	154.63	29.42	3.66e+05	-	-	-	-	-	-	-	-	-
	C(14)	140.57	38.15	2.71e+06	139.89	38.89	2.65e+06	138.12	28.78	2.58e+05	-	-	-	-	-	-	-	-	-
	H(19)	27.01	3.73	1.94e+04	26.78	3.90	1.88e+04	26.43	4.58	1.80e+04	-	-	-	-	-	-	-	-	-
	H(20)	25.91	9.00	1.87e+04	25.74	9.04	1.89e+04	25.61	9.43	1.60e+04	-	-	-	-	-	-	-	-	-
	H(21)	26.41	5.93	1.80e+04	26.22	6.20	1.77e+04	25.88	6.54	1.68e+04	-	-	-	-	-	-	-	-	-
	H(22)	22.59	17.29	2.61e+04	30.41	16.46	2.54e+04	29.92	17.51	2.35e+04	-	-	-	-	-	-	-	-	-
	H(32)	29.54	5.08	2.54e+04	29.37	5.26	7.50e+04	29.07	-4.64	2.42e+04	-	-	-	-	-	-	-	-	-
	H(35)	-34.39	-34.49	9.84e+04	-34.08	-14.59	3.73e+04	33.64	15.21	3.57e+04	-	-	-	-	-	-	-	-	-
	O(7)	265.91	86.05	1.86e+07	266.30	40.71	1.87e+07	271.43	34.89	1.98e+07	-	-	-	-	-	-	-	-	-
	O(8)	301.68	99.46	2.62e+07	297.96	102.21	2.51e+07	322.68	78.63	3.28e+07	-	-	-	-	-	-	-	-	-
	O(16)	-953.82	1140.63	-1.99e+08	-337.20	1113.80	1.86e+08	-239.97	971.80	-1.15e+08	-	-	-	-	-	-	-	-	-
	O(17)	302.25	89.47	2.68e+07	298.39	86.66	2.57e+07	309.02	97.66	2.86e+07	-	-	-	-	-	-	-	-	-

In molecule(1), σ_{aniso}(σ Anisotropic(ppm)) with HF/6-31G, HF/6-31G, B3LYP/6-31G, BLYP/6-31G and B3PW91/6-31G for carbon atoms, C_2 has greatest value and C_{14} has smallest value. Also for hydrogen atoms, with HF/6-31G, H_{19} has greatest value and with HF/6-31G, B3LYP/6-31G, BLYP/6-31G and B3PW91/6-31G, H_{30} has greatest value. In molecule (2) σ_{aniso} with HF/6-31G for carbon atoms, C_2 has greatest value, and with HF/6-31+G and HF/6-31G* C_{12} has greatest value. For hydrogen atoms, with HF/6-31G, HF/6-31+G HF/6-31G* H_{22} has greatest valu and H_{19} as smallest value, and for oxygen atoms, O_{16} has greatest value.

Table 3 show share of orbitals contribute in the bonds (BD for 2-center bond and BD* for 2-center antibond).

Table 3. Relative natural bond orbital (NBO) for several active bond in studied molecules by: HF method with 6-31G, 6-31G* and 6-31+G basis set and B3LYP, BLYP and B3PW91 methods with 6-31G basis set

Method		HF			B3LYP	BLYP	B3PW91
Basis set		6-31G	6-31+G	6-31G*	6-31G		
Name	Parameter / Bond	Bonding	Bonding	Bonding	Bonding	Bonding	Bonding
Molecule 1	C_2-C_7	$0.7123\,sp^{3.76}+0.7019\,sp^{3.53}$	-	$0.7129\,sp^{3.75}d^{0.01}+0.7013\,sp^{3.56}d^{0.00}$	$0.7103\,sp^{3.16}+0.7039\,sp^{3.42}$	$0.7099\,sp^{3.16}+0.7043\,sp^{3.43}$	$0.7106\,sp^{3.15}+0.7036\,sp^{3.42}$
	C_5-C_4	$0.7095\,sp^{2.82}+0.7047\,sp^{3.74}$	-	$0.7096\,sp^{2.80}d^{0.00}+0.7046\,sp^{2.80}d^{0.00}$	$0.7106\,sp^{2.82}+0.7036\,sp^{3.32}$	$0.7088\,sp^{2.80}+0.7054\,sp^{3.73}$	$0.7093\,sp^{2.80}+0.7049\,sp^{3.71}$
	C_9-C_{15}	$0.7083\,sp^{2.31}+0.7059\,sp^{2.17}$	-	$0.7085\,sp^{2.30}d^{0.01}+0.7056\,sp^{2.31}d^{0.00}$	$0.7038\,sp^{2.28}+0.7059\,sp^{2.15}$	$0.7081\,sp^{2.67}+0.7061\,sp^{2.15}$	$0.7088\,sp^{2.87}+0.7054\,sp^{2.54}$
	$C_{12}-C_{13}$	$0.7032\,sp^{1.52}+0.7110\,sp^{1.54}$	-	$0.7033\,sp^{1.51}d^{0.00}+0.7109\,sp^{1.54}d^{0.00}$	$0.7031\,sp^{1.52}+0.7111\,sp^{1.57}$	$0.7031\,sp^{1.52}+0.7111\,sp^{1.57}$	$0.7029\,sp^{1.54}+0.7113\,sp^{1.57}$
	$C_{13}-C_{12}$	$0.7167\,sp+0.6974\,sp$	-	$0.7158\,spd^{0.89}+0.6989\,spd^{0.89}$	$0.7145\,sp+0.6996\,sp$	$0.7139\,sp+0.7002\,sp$	$0.7143\,sp+0.6999\,sp$
	$C_{12}-C_{23}$	$0.7085\,sp^{3.31}+0.7057\,sp^{3.51}$	-	$0.7092\,sp^{3.29}d^{0.01}+0.7050\,sp^{3.49}d^{0.00}$	$0.7067\,sp^{3.28}+0.7075\,sp^{3.47}$	$0.7062\,sp^{3.26}+0.7080\,sp^{3.46}$	$0.7069\,sp^{3.30}+0.7073\,sp^{3.47}$
	$C_{23}-C_{24}$	$0.7078\,sp^{2.27}+0.7065\,sp^{2.53}$	-	$0.7084\,sp^{2.27}d^{0.01}+0.7058\,sp^{2.32}d^{0.00}$	$0.7059\,sp^{2.15}+0.7083\,sp^{2.44}$	$0.7055\,sp^{2.15}+0.7087\,sp^{2.43}$	$0.7061\,sp^{2.25}+0.7081\,sp^{2.46}$
	C_5-H_{34}	$0.7839\,sp^{2.24}+0.6209\,s$	-	$0.7800\,sp^{2.25}d^{0.01}+0.6258\,s$	$0.7851\,sp^{2.26}+0.6194\,s$	$0.7841\,sp^{2.26}+0.6207\,s$	$0.7878\,sp^{2.24}+0.6159\,s$
	C_5-H_{35}	$0.7889\,sp^{2.41}+0.6145\,s$	-	$0.7841\,sp^{2.25}d^{0.01}+0.6206\,s$	$0.7922\,sp^{2.48}+0.6103\,s$	$0.7914\,sp^{2.47}+0.6113\,s$	$0.7956\,sp^{2.53}+0.6058\,s$
	C_6-H_{36}	$0.7886\,sp^{2.42}+0.6149\,s$	-	$0.7838\,sp^{2.41}d^{0.01}+0.6210\,s$	$0.7912\,sp^{2.46}+0.6116\,s$	$0.7901\,sp^{2.47}+0.6129\,s$	$0.7949\,sp^{2.48}+0.6068\,s$
	$C_{11}-H_{39}$	$0.7909\,sp^{2.55}+0.6247\,s$	-	$0.7767\,sp^{2.52}d^{0.02}+0.6299\,s$	$0.7824\,sp^{2.55}+0.6228\,s$	$0.7814\,sp^{2.54}+0.6240\,s$	$0.7851\,sp^{2.56}+0.6194\,s$
Molecule 2	C_2-C_7	$0.7106\,sp^{2.72}+0.7036\,sp^{2.75}$	$0.7113\,sp^{2.71}+0.7029\,sp^{2.77}$	$0.7107\,sp^{2.70}d^{0.00}+0.7035\,sp^{2.70}d^{0.00}$	-	-	-
	C_5-C_4	$0.7028\,sp+0.7114\,sp$	$0.7113\,sp^{2.62}+0.7029\,sp^{2.65}$	$0.7081\,spd^{0.92}+0.7061\,spd^{0.90}$	-	-	-
	$C_{23}-C_{24}$	$0.7201\,sp^{2.74}+0.6939\,sp^{2.45}$	$0.7162\,sp^{2.65}+0.6979\,sp^{2.46}$	$0.7213\,sp^{2.69}d^{0.00}+0.6926\,sp^{2.69}d^{0.01}$	-	-	-
	C_5-O_7	$0.5721\,sp^{2.24}+0.8202\,sp^{1.83}$	$0.5756\,sp^{2.23}+0.8177\,sp^{1.88}$	$0.5708sp^{2.21}d^{0.01}+0.8211\,sp^{1.75}d^{0.01}$	-	-	-
	C_5-O_8	$0.5773\,sp^{2.01}+0.8165\,sp^{1.83}$	$0.5781\,sp^{1.92}+0.8160\,sp^{1.87}$	$0.5737\,sp^{1.91}d^{0.01}+0.8191\,sp^{1.79}d^{0.01}$	-	-	-
	O_8-C_9	$0.8329\,sp^{2.55}+0.5536\,sp^{0.96}$	$0.8347\,sp^{2.54}+0.5507\,sp^{0.95}$	$0.8317\,sp^{2.56}d^{0.01}+0.5582\,sp^{0.97}d^{0.01}$	-	-	-
	C_7-H_{28}	$0.7867\,sp^{2.08}+0.6173\,s$	$0.7878\,sp^{2.05}+0.6160\,s$	$0.7816\,sp^{2.01}d^{0.01}+0.6238\,s$	-	-	-
	C_4-H_{29}	$0.7924\,sp^{2.27}+0.6101\,s$	$0.7931\,sp^{2.29}+0.6091\,s$	$0.7893\,sp^{2.25}d^{0.01}+0.6178\,s$	-	-	-
	C_9-H_{31}	$0.7880\,sp^{2.38}+0.6157\,s$	$0.7891\,sp^{2.35}+0.6143\,s$	$0.7835\,sp^{2.32}d^{0.01}+0.6214\,s$	-	-	-
	$C_{15}-O_{16}$	$0.5800\,sp^{2.21}+0.8146\,sp^{1.32}$	$0.5851\,sp^{2.19}+0.8110\,sp^{1.46}$	$0.5731\,sp^{2.20}d^{0.02}+0.8195\,sp^{1.35}d^{0.03}$	-	-	-
	$C_{15}-O_{25}$	$0.5584\,sp+0.8296\,sp$	$0.5507\,sp^{0.99}+0.8347\,sp^{1.19}$	$0.5491\,spd^{0.86}+0.8358\,spd^{0.80}$	-	-	-

Table 4. Relative GIAO Magnetic shielding for active site of studied molecules obtained using different methods

Method		HF						B3LYP		BLYP		B3PW91	
Basis set		6-31G		6-31+G		6-31G*		6-31G					
Name	Atoms / Parameter	Shielding (ppm)	Degeneracy	Shielding (ppm)	Degeneracy	Shielding (ppm)	Degeneracy	Shielding (ppm)	Degeneracy	Shielding (ppm)	Degeneracy	Shielding (ppm)	Degeneracy
Molecule 1	C(1)	85.53	1	-	-	84	1	76.03	1	72.19	1	78.72	1
	C(2)	73.27	1	-	-	73.08	1	64.22	1	60.12	1	67.62	1
	C(3)	77.93	1	-	-	77.79	1	70	1	66.73	1	72.64	2
	C(4)	72.16	1	-	-	71.88	1	66.63	1	63.90	1	69.37	1
	C(7)	186.74	1	-	-	181.02	1	172	1	165.94	1	175	1
	C(11)	79.09	1	-	-	78.28	1	69.89	1	66.32	1	72.62	1
	C(12)	75.07	1	-	-	75.10	1	65.98	1	61.6	1	69.58	1
	C(13)	182.51	1	-	-	176.81	1	167.74	1	161.74	1	170.78	1
	C(14)	190.74	1	-	-	184.66	1	176.8	1	171.1	1	179.5	1
	C(15)	190.38	1	-	-	184.18	1	176.5	1	170.44	1	179.99	1
	H(16)	27.76	1	-	-	27.36	1	27.56	2	27.06	1	27.15	2
	H(17)	27.21	1	-	-	27	1	26.66	1	26.48	1	26.53	1
	H(18)	26.95	1	-	-	26.66	1	26.55	1	26.38	1	26.44	1
	H(19)	32.36	1	-	-	31.69	1	31.11	1	30.67	5	31.06	2
	H(25)	32.30	1	-	-	31.53	1	30.72	1	30.24	3	30.66	2
	H(30)	27.93	1	-	-	27.61	1	27.23	1	27	1	27.14	1
Molecule 2	C(2)	59.74	1	60.3	1	58.13	1	-	-	-	-		-
	C(3)	58.5	1	58.1	1	59.78	1	-	-	-	-		-
	C(9)	153.05	1	152.9	1	148	1	-	-	-	-		-
	C(12)	-17.03	1	-18.2	1	2.18	1	-	-	-	-		-
	C(13)	159	1	158.71	1	154.8	1	-	-	-	-		-
	C(14)	140.58	1	139.6	1	138.13	1	-	-	-	-		-
	H(19)	27.01	1	26.75	1	26.44	1	-	-	-	-		-
	H(20)	25.92	1	25.75	1	25.61	1	-	-	-	-		-
	H(21)	26.41	1	26.27	1	25.88	1	-	-	-	-		-
	H(22)	30.78	1	30.42	1	29.92	1	-	-	-	-		-
	H(32)	29.54	1	29.37	1	29.07	1	-	-	-	-		-
	H(35)	34.39	1	34.09	1	33.65	1	-	-	-	-		-
	O(7)	265.92	1	266.31	1	270.15	1	-	-	-	-		-
	O(8)	301.68	1	298	1	322.7	1	-	-	-	-		-
	O(16)	-354.19	1	-338.2	1	-240	1	-	-	-	-		-
	O(17)	302.25	1	298.4	1	309.5	1	-	-	-	-		-

According to Tables 3, in molecule (1) with HF/6-31G method, for the C_2-C_7 bond, polarization coefficients of this bond C_2= 0.7123 and C_7= 0.7019 reported, that sizes of these coefficients show the importance of the hybrid C_2 in the formation of the bond. For the C_2-C_7 bond with other methods values of coefficients show the importance of the hybrid C_2 in the formation of the bond. In the C_{12}-C_{13} and C_{12}-C_{14} bonds with HF/6-31G and HF/6-31G* polarization coefficients of this bonds show the importance of the hybrid C_{12} in the formation of the bond, while with B3LYP/6-31G, BLYP/6-31G and B3PW91/6-31G polarization

coefficients of this bonds show the importance of the hybrid C_{13} and C_{14} in the formation of the bond. In the C-H bonds polarization coefficients show the importance of the hybrid C in the formation of the bond. In molecule (2) with HF/6-31G, HF/6-31+G, HF/6-31G* methods, polarization coefficients of the C-O bonds show the importance of the hybrid O in the formation of this bond. Also polarization coefficients of the C-H bonds show the importance of the hybrid C in the formation of this bond. With HF/6-31G, HF/6-31+G, HF/6-31G* methods, polarization coefficients of the C_2-C_3 and C_{13}-C_{14} bonds show the importance of the hybrid C_2 in the formation of C_2-C_3 bond and importance of the hybrid C_{13} in the formation of C_{13}-C_{14} bond.

Table 4 shows of GIAO Magnetic shielding for some of atoms.

As shown in Table 4, in molecule(1), with HF/6-31G and HF/6-31G*, all atoms Degeneracy value is same, also from carbon atoms C_{14} has greatest Shielding value and C_4 has smallest Shielding value. While with B3LYP/6-31G and BLYP/6-31G from carbon atoms C_{14} has greatest Shielding value and C_2 has smallest Shielding value, with B3PW91/6-31G from carbon atoms C_{15} has greatest Shielding value and C_2 has smallest Shielding value. Also with HF/6-31G, HF/6-31G*, B3LYP/6-31G, BLYP/6-31G, B3PW91/6-31G for hydrogen atoms, H_{19} has greatest Shielding value and H_{18} has smallest Shielding value.

In molecule (2), in three methods of HF/6-31G, HF/6-31+G and HF/6-31G* all atoms have same Degeneracy value. With HF/6-31G, HF/6-31+G and HF/6-31G* for carbon atoms, C_{13} has greatest Shielding value and C_{12} has smallest Shielding value, also for hydrogen atoms, H_{35} has greatest Shielding value and H_{20} has smallest Shielding value. For oxygen atoms with HF/6-31G and HF/6-31+G, O_{17} has greatest positive Shielding value and O_{16} has negative Shielding value, but with HF/6-31G*, O_8 has greatest positive Shielding value and O_{16} has negative Shielding value.

With Matlab program is solved determinan 3*3 and chemical shifts(σ) for each of the atom is calculated, then using the Excel program draw the diagrams which shows chemical shifts for each of the atom(Figure 7 , 8). As shown in Figure2, in molecule(1) at all methods biggest signals are for atoms C_{13} and C_{14}, also negative signals are for atoms C_1, C_2, C_3, C_4, C_{11} and C_{12} . Figure 3 show that in molecule (2) at all methods biggest signal is watched for the atom C_{15} and negative signals are for atoms C_2, C_3, C_4, C_5 and C_6.

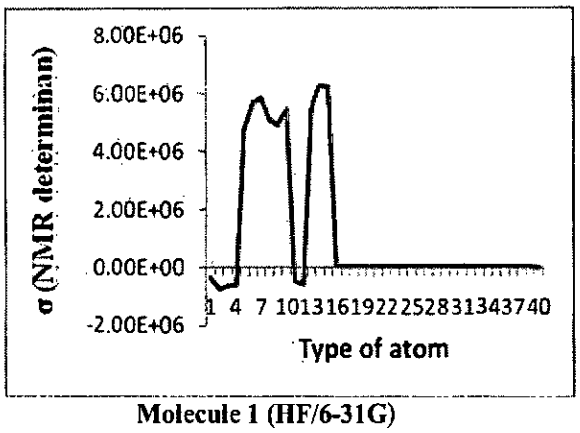
According to Tables 3, in molecule (1) with HF/6-31G method, for the C_2-C_7 bond, polarization coefficients of this bond C_2= 0.7123 and C_7= 0.7019 reported, that sizes of these coefficients show the importance of the hybrid C_2 in the formation of the bond. For the C_2-C_7 bond with other methods values of coefficients show the importance of the hybrid C_2 in the formation of the bond. In the C_{12}-C_{13} and C_{12}-C_{14} bonds with HF/6-31G and HF/6-31G* polarization coefficients of this bonds show the importance of the hybrid C_{12} in the formation of the bond, while with B3LYP/6-31G, BLYP/6-31G and B3PW91/6-31G polarization coefficients of this bonds show the importance of the hybrid C_{13} and C_{14} in the formation of the bond. In the C-H bonds polarization coefficients show the importance of the hybrid C in the formation of the bond. In molecule (2) with HF/6-31G, HF/6-31+G, HF/6-31G* methods, polarization coefficients of the C-O bonds show the importance of the hybrid O in the formation of this bond. Also polarization coefficients of the C-H bonds show the importance of the hybrid C in the formation of this bond. With HF/6-31G, HF/6-31+G, HF/6-31G* methods, polarization coefficients of the C_2-C_3 and C_{13}-C_{14} bonds show the importance of the hybrid C_2 in the formation of C_2-C_3 bond and importance of the hybrid C_{13} in the formation of C_{13}-C_{14} bond.

Table 4 shows of GIAO Magnetic shielding for some of atoms.

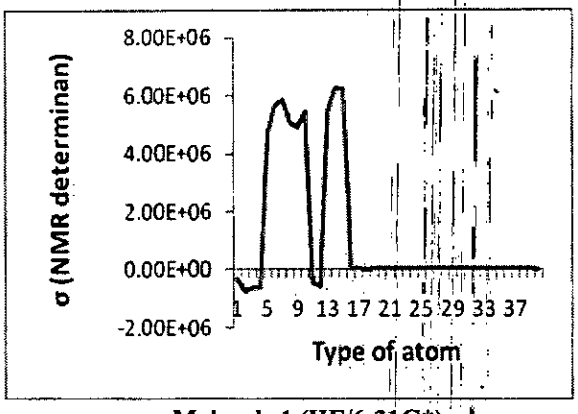
As shown in Table 4, in molecule(1), with HF/6-31G and HF/6-31G*, all atoms Degeneracy value is same, also from carbon atoms C_{14} has greatest Shielding value and C_4 has smallest Shielding value. While with B3LYP/6-31G and BLYP/6-31G from carbon atoms C_{14} has greatest Shielding value and C_2 has smallest Shielding value, with B3PW91/6-31G from carbon atoms C_{15} has greatest Shielding value and C_2 has smallest Shielding value. Also with HF/6-31G, HF/6-31G*, B3LYP/6-31G, BLYP/6-31G, B3PW91/6-31G for hydrogen atoms, H_{19} has greatest Shielding value and H_{18} has smallest Shielding value.

In molecule (2), in three methods of HF/6-31G, HF/6-31+G and HF/6-31G* all atoms have same Degeneracy value. With HF/6-31G, HF/6-31+G and HF/6-31G* for carbon atoms, C_{13} has greatest Shielding value and C_{12} has smallest Shielding value, also for hydrogen atoms, H_{35} has greatest Shielding value and H_{20} has smallest Shielding value. For oxygen atoms with HF/6-31G and HF/6-31+G, O_{17} has greatest positive Shielding value and O_{16} has negative Shielding value, but with HF/6-31G*, O_8 has greatest positive Shielding value and O_{16} has negative Shielding value.

With Matlab program is solved determinan 3*3 and chemical shifts(σ) for each of the atom is calculated, then using the Excel program draw the diagrams which shows chemical shifts for each of the atom(Figure 7 , 8). As shown in Figure2, in molecule(1) at all methods biggest signals are for atoms C_{13} and C_{14}, also negative signals are for atoms C_1, C_2, C_3, C_4, C_{11} and C_{12} . Figure 3 show that in molecule (2) at all methods biggest signal is watched for the atom C_{15} and negative signals are for atoms C_2, C_3, C_4, C_5 and C_6.



Molecule 1 (HF/6-31G)



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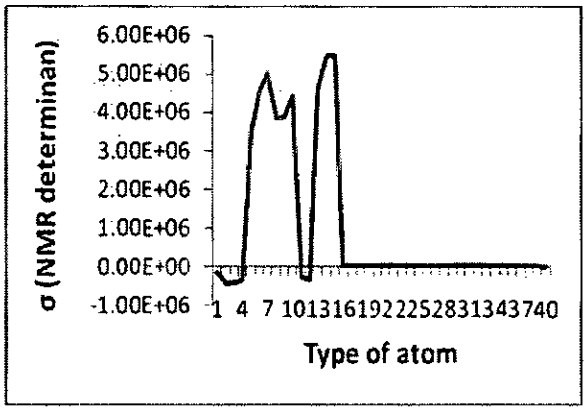

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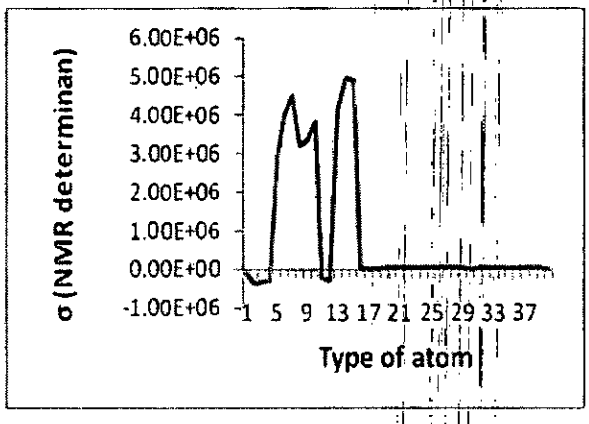

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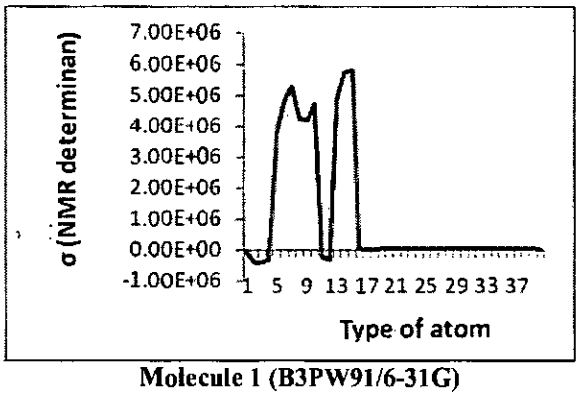
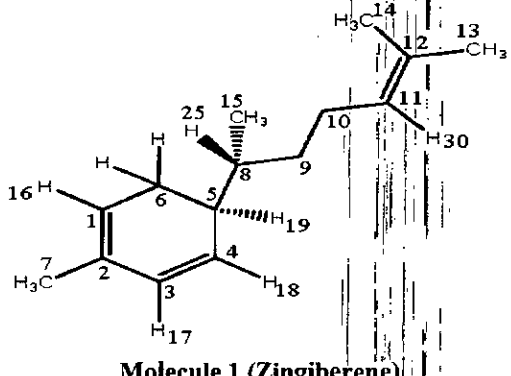
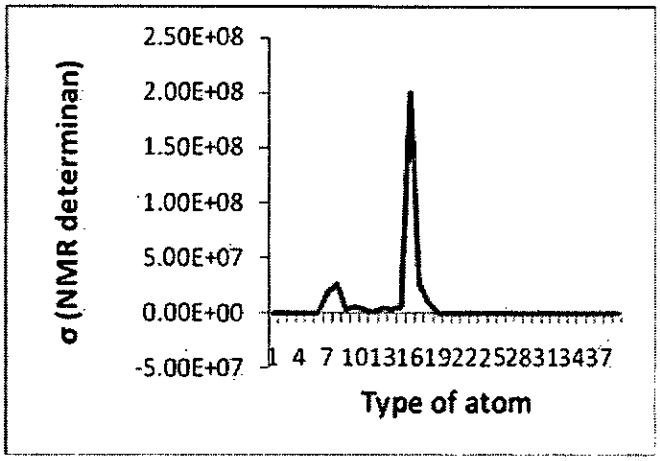


Molecule 1 (B3PW91/6-31G)

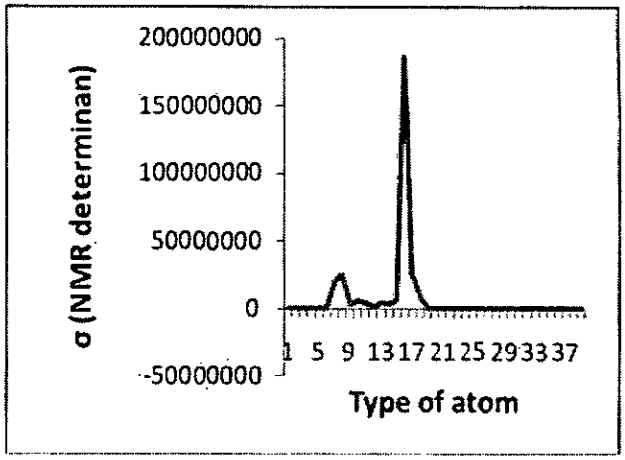


Molecule 1 (Zingiberene)

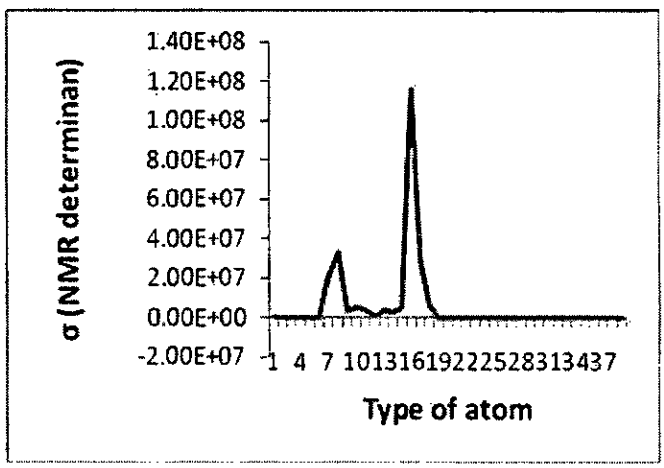
Fig. 7. Diagrams which shows chemical shifts for each of the atom at the molecule (1).



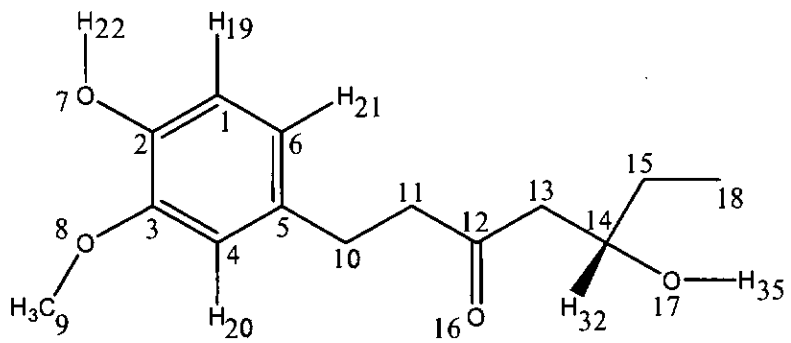
Molecule 2 (HF/6-31G)



Molecule 2 (HF/6-31+G)



Molecule 2 (HF/6-31G*)



Molecule 2 (Gingerol)

Fig. 8. Diagrams which shows chemical shifts for each of the atom at the molecule (2).

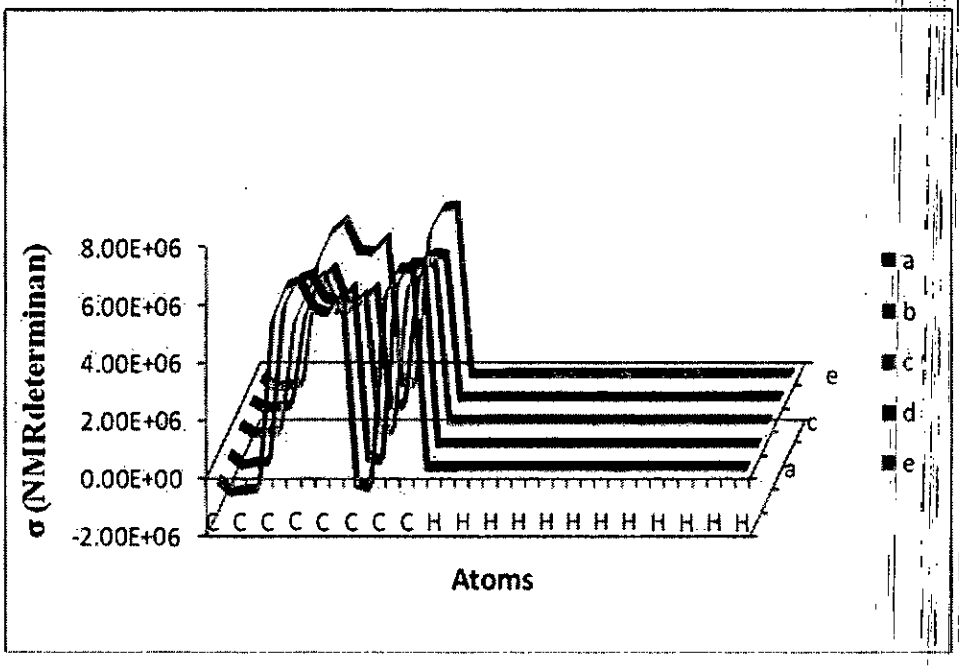


Fig. 9. The graphs of chemical shifts for molecule 1. (a) HF/6-31g, (b) HF/6-31g*, (c) B3LYP/6-31g, (d) BLYP/6-31g, (d) B3PW91/6-31g.

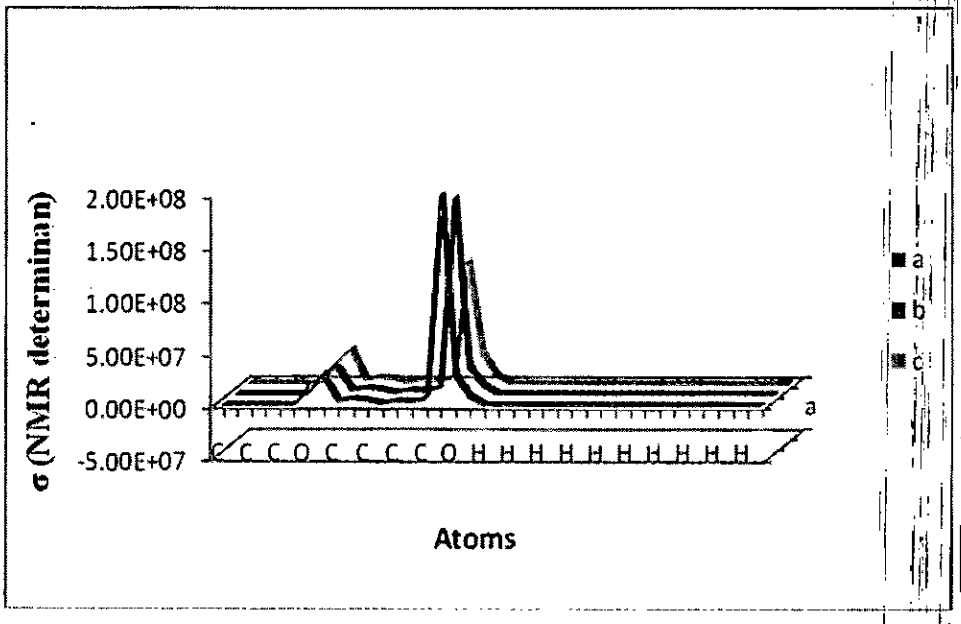


Fig. 10. The graphs of chemical shifts for molecule 2. (a) HF/6-31g, (b) HF/6-31+g (c) HF/6-31g*.

REFERENCES

[1] P. Schauenberg, F. Paris, "*Guide to Medicinal Plants*." Keats Publishing, New Canaan CT, 1977.

[2] C. K. Kokate, et.al, *Pharmacognosy*, Nirali Prakashan, 4th edition, 1996.

[3] B. Misra. *Bhavaprakasha Nighantu*, 5th edition, p.14, 1969.

[4] Nadakarni, Indian Materia Medica, 1, 1308, 1993.

[5] *British Herbal Pharmacopoeia*, B.H.M.A. 239-240, 1983.

[6] T. E. Wallis, *Textbook of Pharmacognosy*, C.B.S. Publishers, 5th edition, 1985.

[7] H. M. Chang, *et al*, "Pharmacology and Applications of Chinese Materia Medica." World Scientific, Singapore, 1987.

[8] D. B. Mowrey, *et al*, "Motion Sickness, Ginger, and Psychophysics." *Lancet*. 1(8273), 655-657, 1982.

[9] T. Kawai, *et al*, "Anti-emetic principles of Magnolia obovata Bark and Zingiber officinale Rhizome." Planta Med. 60, 17-20, 1994.

[10] W. Blumberger, *et al*, "The Physiology of Spices and Condiments. The Action of Ginger on the Amount and Condition of the Saliva." *Nutritio et Dieta* (Eur. Rev. Nutr. & Diete.). 7(3), 222-237, 1965.

[11] J. Yamahara, *et al*, "Cholagogic Effect of Ginger and its Active Constituents." J. Ethnopharm. 13(2), (1985) 217.

[12] E. H. Thompson, *et al*, "Ginger Rhizome: A New Source of Proteolytic Enzyme." J. Food Science, 38, (1973), 652.

[13] M. Suekawa, *et al*, "Pharmacological Action of Pungent Constituents, (6)-Gingerol and (6)-Shogaol." J. Pharma. - Dynamics. 7(11), (1984) 836.

[14] H.G. Desai, *et al*, "Effect of Ginger and Garlic on DNA Content of Gastric Aspirate." Ind. J. Med. Res. 92, (1990), 139.

[15] J. Yamahara, *et al*, "The Anti-ulcer Effect in Rats of Ginger Constituents." J. Ethnopharm. 23(2-3), (1988), 299.

[16] M. A. al-Yahya, *et al*, "Gastroprotective Activity of Ginger (Zingiber officinale Rose.) in Albino Rats." Am. J. Chin. Med. 17(1-2), (1989), 51.

[17] K. C. Srivastava, "Effects of Aqueous Extracts of Onion, Garlic and Ginger on Platelet Aggregation and Metabolism of Arachidonic Acid in the Blood Vascular System; In vitro Study." Prosta. Leuk. & Med. 13(2), (1984), 227.

[18] K. C. Srivastava, "Aqueous Extracts of Onion, Garlic and Ginger Inhibit Platelet Aggregation and Alter Arachidonic Acid Metabolism." Biomed. Biochim. Acta. 43 (8-9), (1984), 335.

[19] K. C. Srivastava, "Isolation and Effects of Some Ginger Components of Platelet Aggregation and Eicosanoid Biosynthesis." Prosta. Leuk. & Med. 25(2-3), (1986), 187.

[20] J. H. Guh, *et al*, "Antiplatelet Effect of Gingerol Isolated from Zingiber officinale." J. Pharm. & Pharm. 47(4), (1995), 329.

[21] N. Mascolo, *et al*, "Ethnopharmacologic Investigation of Ginger (Zingiber officinale)." J. Ethnopharm. 27, (1989), 129.

[22] J. N. Sharma, *et al*, "Suppressive Effects of Eugenol and Ginger Oil on Arthritic Rats." Pharm. 49(5), (1984), 314.

[23] D. L. Flynn, *et al*, "Inhibition of Neutrophil 5-Lipoxygenase Activity by Gingerdione, Shogaol, Capsaicin and Related Pungent Compounds." Prosta. Leuk. & Med. 24 (226), (1986), 195.

[24] F. Kiuchi, *et al*, "Inhibitors of Prostaglandin Biosynthesis from Ginger." Chem. & Pharma. Bull. 30(2), (1982), 754.

[25] S. Iwakmi, *et al*, "Inhibition of Arachidonate 5-Lipoxygenase by Phenolic Compounds." Chem & Pharma. Bull. 34(9), (1986), 3960.

[26] F. Kiuchi, *et al*, "Inhibition of Prostaglandin and Leukotriene Biosynthesis by Gingerols and Diarylheptanoides." Chem. & Pharma. Bull. 40(2), (1992), 387.

[27] N. Suekawa, *et al*, "Pharmacological Studies on Ginger IV. Effect of (6)-Shogaol on the Arachidonic Cascade." *Nippon Yakurigakuzasshi (Folia Pharmacologica Japonica)*. 88(4), (1986), 263.

[28] N. R. Famsworth, *et al*, "Bunyapraphatsara, N, eds." Thai Medicinal Plants. Medicinal Plant Information Centre, Bangkok, 1992.

[29] N. Shoji, *et al*, "Cardiotonic Principles of Ginger (Zingiber officinale Roscoe.)." J. Pharm. Sci. 71 (10), (1982), 1174.

[30] M. Kobayashi, *et al*, "Cardiotonic Action of (8)-Gingerol, An Activator of Ca2+ pumping Adenosine Triphosphatase of Sarcoplasmic Reticulum in Guinea Pig Atrial Muscle." J. Pharm. & Exper. Therap. 246 (2), (1988), 667.

[31] V. S. Govindarajan, "Ginger- Chemistry, Technology and Quality evaluation; Parts 1 & 2." *CRC* Critical Rev. in Food, Science and Nutrition. 17(1), 1-96, 1982, 17(3), (1982), 189.

[32] H. Hikino, *et al*, "Anti-hepatotoxic Actions of Gingerols and Diarylhepanoids." J. Ethnopharm. 14, (1985), 31.

[33] K. Naora, *et al*, "Pharmacokinetics of (6)-Gingerol after Intravenous Administration in Rats with Acute Renal or Hepatic

Failure." Chem. & Pharm. Bull. 40 (5), (1992), 1295.

[34] P. Monge, et al, "The Metabolism of Zingeronem, a Pungent Principle of Ginger." Xenobiotica. 6 (7), (1976), 411.

[35] Mahmoud, et al, "Mutagenic andToxic Activities of Several Spices and Some Jordanian Medicianl Plants." Inter. J. Pharm. 30 (2), (1992), 81.

[36] H. Nakamurah, et al, "Mutagen and Anti-mutagen in Ginger, Zingiber officinale." Mut. Res. 103, (1982), 119.

[37] D. S. Qian, et al, "Pharmacologic Studies of Antimotion Sickness Actions of Ginger." Chung-kuochung hsii chieh ho tsa chih. 12(2), 70, (1992), 95.

[38] Qureshi, et al, "Studies on Herbal Aphrodisisacs Used in Arab System of Medicine." Am. J. Chin. Med. 17 (1-2), (1989), 57.

[39] J. M. Futrell, et al, "Spice Allergy Evaluated by Results of Patch Tests." Cutis. 52 (5), (1993), 288.

[40] C. Moller, M.S. Plesset,"Note on an Approximation Treatment for Many-Electron Systems." Phys. Rev. 46, (1934), 618.

[41] D. Becke, "Density-Functional Exchange-Energy Approximation with Correct Asymptotic- Behavior." Phys. Rev. A. 38 (6), (1988), 3098.

[42] T. Lee, W. T. Yang, R. G. Parr, "Development of the Colle-Salvetti Correlation-Energy Formula into a Functional of the Electron-Density." Phys. Rev. B. 37 (2), (1988), 785.

[43] D. Becke, "Density-Functional Thermochemistry 3. The Role of Exact Exchange." J. Chem. Phys. 98 (7), (1993), 5648.

[44] J. P. Predew, Y. Wang, "Accurate and simple analytic representation of the electron-gas correlation energy." Phys. Rev. B. 45, (1992), 13244.

[45] M. Monajjemi, F. Naderi, H. Aghaie, Yari M, D. N. Mansoor, S. Afsharnezhad, F. Mollaamin, "Study of thermodynamic functions value for CTAB." Res. J. Chem. and Environment. 11 (2), (2007), 56.

[46] M. Monajjemi, M.T. Azad, H.H. Haeri, K. Zare, Sh. Hmedani Sh, "Ab initio conformational analysis of glutamic acid, chemical shift anisotropy and population studies." J. Chem. Res. 8, (2003), 854.

[47] M. Monajjemi, H. Heshmat, H. H. Haeri, F. Keveh, "Theoretical study of vitamin properties from combined QM/MM methods: comparison of chemical shifts and energy." Russ. J. Phys. Chem. 80, (2006), 1061.