AL-Qadisiya Journal For Science Vol .18 No.4 Year2013

Preparation of Microwave assisted of β-enaminone Derived from Bisdemethoxycurcumin

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Abstract

β-enaminone was prepared by microwave assisted reaction between bisdemethoxycurcumin and ammonium acetate in presence of Montmorillonite (K-10) as catalyst. Reaction time did not exceed 60 s. The structure of product was established by ^{1}H NMR, the spectrum is characterized by a singlet of one proton integral at 5.44 ppm which is assigned to the vinylic proton. The spectrum of ^{13}CNMR is characterized by signal at 186.3 ppm which indicate the presence of carbonyl group. While IR spectrum characterized by strong band at 3419 cm^{-1} is attributed to the intermolecular hydrogen bonded phenolic group. Computational calculations using Semi-empirical method with PM3.

Keywords: Microwave, β-enaminone, Bisdemethoxycurcumin

Introduction

The term enaminone is used to indicate any compound containing the conjugated system N-C=C-C=O. It may be mono-enamine of 1,3-diketen or 3-keto-ester[1]. Enaminones are an important class of organic synthetic intermediates for the synthesis of a variety of heterocycles and pharmaceutical compounds. Their basic structural units, N–C=C–C=O, are responsible for the synthesis of many therapeutic agents of both natural and synthetic sources, including taxol, anticonvulsants, anti-inflammatory agents and ducarmycin classes of antitumor agents, as well as quinoline antibacterial and quinoline antimalarial agents[2-4]. They are also intermediates for the synthesis of several amino acids, aminols, peptides and alkaloids[5-7].

The conventional method for the synthesis of enaminones is the azeotropic removal of water by refluxing an amine with 1,3-diketone in an aromatic solvent[8]. Various modified synthetic pathways have been reported in literature such as the addition of metallic esters or amide enolates to nitriles[9], tosyl imines[10] or imidoyl halides. Apart from there, the enamination of 1,3-dicarbonyl compounds has been carried out using catalyst systems such as silicon/micro-wave[11], clay K_{10} / ultrasound[12] and $NaAuAl_4$[13]. More recently $Bi(TFA)_3$ as well as $Zn(ClO_4)_2.6H_2O$[14] have also been reported as effective catalysts. On the other hand Bisdemethoxycurcumin is an α,β-unsaturated 1,3-diketone that constitutes one of the three major components of the Indian herb *Curcuma longa* [15,16].

The aim of this work is to prepared of β-enaminone derived from bisdemethoxycurcumin and ammonium acetate under microwave irradiation.

Experimental

a. Material and chemicals

The material and all Chemicals used were of (BDH , Fluka, Merk), used Montmorillonite K-10, ammonium acetate, ethanol, chloroform, tetrahydrofuran.

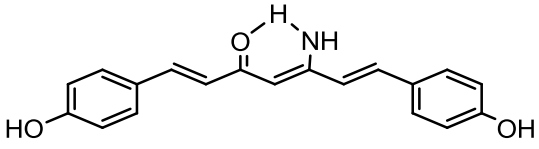
b. Instrument and measuring device

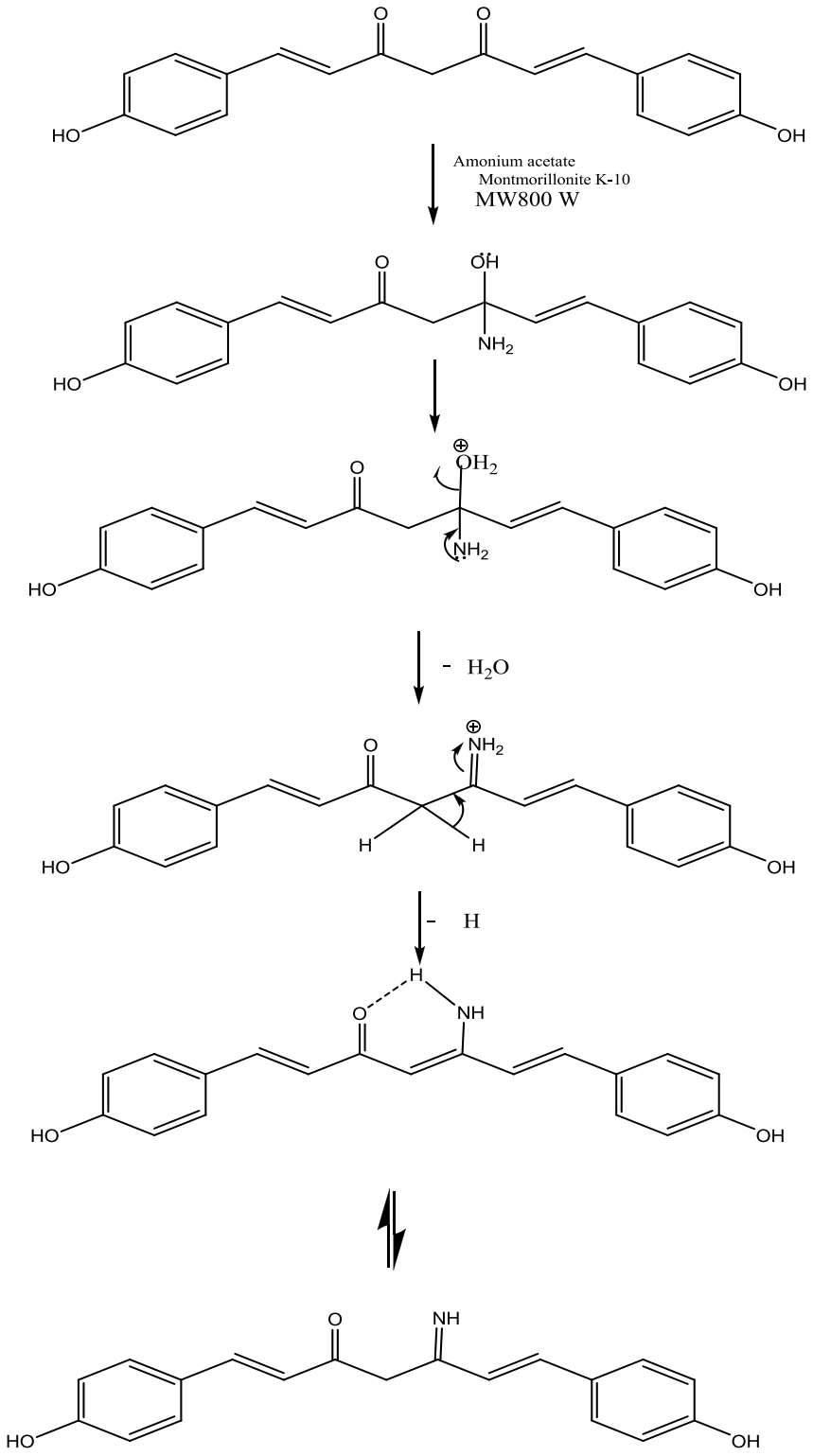
Domestic microwave oven (Samsung 800 MW, 2450MHz). Melting point was determined in open Capillary tubes using Electro thermal (Blaok 9300) apparatus which were un corrected. Elemental analysis was performed with a Elementary vairo-EL instrument in India. IR spectrum was record as KBr disc using Shimadzo–Japan apparatus in range (4000-500cm^{-1}). Elecronic spectrum was measured in the range (215-480 nm) for solution in ethanol at room temperature (30°C) using (Spectra Scan 80D) Uv.Vis Spectrophotometer-U.K. NMR spectra were recorded on a Bruker's 400 MHz FT NMR instrument using DMSO-d6 as solvent and TMS as internal reference (chemical shifts in δ ppm) in India. Electrospry Ionization Mass Spectrometry was recorded on Micro Mass ESI- TOF MS in India.

Prepared of β-enaminone

Bisdemethoxycurcumin (2g, 6.5mmol) and Montmorillonite K-10 (3 g) were mixed in a mortar and placed in a 10 ml beaker. The appropriate amount of ammonium acetate (6.5 mmol) was added to the mixture, which was then thoroughly mixed. The mixture was irradiated in a commercial microwave oven (Samsung 800 MW) for 60 s at 800W . The extent of reaction was monitored by TLC using ethanol/chloroform (4:96) as the eluent. On completion, the mixture was extracted with ethanol. The Montnorillonite was removed by filtration and the solvent was evaporated. The products were separated by column chromatography (silica gel) using THF/chloroform (1:5) as the eluent. The product fractions were further separated by preparative TLC (silica gel) using the same eluent. The β- enaminone was obtained as yellow powder (M.P 200 ˚C) . The preparation of enaminone was carried out according to Scheme 1 [17] . The structure and physical properties of this Schiff base was given in table (1) .

Table 1: Physical properties of compound 1.

Compound	Chemical structure	Physical state	M.P(°C)	Color	M.W	Yield%
1		powder	200	Yellow	308	48



Scheme (1) : The mechanism, reaction conditions of the prepared compound 1[18].

Characterization by computational method

The prepared compound was evaluated by full geometry optimization and UV-V were carried out using Semi-empirical method with PM**3.**

Results and Discussion

1.Elemental analysis

The characterization was carried out for studied compound through elemental analysis spectrometric calculated :C : 74.25 ; H :5.58 ; N: 4.56 % ,found: C :74.40 ; H :5.33 ; N : 4.61 %.

2 . ^{1}HNMR Spectrum

The spectrum experimental data are gathered in Table (2). It is well known that the ^{1}H NMR spectrum of bisdemethoxycurcumin contains one singlet at 16.40 ppm due to the protons of two hydroxyl groups which reflects its symmetric structure Fig(1). Concerning the studied compound the spectrum is characterized by two singlets with an integral of one proton for each signal at chemical shifts appear at 9.40 and 9.41 ppm which are assigned to two hydroxyl groups at different environments Fig(2). The spectrum is also characterized by a singlet of one proton integral at 5.44 ppm which is assigned to the vinylic proton. The olefinic protons have doublet peaks at ranges 6.41- 7.46 ppm, while the chemical shifts of aromatic protons appear at the range 6.78-7.46 ppm.

Table 2: Chemical shifts (δ, ppm) ^{1}H NMR of the studied compound 1.

Functional group	Hydroxyl proton	Vinylic proton	Olefinic protons	Aromatic protons
(δ, ppm)	9.40 9.41	5.44	6.41-7.46	6.78- 7.46

3.^{13}CNMR Spectrum

The spectrum experimental data are gathered in Table (3). The spectrum is almost identical and characterized by signal at 186.3 ppm Fig (3) which indicate the presence of carbonyl group in that compound[19]. The carbon atom that attached to vinylic proton has a distinguished peak at 96.5 ppm. The peak at 158.7 ppm could be attributed for =C-N has the same chemical shift carbons in cyclic enamines[20]. The olefinic and other aromatic carbon are characterized by peaks within the range 136.9-115.6 ppm.

Table 3: Chemical shifts (δ, ppm) ^{13}CNMR of the studied compound 1.

Functional group	Carbonyl group	Vinylic carbon	=C-N	Olefinic carbon	Aromatic carbon
(δ, ppm)	186.3	96.5	158.7	136.9-115.6	136.9-115.6

4.IR Spectrum

FTIR spectrum of compound is listed in Table (4). The spectrum was characterized by strong band at 3419 cm^{-1} Fig (5) is attributed to the intermolecular hydrogen bonded phenolic OH group. As well a strong absorption bands within the range 1440-1600 cm^{-1} which was attributed to the stretching vibration of C=O and C=C groups and the bending of N-H group. It is difficult to separate among these bands completely because of the partition of bands in the rings system conjugated whose intra hydrogen bonded.

Table 4 : Major IR absorption bands (cm^{-1}) of Compound 1.

Functional group	OH	C=O	C=C	N-H bend.
ν(cm^{-1})	**3419**	**1440-1600**	**1440-1600**	**1440-1600**

5.UV-Vis Spectrum

The electronic absorption spectrum of studied compound exhibit three bands within the 238 nm Fig(6) due to the excitation of the electrons (π-π^* transitions) of aromatic rings and 324 nm is assigned to (π-π^* transitions) within the system Ar – C = C – (C = O) – C = C –. While third band 424nm due to system Ar – C = C – (C = O) – C = C –(C-N)-C=C-.

6. Computational calculations

The calculated C=O and C=C bonds length by PM3 method are 1.237 and 1.373 Å Fig(8) and longer than their values in aliphatic ketones and ethylene which are while the bond C-C and C-N are shorter than their value in alkanes and aliphatic amines .

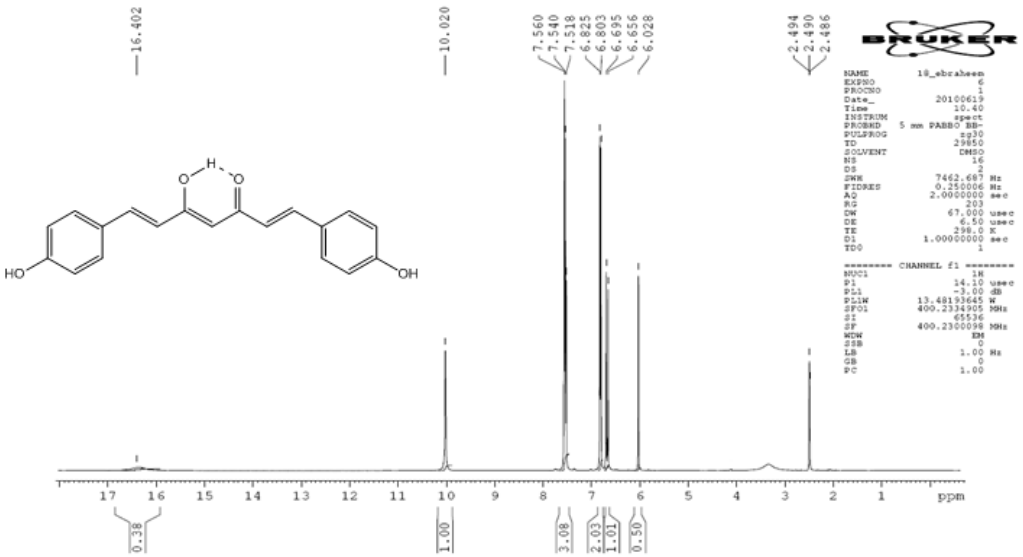


Fig.(1) [1]HNMR of Bisdemethoxycurcumin.

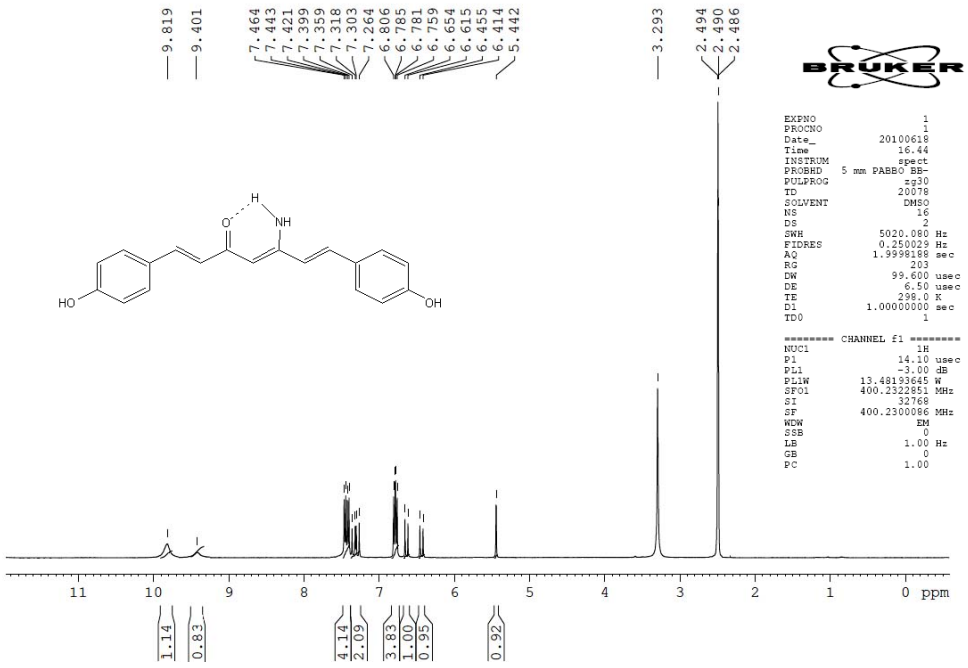


Fig.(2) [1]HNMR of compound 1.

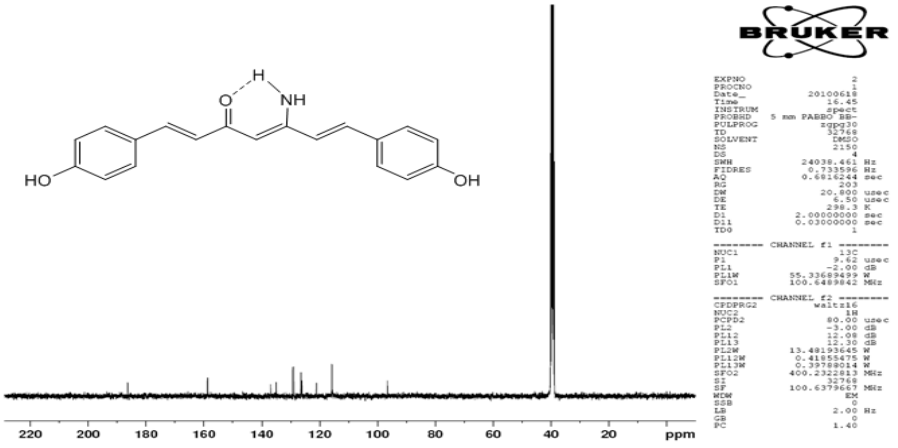


Fig.(3) ^{13}CNMR of compound 1.

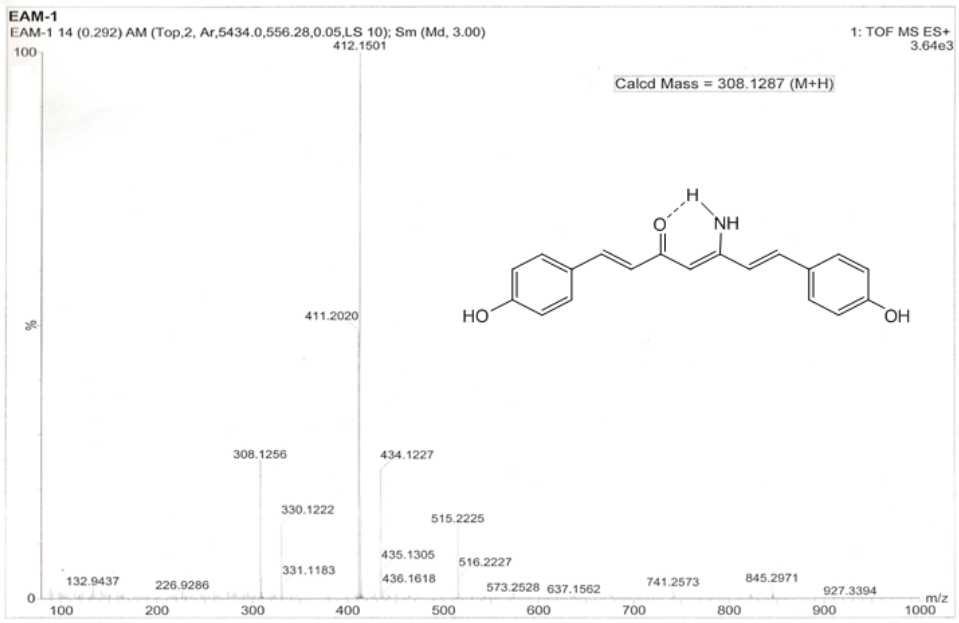


Fig.(4) Mass spectrum of the prepared compound 1.

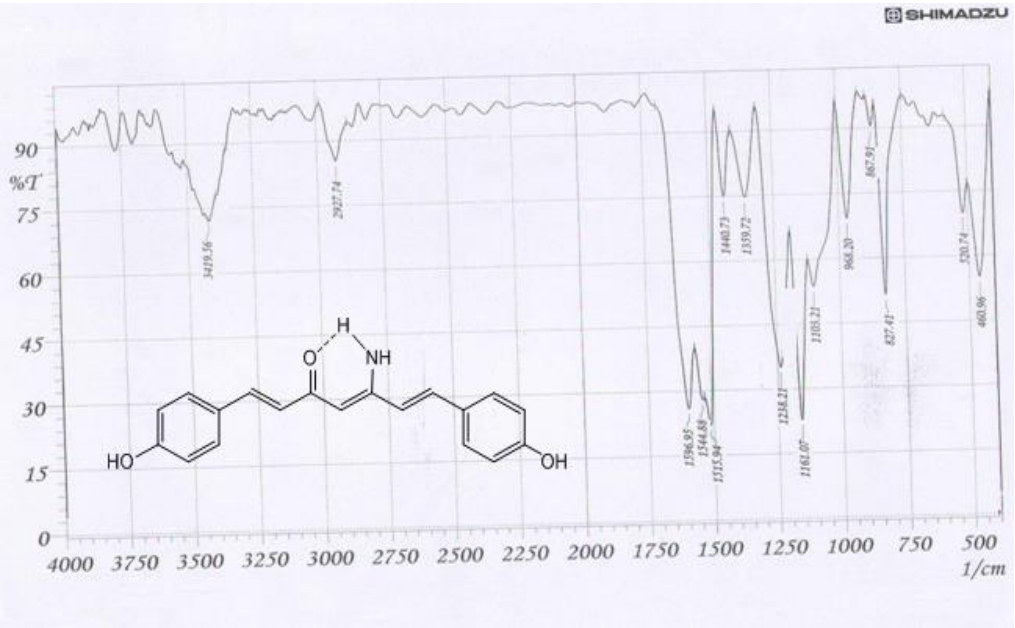


Fig.(5) IR spectrum of the prepared compound 1.

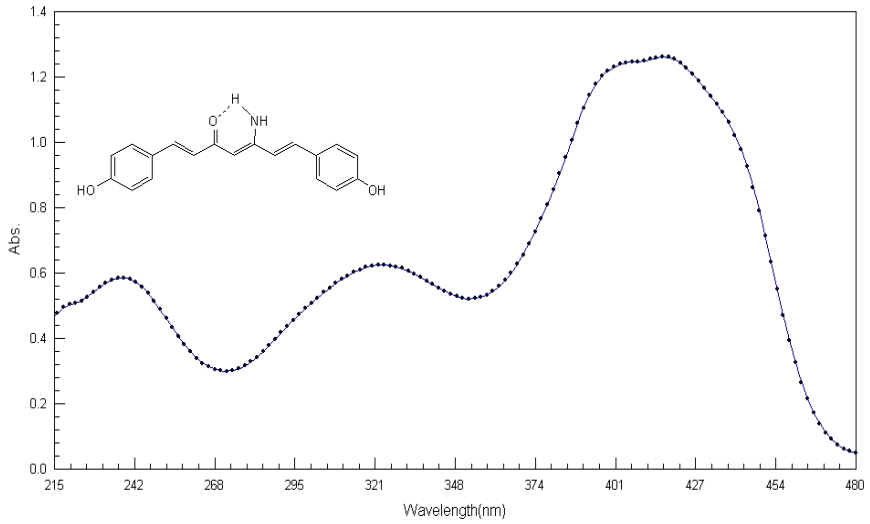


Fig.(6) UV- V spectrum of the prepared compound 1.

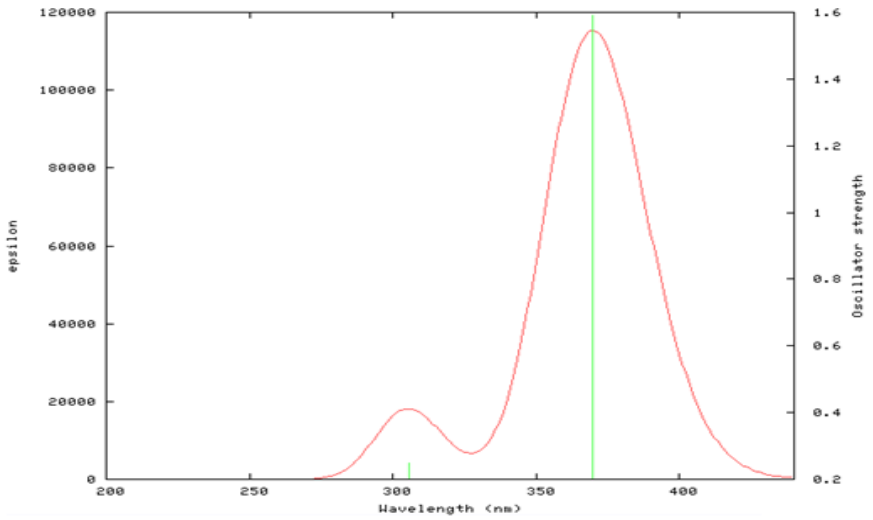


Fig.(7) UV- V theoretical of the prepared compound 1.

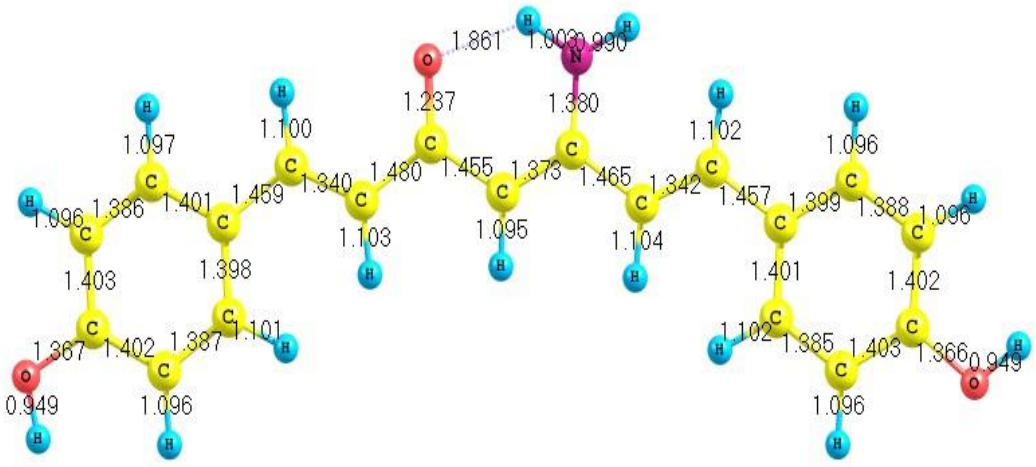


Fig. (8) The optimized structure of compound 1 by PM3 method.

Conclusion

In conclusion, this work has demonstrated the positive role of microwave irradiation in the preparation of β-enaminone from the reaction of bisdemethoxycurcumin and ammonium acetate in presence of Montmorillonite (K-10) as catalyst. The reaction was complete within one minute. Several NMR techniques included ^{1}H NMR and ^{13}C NMR (in DMSO-d_6) were used to investigate the chemical structure of the prepared compound. The NMR spectra of the β-enaminone is essentially different from that of bisdemethoxycurcumin by various characteristic signals. The structure of product was established by elemental analysis and from mass , IR, UV-V and computational method.

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تحضير ألبيتا اينامينون بمساعدة المايكروويف المشتق من ثنائي دي ميثوكسي كركمين

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الخلاصة

في هذا البحث تم تحضير بيتااينامينون جديد بمساعدة أشعة المايكروويف وذلك من تفاعل ثنائي دي ميثوكسي كركمين مع خلات الامونيوم بوجود طين K-10 كعامل مساعد. حيث كان زمن التفاعل دقيقة واحدة فقط. تم تشخيص المركب المحضر بوساطة أطياف الرنين النووي المغناطيسي للبروتون إذ تميز طيفه بظهور أشارة مفردة عائدة لبروتون مجموعة الفينايل تقع عند 5.44 جزء من مليون ، كما تضمن طيف الكاربون – 13 للمركب المحضر أشارة لكاربون مجموعة الكاربونيل تقع عند 186.3 جزء من مليون ، أما طيف تحت الحمراء فقد تميز بظهور حزمة امتصاص قوية تقع عند 3419 سم$^{-1}$ تعزى إلى مجموعة الهيدروكسيل الفينولية ذات التآصر الهيدروجيني البيني ، كما درست الأطياف المرئية وفوق البنفسجية وطيف الكتلة للمركب المحضر و حسبت أطوال الأواصر وأطياف UV-V باستخدام المستوى النظري(PM3) الذي هو ضمن المستويات النظرية للحسابات شبه التجريبية.