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Synthesis, Hammett spectral correlation and biological evaluation of some substituted (*E*) 1-hydroxy-2-naphthyl chalcones

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ABSTRACT

A series of some substituted (E)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-oneshave been synthesized by microwave assisted Silica- H_3PO_4catalyzed green Crossed-Aldol condensation of 1-hydroxy-2-acetylenaphthone and substituted benzaldehydes. These chalcones were characterized by their physical constants and spectral data. From IR and NMR spectra, the spectral frequencies of vCOs-cis and s-trans, deformation modes of vCHip, vCHop, vCH=CHop and vC=Cop(cm^{-1}), δH and δC of α, β and CO (ppm) of synthesized chalcones were correlated with Hammett substituent constants, F and R parameters. From the results of statistical analyses the effects of substituents on the group frequencies have been discussed. The antimicrobial activities of all chalcones have been studied using Bauer-Kirby method.

Keywords*:* Solvent-free synthesis, UV spectra, IR spectra, NMR spectra, Hammett correlations, Antimicrobial activities

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INTRODUCTION

Chalcones(1, 3-diarylpropinones) are natural substances found in a number of plantsor synthetically preparedand their derivatives are important intermediates in organic synthesis [1-4].These are main precursors in the biosynthesis of flavonoids[5]. They have been reported to possess various pharmacological activities likeanticancer[6,7], antimalarial[8], antiplasmodial[9], anti-inflammatory[10], antitubercular[11], cytotoxic[12], antidepresent[13], antibacterial[14], antiHIV[15], antifouling[16], trypanocidal[17], leishmanial[18], gastroprotective[19], modulation of nitric oxide production[20] and so on. Additionally, some of chalcone derivatives have been found to inhibit several important enzymes in cellular systems, such as xanthine oxidase[21] and protein tyrosine kinase[22]. These compounds are valuable synthons for the preparation of five and six membered ring systems[23] as well as intermediate in the synthesis of many pharmaceuticals[24]. Because of their varied pharmacological activity and synthetic utility, much attention has been paid to develop newer strategies for the synthesis of such compounds. In addition compounds are of a high interest due to their use as starting materials in the synthesis of a series of heterocyclic compounds[25]like isoxazole, quinolinones, thiadiazine, benzodiazepine, benzothiazipine, benzofuranones, tetrahydro-2-chromens[26] flavones etc. Moreover, these are important intermediates in many addition reactions of nucleophiles due to inductive polarization of carbonyl group at the a-position. These finding explain the significant interest of scientist in this particular group of compounds. Several strategies for the synthesis

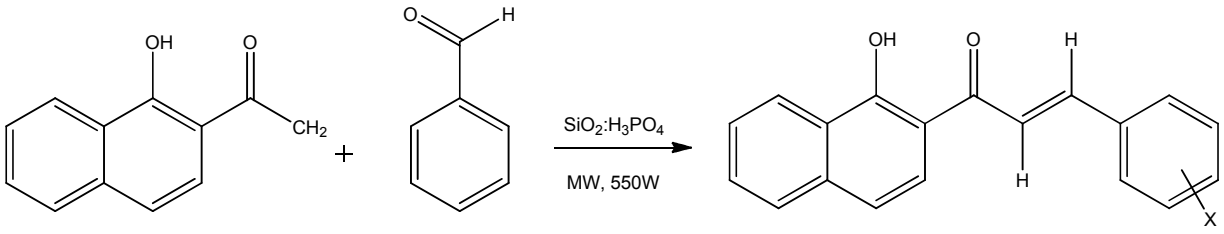
of these systems based on the formation of carbon-carbon bond have been reported. Among them the direct aldol condensation and Claisen-Schmidt condensation still occupy prominent positions. The main method for the synthesis of Chalcones is Claisen- Schmidt condensation in the presence of aq. alkaline bases[27] Conventional methods present several hurdles, such as toxic reagents, waste disposal problem, strong acidic or basic conditions and low selectivity makes these methods environmentally hazardous. In this respect solvent phase synthesis under microwave irradiations [28-31]is considered as eco-friendly alternative. Under the frame work of "Green Chemistry" we have developed an environmentally benign synthesis of Chalcones by condensing 1-(1-hydroxynaphthalen-2-yl)ethanoneand substituted benzeldehydes using microwave irradiation in the presence of SiO_2-H_3PO_4[28, 32, 33]as catalytic amount. The structures of the various synthesized compounds were assigned on the basis of UV, IR, ^{1}H-NMR, ^{13}C-NMR, mass spectra and elemental analysis. These compounds were also screened for their antibacterial activity.

MATERIALS AND METHODS

General

All the chemicals involved in the present investigation, have been procured from Sigma-Aldrich and E-Merck chemical companies. Melting points of all chalcones have been determined in open glass capillaries on SUNTEX melting point apparatus and are uncorrected. The UV spectra of all the chalcones, synthesized, have been recorded with ELICO-BL222 spectrophotometer (λ_{max} nm) in spectral grade methanol solvent. Infrared spectra (KBr, 4000-400 cm-1) have been recorded on AVATAR-300 Fourier transform spectrophotometer. The NMR spectra were recorded in Bruker AV400 NMR spectrometer operating at 400 MHz has been utilized for recording ^{1}H NMR spectra and 100 MHz for ^{13}CNMR spectra in $CDCl_3$ solvent using TMS as internal standard.

General procedure for preparation of *substituted (E)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones* :
An appropriate equi-molar quantities of 1-(1-hydroxynaphthalen-2-yl)ethanone(2 mmol), substituted benzaldehydes (2 mmol) and SiO_2-H_3PO_4 (0.5 g) [28, 32, 33] were taken in a 50 mLborosilbeaker and closed with lid. The mixture has been subjected to microwave irradiation at 550W, for 6-12 minutes in a microwave oven (**Scheme 1**) (Samsung, Microwave Oven, and 100-700 W) and then cooled to room temperature. After separating the organic layer with dichloromethane the solid product has been obtained on evaporation. The solid, on recrystallization with benzene-hexane mixture gives glittering product. The insoluble catalyst has been recycled by washing with ethyl acetate (8 mL) followed by drying in an oven at 100 °C for 1h and reused for further reactions. The analytical data of chalcones are presented in **Table 1.**



X=H, 4-Br, 2-Cl, 3Cl, 4Cl, 4-F, 4-CH_3, 2-NO_2, 4-NO_2

Scheme 1. Synthesis of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-onesusing silica-phosphoric acid catalyzed aldol condensation between 1-hydroxy-2-acetyl naphthalene and substituted benzaldehydes

Table-1. Analytical and physical constant of substituted(*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-one

Entry	X	M. F.	M.W.	M.P. (°C)	Mass (m/z)
1	H	$C_{20}H_{18}O_2$	290	123	290[M^+], 257, 197, 184, 171, 143, 131, 103
2	4-Br	$C_{20}H_{17}BrO_2$	369	122-123	369[M^+], 335,273,208,197, 184, 180, 171,167,154,143,78
3	2-Cl	$C_{20}H_{17}ClO_2$	324	105-106	324[M^+], 326[M^{2+}] 291, 273, 197, 184, 171, 165, 143, 137, 143, 137, 124, 111, 34
4	3-Cl	$C_{20}H_{17}ClO_2$	324	103-104	324[M^+],326[M^{2+}] 291, 273, 197, 184, 171, 165, 143, 137, 143, 137, 124, 111, 34
5	4-Cl	$C_{20}H_{17}ClO_2$	324	88-89	324[M^+], 326[M^{2+}] 291, 273, 197, 184, 171, 165, 143, 137, 143, 137, 124, 111, 34
6	4-F	$C_{20}H_{17}FO_2$	308	90-91	308[M^+], 275, 273,197, 184, 171, 149, 143, 121, 108, 95
7	4-CH_3	$C_{21}H_{20}O_2$	304	96-97	304[M^+], 273, 271, 197, 184, 171, 145, 143, 117, 104, 91
8	2-NO_2	$C_{20}H_{17}NO_4$	335	80-81	335[M^+], 302, 273, 197, 184, 176, 171, 148, 143, 135, 122, 45
9	4-NO_2	$C_{20}H_{17}NO_4$	335	72-73	335[M^+], 302, 273, 197, 184, 176, 171, 148, 143, 135, 122, 45

RESULTS AND DISCUSSION

Spectral linearity

In the present study the spectral linearity of chalcones[1, 28-33, 34, 35] has been studied by evaluating the substituent effects on the group frequencies. The assigned group frequencies of all chalcones like UV-Vis absorption λ_{max}(nm), carbonyl stretches νCO*s-cis and s-trans*, the deformation modes of vinyl part CH *out ofplane*, *in-plane*, CH=CH and >C=C<*out ofplanes*(cm^{-1}), the vinyl hydrogen and chemical shifts δ(ppm) of Hα, H_β, Cα, C_β ,CO are assigned and these frequencies are correlated with various substituent constants, Swain-Lupton's[36]F and Rparameters.

UV spectral study

The measured absorption maxima ($\lambda_{max,}$ nm) of these (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones are presented in **Table 2**. These values are correlated with Hammett substituent constants and F and R parameters using single and multi-linear regression analysis [1, 2, 3, 4, 5, 23-28]. Hammett correlation involving the group frequencies and absorption maxima, the form of the Hammett equation employed is

$$\lambda = \rho\sigma + \lambda_o \quad \text{... (1)}$$

Table-2: UV-Vis λ_{max}(nm) and infrared spectral data (ν, cm^{-1}), NMR chemical shifts (δ, ppm)of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones

Entry	X	UV	IR						^{1}HNMR		^{13}C NMR		
		λmax	$CO_{(s\text{-}cis)}$	$CO_{(s\text{-}trans)}$	CH_{ip}	CH_{op}	$CH{=}CH_{op}$	$C{=}C_{op}$	H_α	H_β	CO	Cα	C_β
1	H	302.36	1677.47	1625.8	1112.27	811.63	1024.54	570.13	7.91	8.35	188.27	122.76	136.18
2	4-Br	311.78	1633.72	1573.04	1119.19	794.64	1061.25	569.77	7.96	8.27	190.88	121.71	138.29
3	2-Cl	299.04	1670.80	1620.98	1088.69	814.28	1031.5	570.72	6.74	7.44	179.85	121.90	141.43
4	3-Cl	318.50	1697.54	1635.51	1118.15	750.41	1035.62	549.72	6.68	7.89	179.49	116.17	130.71
5	4-Cl	329.51	1631.78	1581.63	1112.93	817.82	1068.56	564.24	7.32	7.83	189.56	123.84	137.70
6	4-F	330.38	1644.78	1571.99	1114.98	794.67	1058.92	576.72	7.71	8.29	187.98	123.34	136.58
7	4-Me	338.67	1625.99	1573.91	1114.86	798.53	1060.85	584.43	7.32	7.88	177.43	122.59	140.83
8	2-NO_2	295.89	1625.99	1521.84	1111.00	869.90	1066.64	574.72	7.33	8.38	189.44	125.56	138.78
9	4-NO_2	345.48	1624.06	1573.91	1122.57	856.39	1080.14	569.00	6.83	8.33	188.48	120.80	135.51

where$\lambda_o$is the frequency for the parent member of the series. The results of statistical analysis [1, 28-33, 34, 35] of valueswith Hammett substituent constants, F and R parameters. The result of statistical values shown in **Table 3.** The Hammett constants σ(r= 0.903) and σ^+ (r=0.907)are correlated satisfactorily. The remaining Hammett substituent constants and parameters were failed in correlation. This is due to weak filed, resonance and inductive effects of the substituents it is predicting the reactivity on the absorption maximum. This is evident with resonance structure shown in **Figure 1.**

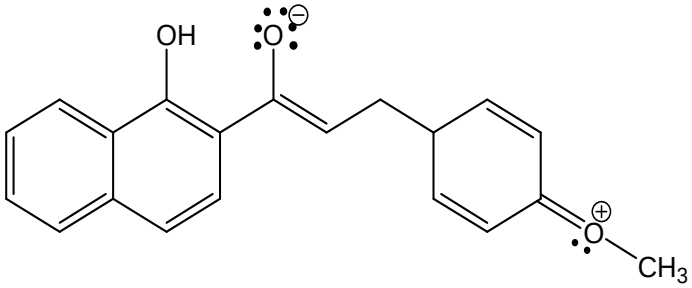


Figure-1:Resonance structure

The multi regression analysis of these frequencies of all ketones with inductive, resonance and Swain – Lupton's [36] constants produce satisfactory correlations as evident in equations (2 and 3).

$$\lambda_{max}(nm) = 315.518(\pm12.283) - 15.351(\pm5.259)\sigma_I - 20.873(\pm7.949)\sigma_R \quad \text{...(2)}$$

(R =0.932, n = 9, P > 90%)

λ_{max}(nm) = 314.075(±12.317) –8.401(±2.681)F -11.819(±3.458)R ...**(3)**

(R = 0.928, n =9, P > 90%)

IR spectral study

The carbonyl stretching frequencies (cm^{-1}) of *s-cis* and *s-trans* isomers of present study are presented in **Table. 2,** and the corresponding conformers are shown in **Figure. 2.** The stretching frequencies for carbonyl absorption are assigned based on the assignments made by Hays and Timmons [37] for *s-cis* and *s-trans* conformers at 1690 and 1670 cm^{-1}, respectively. These data have been correlated with Hammett substituent constants and Swain-Lupton constants [36]. In this correlation the structure parameter Hammett equation employed is as shown in the following equation:

$\nu = \rho\sigma + \nu_0$ ... **(4)**

Where ν is the carbonyl frequencies of substituted system and ν_0 is the corresponding quantity of unsubstitued system; σ is a Hammett substituent constant, which in principle is characteristics of the substituent and ρ is a reaction constant which is depend upon the nature of the reaction. The results of single parameter statistical analysis of carbonyl frequencies with Hammett substituent constants of the *s-cis*conformersσ(r=0.900)andσ^+(r=0.903)were correlated satisfactorily. Remaining Hammett constantand F& R parameters has shown poor correlation. No satisfactory correlation was found for *s-trans* conformers, the frequency of CH*ip*have shown satisfactory correlation with R parameter however remaining Hammett substituent constant and F parameter has shown poor correlation it is due to weak polar, inductive and Field effect of the substituents. Deformation modes of IR frequency for CH*op*and $CH{=}CH_{op}$has shown no satisfactory correlation with all Hammett substituent constants and F & R parameters. It is evident that incapability of polar, inductive, field and resonance effect of the all substituent. These substituent. This failure in correlation is due the conjugation between the substituent and the carbonyl group in chalcones as shown in **Figure 1**. C=C *out of plane*has shown satisfactory correlation with σ(r=0.901). The remaining Hammett substituent constants and parameter F and R gave poor correlation due to the conjugation between the substituent and the vinyl group in chalcones the result of statistical analysis values are shown in **Table-3**. In view of the inability of some of the σ constants to produce individually satisfactory correlations, it was thought that worthwhile to seek multiple correlations involving either σ_I and σ_R constants or Swain-Lupton's [36], F and R parameters. The correlation equations for s-*cis*, s-*trans* and *deformation modes* are given in equations (5-16).

$\nu CO_{s\text{-}cis}(cm^{-1})$= 1650.64(±21.641)- 4.775(±46.266)σ_I + 4.891(±56.290)σ_R ...**(5)**

(R = 0.905, n = 9, P > 90%)

$\nu CO_{s\text{-}cis}(cm^{-1})$=1656.818(±20.462)-11.285(±44.324)F+18.539(±42.292)R ...**(6)**

(R = 0.922, n = 9, P > 90%)

$\nu CO_{s\text{-}trans}(cm^{-1})$=1598.422(±26.057)-52.065(±55.707)σ_I- 38.773(±67.777)σ_R ...**(7)**

(R = 0.933, n = 9, P > 90%)

$\nu CO_{s\text{-}trans}(cm^{-1})$= 1607.086(±24.638)-64.693(±53.369) F-17.148(±50.923) R ...**(8)**

(R = 0.944, n = 9, P > 90%)

$\nu CH_{ip}(cm^{-1})$= 1114.098(±7.621) -7.107(±16.293) σ_I-6.748(±19.822) σ_R ...**(9)**

(R =0.922, n = 9, P > 90%)

$\nu CH_{ip}(cm^{-1})$ = 1111.752(±7.187) -4.791(±15.568) F -11.632(±14.854) R ...**(10)**

(R = 0.930, n = 9, P> 90%)

$\nu CH_{op}(cm^{-1})$ = 811.632(±27.391)+ 20.017(±58.560) σ_I+37.848(±71.247)σ_R ...**(11)**

(R = 0.922, n = 9, P > 90%)

$\nu CH_{op}(cm^{-1})$= 806.711(±27.050) +20.386(±58.595) F +10.211(±55.909) R ...**(12)**

(R =0.914, n = 9, P > 90%)

$\nu CH{=}CH_{op}(cm^{-1})$=1044.514(±14.465)+15.956(±30.925)σ_I-21.375(±37.625)σ_R ...**(13)**

(R = 0.931, n = 9, P > 90%)

$\nu CH{=}CH_{op}(cm^{-1})$=1041.036(±13.042)+18.268(±28.251) F-25.622(±26.956) R ...**(14)**

(R = 0.946, n = 9, P> 90%)

$\nu C{=}C_{op}(cm^{-1})$= 569.433(±23.650)-38.430(±50.562)σ_I-7.930(±61.517)σ_R ...**(15)**

(R =0.929, n = 9, P > 90%)

$\nu C{=}C_{op}(cm^{-1})$= 562.125(±23.637)-20.837(±51.202) F –11.195(±48.855) R ...**(16)**

(R = 0.925, n = 9, P> 90%)

Table-3:Results of statistical analysis of Ultra violet absorptions(λ_{max} nm), infrared ν(cm^{-1}) CO*s-cis*, CO*s-trans*, CH*ip*, CH*op*, CH=CH*op*, C=C*op*, NMR chemical shifts H*α*, Hβ, CO, C*α* and Cβ (δ, ppm)of substituted(*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-oneswith Hammett constants σ, σ^+, σ_I , σ_R and F and R parameters

Frequency	Constants	r	I	ρ	s	n	Correlated derivatives
λ_{max}(nm)	σ	0.903	315.398	-11.145	16.884	7	4-Br, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.917	314.232	-5.579	17.084	6	4-Br, 3-Cl, 4-Cl, 4-F,4-CH_3, 4-NO_2
	σ_I	0.823	318.790	-13.893	16.971	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.802	310.212	-19.286	16.858	6	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.808	315.897	-5.678	17.273	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.801	311.291	-10.057	17.110	6	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
ν$CO_{s\text{-}cis}$(cm^{-1})	σ	0.900	1646.20	12.049	28.622	8	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 4-NO_2
	σ^+	0.903	1646.40	17.756	27.358	8	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 4-NO_2
	σ_I	0.876	1649.87	-5.116	28.909	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.803	1648.99	5.385	28.916	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2,4-NO_2
	F	0.827	1653.96	-15.556	28.640	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.822	1630.78	20.906	28.344	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
ν$CO_{s\text{-}trans}$(cm^{-1})	σ	0.826	1590.79	-28.571	36.512	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.802	1586.64	-1.454	37.881	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.783	1604.50	-4.357	35.722	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.815	1580.42	-33.389	37.232	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.842	1609.72	-60.743	34.265	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.702	1585.64	-3.579	37.875	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
νCH_{ip}(cm^{-1})	σ	0.834	1113.83	-7.333	10.082	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.844	1113.52	-8.703	9.328	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2,4-NO_2
	σ_I	0.798	1115.15	-6.636	10.271	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.712	1111.64	-6.013	10.334	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.805	1113.54	-2.111	10.396	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.902	1110.16	-10.627	9.980	8	H, 4-Br, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
νCH_{op}(cm^{-1})	σ	0.806	810.92	7.410	37.589	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.815	813.04	-11.166	37.417	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.811	805.69	17.373	37.417	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.815	818.55	35.778	36.921	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.812	805.13	18.033	37.373	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.804	813.46	5.935	37.644	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
ν$CH{=}CH_{op}$(cm^{-1})	σ	0.813	1055.40	-7.861	20.128	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.731	1055.60	-15.272	18.631	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.821	1047.86	17.449	19.823	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.823	1050.02	17.449	19.735	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.732	1044.98	24.171	19.274	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.840	1047.09	29.453	18.585	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
ν$C{=}C_{op}$(cm^{-1})	σ	0.901	559.330	-16.385	32.555	7	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3
	σ^+	0.822	558.411	-16.992	31.813	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.839	570.676	-37.876	31.617	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.784	556.151	-3.956	33.058	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.814	563.851	-18.258	32.709	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.805	555.219	-6.825	33.014	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
δH_α(ppm)	σ	0.722	7.420	-0.309	0.471	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.823	7.391	-0.195	0.472	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.762	7.536	-0.448	0.470	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.675	7.394	0.114	0.483	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.809	7.442	-0.181	0.481	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.705	7.351	-0.094	0.483	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
δH_β(ppm)	σ	0.704	8.074	-0.005	0.349	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.820	8.086	-0.135	0.342	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.702	8.080	-0.018	0.349	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.607	8.106	0.181	0.347	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.813	8.007	0.173	0.346	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.704	8.050	-0.095	0.348	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
δCO(ppm)	σ	0.902	191.123	0.089	2.116	7	4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3,2-NO_2
	σ^+	0.887	191.085	0.570	2.095	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.833	190.687	1.234	2.093	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.838	190.615	-2.863	2.029	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.786	190.552	1.529	2.077	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.806	190.901	-0.972	2.099	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
δC_α(ppm)	σ	0.902	123.237	-2.563	3.256	8	H, 4-Br, 2-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2

	σ^+	0.904	123.124	-3.003	2.980	6	H, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.802	123.038	-0.511	3.377	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.901	122.533	-1.750	3.360	8	H, 4-Br, 2-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.807	122.509	0.898	3.251	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.902	122.050	-3.313	3.251	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
δC_β(ppm)	σ	0.801	137.361	-0.180	3.406	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ^+	0.837	137.272	-0.685	3.387	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_I	0.821	137.816	-1.321	3.390	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	σ_R	0.718	137.898	3.090	3.344	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	F	0.802	137.847	-1.340	3.388	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2
	R	0.819	137.924	2.430	3.338	9	H, 4-Br, 2-Cl, 3-Cl, 4-Cl, 4-F,4-CH_3, 2-NO_2, 4-NO_2

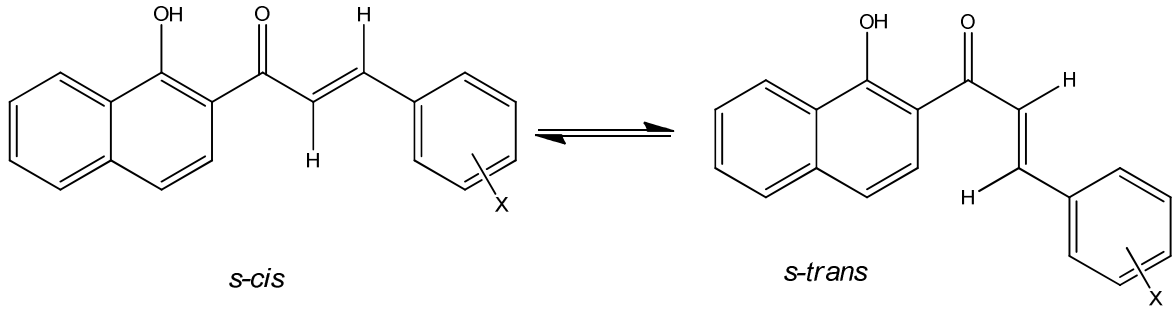


Figure-2:The *s-cis*and *s-trans* conformers of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones

^{1}H NMR spectral study

The ^{1}H NMR spectra of synthesized chalcones were recorded in deuteriochloroform solutions employing tetramethylsilane (TMS) as internal standard. The signals of the ethylenic protons were assigned from their spectra. They were calculated as AB or AA' or BB' systems respectively. The lower chemical shifts(ppm) obtained for Hα and higher chemical shifts (ppm) obtained for H_β in this series of ketones. The vinyl protons give an AB pattern and the β-proton doublets were well separated from the signals of the aromatic protons. The assigned vinyl proton chemical shifts δ(ppm) of all ketones were presented in Table 2.

In nuclear magnetic resonance spectra, the proton or the ^{13}C chemical shifts (δ) depends on the electronic environment of the nuclei concerned. The assigned vinyl proton chemical shifts (ppm) have been correlated with reactivity parameters using Hammett equation in the form of

$$\text{Log } \delta = \text{Log } \delta_0 + \rho\sigma \quad \textbf{… (17)}$$

Whereδ_0 is the chemical shift of unsubstituted ketones.

The assigned H_α and H_β proton chemical shifts (ppm) are correlated with various Hammett sigma constants. The results of statistical analysis [1, 2, 3, 4, 5, 23-28] are presented in Table 3. The obtained all correlations has shown not satisfactorilyfor H_α and $H_\beta$for all Hammett substituent constant and F & R parameters for both the proton chemical shifts and is due to the reasons stated in earlier and the conjugative structure shown in Figure 2.

Application of Swain-Lupton [36] treatment to the relative chemical shifts of H_α and H_β with F and R values is successful with resonance, inductive and fail with F & R parameter generates the multi regression equations (18-21).

δH_α(ppm) = 7.547(±0.352) -0.443(±0.752)σ_I +0.068(±0.914)σ_R **...(18)**
(R = 0.932, n = 9, P> 90%)

δH_α (ppm) = 7.421(±0.348) -0.213(±0.754)F -0.139(±0.719)R **...(19)**
(R = 0.912, n = 12, P> 90%)

δH_β(ppm) = 8.108(±0.250) -0.005(±0.556)σ_I -0.180(±0.676)σ_R **...(20)**
(R =0.911, n = 12, P > 90%)

δH_β(ppm) = 7.998(±0.251) + 0.159(±0.544)F-0.061(±0.519)R **...(21)**
(R = 0.912, n = 12, P> 90%)

^{13}C NMR spectral study

Spectral analysts, organic chemists and scientists [1, 2, 3, 4, 5, 23-28] have made extensive study of ^{13}C NMR spectra for a large number of different ketones and styrene's. The assigned vinyl C_α, C_β and carbonyl carbon chemical shifts values are presented in Table-5. The results of statistical analysis are given in Table 6. TheCOchemical shifts(ppm) gave satisfactory correlation with Hammett substituent constants σ(0.902) the remaining Hammett substituent constant, parameters F and R has shown poor correlation. The chemical shifts (ppm) of C_α carbon with Hammett σ(0.902), σ^+ (r=0.904), σ_R(r=0.901) and R(0.902) were satisfactory correlation Remaining Hammett σ_I constants, F parameter were fails in correlation. This is due to inductive and field effect of the substituents; this is stated earlier with the resonance conjugative structure shown in Figure 2. The $C_\beta$chemical shifts (ppm) of all ketones gave shown no satisfactory correlation with All Hammett substituent constants and F and R parameters..

The Swain Luptons' [36] parameter correlations were satisfactorily obtained within these carbon chemical shifts and the regression equations are given in (22-27).

$\delta CO(ppm) = 190.255(\pm1.507)+1.041(\pm3.222)\sigma_I - 2.756(\pm3.919)\sigma_R$ ...**(22)**
(R =0.933, n = 9, P > 90%)
$\delta CO(ppm) = 190.447(\pm1.501)+1.371(\pm3.252)F - 0.684(\pm3.103)R$ ...**(23)**
(R =0.936, n = 9, P> 90%)
$\delta C_\alpha(ppm) = 122.754 (\pm2.514) - 0.638(\pm5.374)\sigma_I - 1.816(\pm6.539)\sigma_R$ ...**(24)**
(R = 0.911, n = 9, P > 90%)
$\delta C_\alpha(ppm) = 122.003(\pm2.360) + 0.142(\pm5.111)F - 3.283(\pm4.877)R$ ...**(25)**
(R =0.922, n = 9, P> 90%)
$\delta C_\beta(ppm) = 138.282(\pm2.496) - 1.113(\pm0.035)\ \sigma_I + 2.975(\pm6.492)\sigma_R$ ...**(26)**
(R =0.922, n =9, P > 90%)
$\delta C_\beta(ppm) = 138.195(\pm2.418) - 0.819(\pm5.224)F + 2.261(\pm4.998)R$ ...**(27)**
(R =0.920, n = 9, P> 90%)

Antimicrobial activities

Antimicrobial research over the past 50 years has been focused on meeting medical needs to treat infections disease caused by life threating pathogens. Inspite of the introduction of a varietyof antibacterial agents in multiple unrelated drug classes, resistance continues to emerge. The pharmaceutical field must respond to these clinical challenges by bringing forward a stream of new agent with promising antibacterial activity against bacteria, advantages of these agents include their higher predictability for success, well defined biomarkers, shorter clinical trials, and shorter duration of therapy leading to fewer long time safety concerns. Antibacterial drug discovery remains an important opportunity for the pharmaceutical sector.

An antimicrobial is a substance that kills or inhibits the growth of microorganisms such as bacteria, fungi or protozoan. These include host defense mechanisms, the location of infection, and the pharmacokinetic and pharmacodynamics properties of the antibacterial. Antimicrobial drugs either kill microbes (microbiocidal) or prevent the growth of microbes (microstatic). Disinfectantsare antimicrobial substances used on non-living objects or outside the body. Antimicrobials include not just antibiotics but synthetically formed compounds as well. They are exhibit versatile biological activities among which Antifeedent[38], Anti-bacterial[39], Antiulcer[40], Antifungal[41], Antioxidant[42], Antivasodilatory[43], Antimitotic[44], Antimalarial[45], Antileshmanial[46], Anti-inflammatory[47], Chemopreventive[48], Cardiovascular disease[49], Anticancer[50], Cytotoxic[51], Antiprolifirative[52], Antiviral[53], Anti–HIV[54], Antimycobacterial[55], Antifibrogenic[56], Antitrichomonal[57], Cytotoxic and anti-Trypanosomacruzi[58], Immune-modulatory[59], Physiological oxidation[60], Antiplatelet[61], Antimicrobial[62], Anticancer[63], Antitubercular[64], Inhibition of chemical mediators release[65],Inhibition of tyrosinase[66], Inhibition of leukotriene B_4[67], Inhibition of aldose reductase[68], Antimutagenic[69], Antipyretie[70], Anxiety and tension[71], Antiplaque activities & also prevents dementia[72-80], Inhibition of lipid peroxidation[81], Anti-allergic[82], Anticonvulsant[83],Antihypertensive[84], Antinocicepative[85][85], Plantgrowthregulator[86], Antipepticulcer[87], Narcosis Potentiation[88], Animal toxins[89, 90],Nitric oxide inhibition[91],Throneinhibition[92], Anti-histamin activity[93], Antiplasmodial[94], Antidepresent[95], Antifouling[96],Anti trypanocidal[97], Antigastroprotective[98], Arthropodicidal[99], Anti-infective agents[100], Anti-diabetic effects[101, Anti fibrogenic activities and modulation of P-glycoprotein-mediated multi-drug resistance[102], Skin carcinogenesis[103] and Anti filarial[104]activities have been cited in

literature. Number of chalcone derivatives has also been found to inhibit several important enzymes in cellular systems, including Xanthine oxidase[105], Epoxide hydrolase[106]and Quinone reductase [107]activities also have been cited in literature.

Antibacterial sensitivity assay

Antibacterial sensitivity assay was performed using Kirby-Bauer [108] disc diffusion technique. In each Petri plate about 0.5ml of the test bacterial sample was spread uniformly over the Solidified Mueller Hinton agar using sterile glass spreader. Then the discs with 5mm diameter made up of Whatmann No.1 filterpaper, impregnated with the solution of the compound were placed on the medium using sterile forceps. The plates were incubated for 24 hours at 37^{o}C by keeping the plates upside down to prevent the collection of water droplets over the medium. After 24 hours, the plates were visually examined and the diameter values of the zone of inhibition were measured. Triplicate results were recorded by repeating the same procedure.

Table-4: The Zone of inhibition(mm) values of antibacterial activity of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones

S.NO.	Substituents	Zone of Inhibition (mm)				
		Gram positive Bacteria			Gram negative Bacteria	
		B.subtilis	*M.luteus*	*S.aureus*	*E.coli*	*P.aeruginosa*
1	H	-	8	7	8	8
2	4-Br	8	8	9	-	-
3	2-Cl	7	10	7	7	7
4	3-Cl	7	7	-	7	7
5	4-Cl	-	8	7	-	-
6	4-F	-	8	7	8	7
7	4-CH_3	7	-	9	8	7
8	2-NO_2	8	7	6	7	8
9	4-NO_2	7	7	7	7	8
Standard	Ampicillin	14	15	14	16	15
Control	DMSO	-	-	-	-	-

PLATE-1

PLATE-2

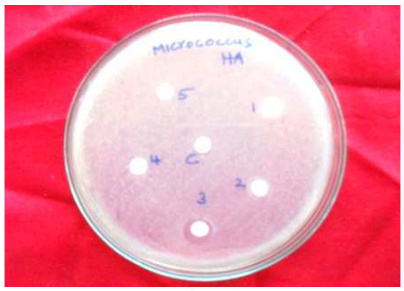


PLATE-3

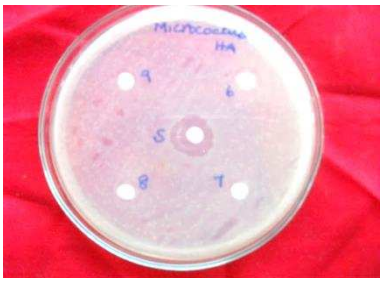


PLATE-4

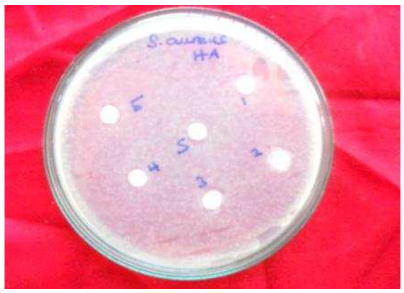


PLATE-5

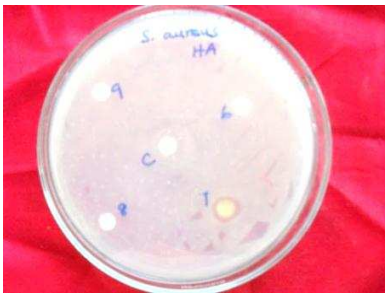
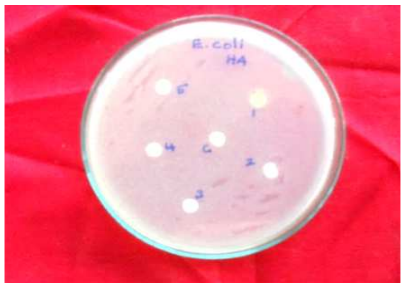


PLATE-6



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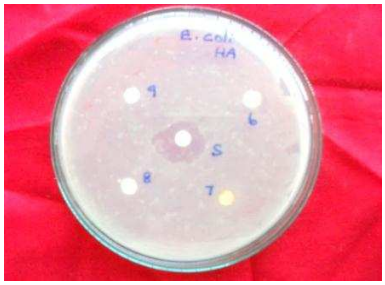

PLATE-8

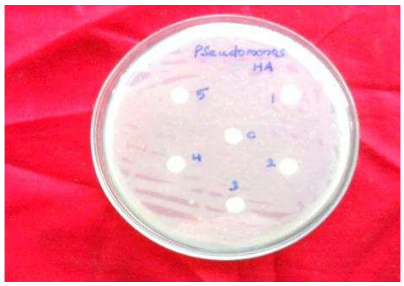

PLATE-9

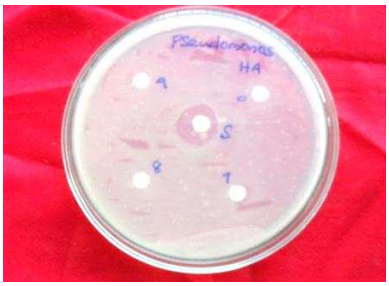

PLATE-10

The antibacterial screening effect of synthesized chalcones is shown in **Figure-3.**(Plates 1-10). The zone of inhibition is compared using **Table-4**and the clustered column chart is shown in **Figure-4**. A very good antibacterial activity has been possessed by all substituents on the microorganisms in general. All the compounds showed good activities on *B.subtilis*species except H,4-F and 4-Cl. The substituent 2-Cl shown good activity against *M.luteus*and H, 4-Br, 4-Cl and 4-F have shown good activityagainst *M.luteus.* The substituent 4-Br and 4-CH_3has shown good activity against bacterial species of *S.aureus.* The entire compound shown moderate activity against *Escherichia coli*except 4-Cl substituent. The substituent H, 2-NO_2 and 4-NO_2 have improved antibacterial activity against *Pseudomonas aerogenosa.*

Figure-3: Antibacterial activities of substituted(*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones :petri dishes

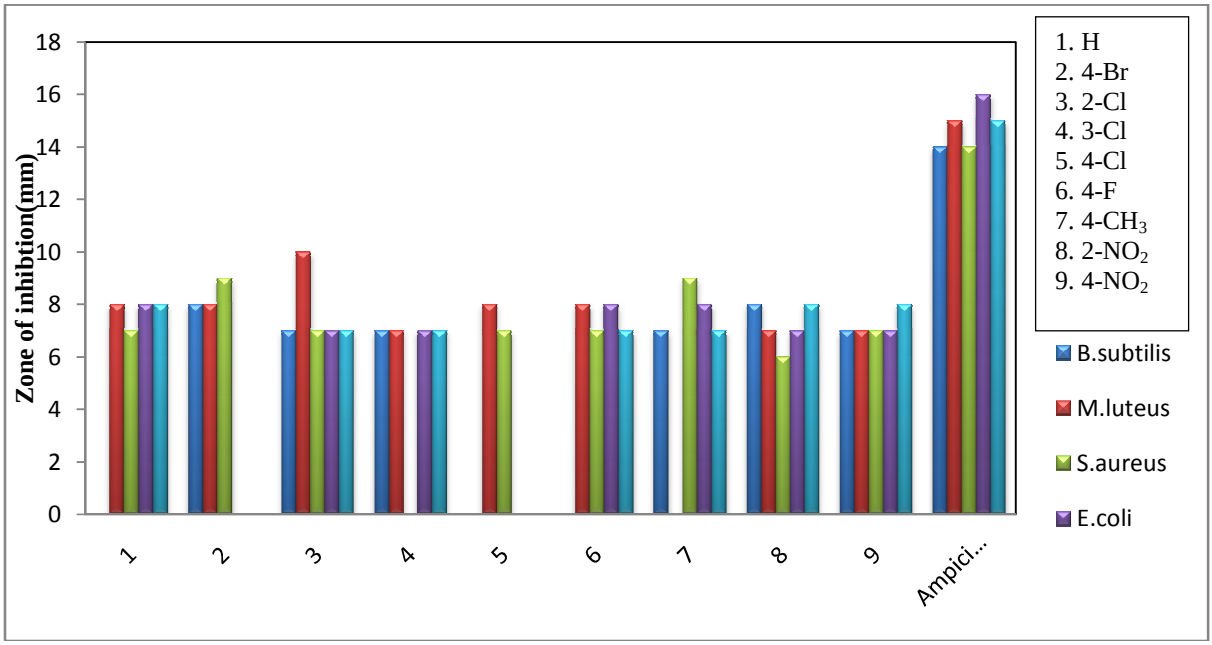

Figure-4: Antibacterial activity of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones :clustered-column chart

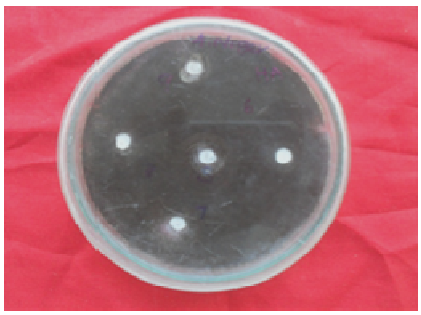

PLATE-11

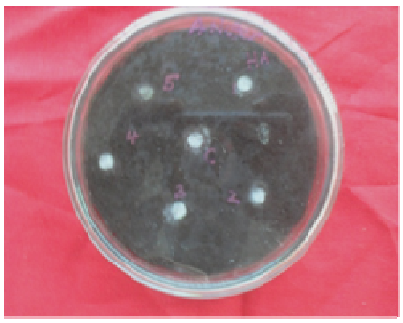

PLATE-12

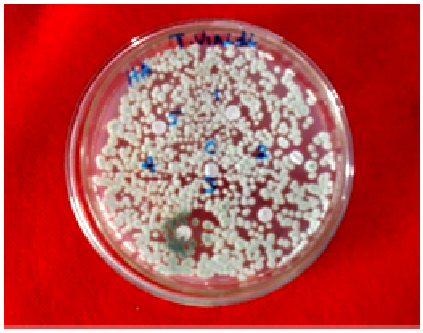

PLATE-13

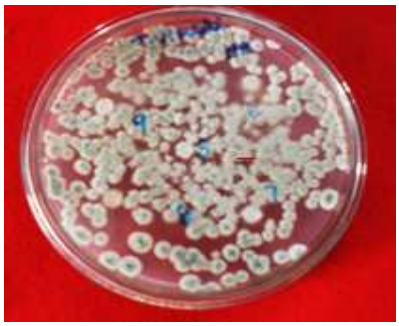

PLATE-14

Figure-5.Antifungal activities of substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones-petri dishes

Antifungal sensitivity assay

Antifungal sensitivity assay was performed using Kirby-Bauer[108] disc diffusion technique. PDA medium was prepared and sterilized as above. It was poured (ear bearing heating condition) in the Petri-plate which was already filled with 1 ml of the fungal species. The plate was rotated clockwise and counter clock-wise for uniform spreading

of the species. The discs were impregnated with the test solution. The test solution was prepared by dissolving 15mg of the chalcone in 1ml of DMSO solvent. The medium was allowed to solidify and kept for 24 hours. Then the plates were visually examined and the diameter values of zone of inhibition were measured. Triplicate results were recorded by repeating the same procedure.

The antifungal activities of substituted chalcones synthesized in the present study are shown in **Figure-5**for Plates **(11-14)** and the zone of inhibition values of the effect is given in **Table5.** The clustered column chart, shown in **Figure-6**reveals that all the compounds have good antifungal activity against all the two fungal species namely *A.niger*, and *T.viride.* The substituentshave shown improved antifungal activity*A.niger* except, 4-Br, 4-CH_3 and 4-NO_2substituents. All the substituent has shown moderate antifungal activity and s against*T.viride*except4-Br and 3-Cl substituents.

Table-5: Zone of inhibition(mm)values of antifungal activity of substituted(*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones

S.No.	Substituents	Zone of Inhibition(mm)	
		A.niger	*T.viride*
1	H	8	8
2	4-Br	-	-
3	2-Cl	6	-
4	3-Cl	9	8
5	4-Cl	6	8
6	4-F	9	7
7	4-CH_3	-	9
8	2-NO_2	8	8
9	4-NO_2	-	9
Standard	Miconazole	9	14
Control	DMSO	-	-

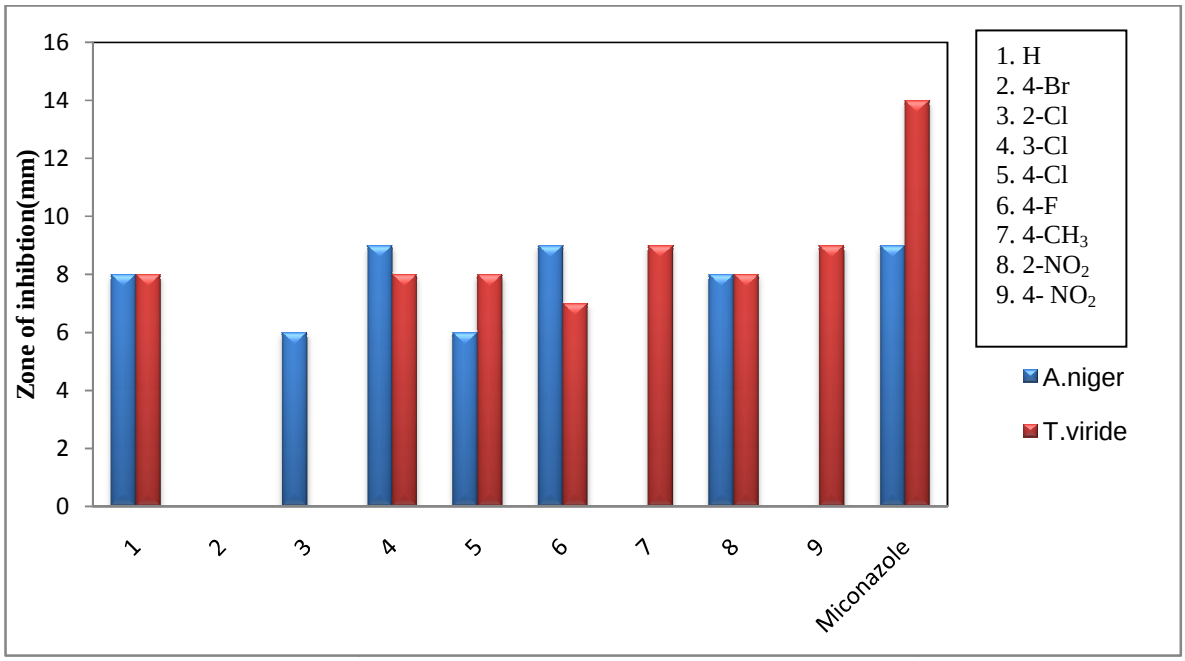

Figure-6.Antifungal activity ofsubstituted(*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-ones:clustered column chart

CONCLUSION

Some substituted (*E*)-1-(1-hydroxynaphthalen-2-yl)-3-phenylprop-2-en-1-oneshave been synthesized by condensation of 1-hydroxy-2-acetylnaphthalenand substituted benzaldehydes using SiO_2-H_3PO_4 acid catalyst in microwave technique. The synthesized*E*-prop-2-en-1-ones have been characterized by their physical constants and

spectral data. The functional group frequencies of UV, IR, NMR spectral data of these*E*prop-2-en-1-ones has been correlated with Hammett substituent constants, F and R parameters. From the results of statistical analyses the effects of substituent on the spectral data have been studied. The antimicrobial activities of all synthesized *E*-prop-2-en-1-ones have been studied using Bauer-Kirby method.

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