Synthesis of some heterocyclic compounds derived from 1-Aryl-3-(4-hydroxy-3-methoxyphenyl) propene-1-one

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Abstract

A series of heterocyclic compounds have been synthesized using 1–aryl-3-(4-hydroxy-3-methoxypheny) prop-2-ene-1-one (1-4) as starting material which was prepared by Claisen-Schmidt condensation between vanillin and substituted acetophenone. Benzoxazepine derivatives (5-8) and benzodiazepine derivatives (9-12) were synthesized from the reaction of o-aminophenol, o-phenlendiamine with compounds (1-4) respectively. The reaction of compounds (1-4) with hydrazine hydrate afforded pyrazol derivatives (13-16). While the reaction of compounds (1-4) with hydrazine hydrates in the presences a few drops of glacial acetic acid gave 1- acetyl pyrazol derivatives (17-20). Oxirane derivatives (21-24) were synthesized from the reaction of compounds (1-4) with hydrogen peroxide in the basic medium. Reaction of phenylthiourea with compounds (1-4) afforded pyrimidinethion derivative (25-27). Finally isoxazol derivatives (28-31) were synthesized by the reaction of compounds (1-4) with hydroxylamine hydrochloride in presences of triethylamine.

Keywords: Vanillin, Pyrazol, Oxirane, Pyrimidinethion, Isoxazol

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تحضير بعض من المركبات الحلقية غير المتجانسة المشتقة من 1- اريل -3-(4-هيدروكسي-3-ميثوكسيفنيل) بروبين-1-اون

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الخلاصة

في هذا البحث تم تحضير1- أريل-3-(-4 هيدروكسي-3-ميثوكسي فنيل)- بروب-2-ين-1-اون (4-1) عن طريق تكاثف كليزن- شمدت بين الفانيلينومعوضات الاسيتوفينون.حضرت معوضات بنزواكسازبين(8-5) من مفاعله المركبات(4-1) مع أورثو-أمينو فينول.مشتقات البنزوثنائي أزين (12-9) حضرت من تفاعل المركبات (4-1) مع أورثوفنيلين ثنائي الأمين . تفاعل المركبات (4-1) مع الهيد رازين أعط مشتقات البايرازول (16-13) ، بينما تفاعل المركبات (4-1) مع الهيد رازين المائي بوجود قطرات حامض ألخليك أعطى البايروزلات المعوضة في الموقع(1) بمجوعة الاستيل .(20-17) وكذلك تم تحضير معوضات الاوكسيران (24-21) من تفاعل المركبات (4-1) مع 30% بيرو كسيد الهيدروجين . تفاعل المركبات(4-1) مع الفنيلثايويوريا أعطت معوضاتا لبرميدينثايون(27-25)، وأخيرا حضرت مشتقات الايزواوكسازول(31-28) عن طريق مفاعله المركبات (4-1) مع الهيدروكسيل أمين هيدروكلوريد شخصت المركبات المحضرة بالطرق الطيفية والفيزياويه المتاحة.

كلمات مفتاحية: فانيلين، بايرازول، اوكسيران، بريميدين ثايون، ايزواوكسازول.

Introduction

The chemistry of chalcone characteristic by extensive scientific studies by many researchers, some of these chalcone syntheses are by the reaction of acetophenone with substituted aldehyde [1], othersreseacherersuse micro wave technology for preparation of a number of these derivatives [2]. This type or compounds encouraged us to synthesize a new heterocyclic derived from these compounds. Rana and Singh have synthesized pyarzole-1-ethanone derivatives depending on chalcone as starting material [2], many pyrazoline and isoxazole and pyrimidinone derivatives were synthesized depending on chalcone derivatives as starting material [3,4].

Hetrocycliccompounds have dispelled an impressive array of biological activity among which anti-malarial [5], anti-protozoa [6], anti-Inflammatory [7] and immunlodulatory [8].

In this paper chalcone derivatives was used as important starting materials for the synthesis of various classes of heterocyclic compounds such as isoxazole, pyrazolines, substituted pyrazolines and pyrimidinone derivative. Many1, 5-benzoxazepines and benzodiazepine derivative were also prepared.

Experimental

Melting points were measured on Electro thermal Melting Point Apparatus and are uncorrected. The IR spectra were recorded by using infrared spectrophotometer model Tensor 27 Bruckner Co. Germany. Ultra violet light recorded by Shimadzu UV-210 Double-Beam Spectrophotometer in DMF as solvent.

General procedure for synthesis of 1-aryl-3-(4-hydroxy-3-methoxyphenyl) prop-2-ene-1-one (1-4).

A mixture of (1.52g, 0.01mol) vanillin, (0.01mol) substituted acetophenone in 20ml absolute ethanol and 10 drops of thionyl chloride were stirring for 10 hr., and then refluxed for 6 hr. The solvent was evaporated under reduce pressure crush ice was added to the precipitate and left in cool condition overnight, the precipitate separated by filtration, dried and recrystallized from ethanol [9]. The physical properties and spectral data were listed in Tables (1,9).

2-Aryl-4-(4-hydroxy-3-meyhoxyphenyl) -2, 3-dihydro-1H-1, 5-benzoxazepine (5-8)

A mixture of the apreroppratechalcone derivative (1-4) (0.025 mol), o- aminophenol (0.025 mol, 2.74 g) in 20 ml methanol and a few drops from glacial acetic acid was refluxed for 8hr, the solvent was evaporated under reduced pressure, and the residue was recrystallized from dichloromethane [10]. The physical properties and spectral data were listed in Tables (2,10).

4- Aryl-2-(4-hydroxy-3-methoxyphenyl) -2, 3-dihydro-1H-1, 5-benzodiazepine (9-12).

A mixture of the appropriate chalcone derivative (1-4) (0.02mol), o- phenylendiamine(0.02 mol, 2.16 g) in absolute ethanol 20 ml and a few drops of glacial acetic acid was refluxed for12 hrs., the solvent was removed under reduce pressure, the obtained precipitate was

recrystallized from dry ethanol [11]. Some physical properties and spectral data were listed in Tables (3,11)

3- Aryl-5-(4-hydroxy-3-melthoxyphenyl) -4, 5-dihydro-1H-pyrazole (13-16)

A mixture of the appropriate chalcone derivative (1-4) (0.004mol) , (0.025mol, 1.25g) hydrazine hydrate in 20 ml glacial acetic acid was refluxed for 8hr ,then ice-water added and left to cool box overnight .the precipitate was filtered and recrystallized from ethanol [12]. The physical properties and spectral data were indicated in Tables (4,12).

1-acetyl-3-aryl-5-(4-hydroxy-3-methoxyphenyl) -4, 5-dihydro-1H-pyrazole (17-20)

A mixture of the appropriate chalcone derivative (1-4) (0.01 mol) in 20 ml absolute ethanol, hydrazine hydrate (0.01 mol, 1 g) and a few drops of glacial acetic acid were refluxed for 9 hr. the excess of solvent was removed, and the product washed with water then recrystallized from ethanol [13,14]. The physical properties and spectral data were listed in Tables (5,13).

2-Aroyl 3-(4-hydroxy-3-methoxyphenyl)-oxariane (21-24)

A mixture of 1ml (10%) NaOH, 10 ml (30%) hydrogen peroxide was added to the appropriate chalcone derivative (1-4) (0.01mol) in 10ml ethanol, the reaction mixture was stirred at room temperature for 14 hr., the mixture was neutralized by HCl and left at room temperature for 24 hr.. The formed precipitate was filtered and recrystallized from ethanol [15]. The physical properties and spectral data were indicated in Tables (6,14).

6- Aryl-4-(4-hydroxy-3-methoxy phenyl)-3-phenyl-3, 4-dihydro pyrimidine-2-(1H) – thione (25-27)

A mixture of the appropriate chalcone derivative (1-4) (0.006 mol) in 10 ml absolute ethanol and (0.46 g) sodium metal dissolved in absolute ethanol was added to the a solution of phenylthiourea (0.006 mol, 0.76 g) in absolute ethanol. The final solution was refluxed for 10hr.Cool, water was then added. The formed precipitate was separated by filtration and then crystallized from ethanol [16]. Some physical and spectral data were indicated in Tables (7,15).

3-aryl-5-(4-hydroxy-3-methoxy phenyl) -4, 5-dihydro isoxazole (28-31)

A mixture of the appropriatechalcone derivative (1-4) (0.023 mol), hydroxyl amine hydrochloride (0.023 mol, 1.59 g) and 0.4 g sodium hydroxide in 30ml ethanol was refluxed for 7 hr., the solvent was removed, and the resultant was poured into ice-water with vigorous stirring, then it was kept in cool box for 24 hr. Then the solid product was filtrated and recrystallized from dioxane [17]. Some physical and spectral data were indicated in Tables (8,16)

Result and Discussion

The 1-aryl-3-(4-hydroxy-3-methoxy phenyl) propen-1-one (1-4) were obtained from refluxing vanillin with substituted acetophenone in absolute ethanol in presences of a few drops of thionyl chloride. These compounds were identified by IR which exhibits characteristic bands in the following range. The bands at (1654-1683 cm^{-1}) [18] were assigned for the carboxyl group stretching. While the bands at (3062-3184 cm^{-1}) related to the ($C-H_{Ar.}$) stretching and bands at (1573-1653 cm^{-1}) for (C=C) groups. The spectrum also showed bands at range (3315-3525 cm^{-1}) for the (OH) [19] group, as shown in Table (9). 1, 5-benzoxapine derivatives (5-8) were prepared by the reaction of appropriate chalcone with o-amino phenol. The product was identified by the stretching bands at (1609-1655cm^{-1}) for the (C=N) group, also bands at (1124-1160 cm^{-1}) and (1245-1285 cm^{-1}) for symmetrical asymmetrical (C-O-C) [20] respectively. The stretching absorption bands at (3435-3566cm^{-1}) for (O-H) groups. Also the spectrum characteristic bythe disappearance of the bands for (C=C) and (C=O) groups as shown in Table (10).

The reaction of chalcone derivative with o.phenylenediamine afforded benzodiazepine derivatives (9-12) which were identified by IR spectrum through the appearance of the following stretching bands; at (1609-1655 cm^{-1}) for C=N group, (3118-3287 cm^{-1}) for N-H stretching, while (3275-3367 cm^{-1}) for O-H stretching and absorption band within the range (1241-1277 cm^{-1}) due to C-N stretching. The spectrum was also characterized by the absence of C=C and C=O groups.

Condensation of of chalcone derivatives with hydrazine hydrate in glacial acetic acid as solvent afforded pyrazole derivatives (13-16) which were identified by IR. These spectra

showed the absence of stretching banding of the carbonyl, C=C groups and the appearances of new bands at (1605-1695 cm^{-1}) for C=N stretching vibration and bands absorbed at (3166-3332 cm^{-1}) and (3524-3584 cm^{-1}) [21] for N-H and O-H respectively, also N-N stretching vibration was absorbed at (1020-1033 cm^{-1}) as shown in Table (12).

The condensation of compounds (1-4) with hydrazine hydrate in absolute ethanol in the presence of a few drops of glacial acetic acid afforded 1-acetylpyrazol derivatives (17-20) which were identified by IR. The appearance of bands at (1506-1596 cm^{-1}) for the C=N [22] stretching vibration. Bands at (1426-1507 $cm^{-1)}$ are assigned to N-N stretching vibration band. The spectrum also showed band at (3612-3499 cm^{-1}) for O-H, also FT-IR indicated by the appearance of band at (1596-1646 cm^{-1}) for carbonyl group, as well as the disappearance of stretching bands related to C=C group, table(13).Shows the spectral data of these compounds.

Compounds (21-24) were identified by the appearance of the following bands; at (1640-1653 cm^{-1}) for carbonyl group , bands at (1076-1168cm^{-1})& (1278-1285cm^{-1}) for symmetrical and asymmetrical (C-O-C) bonds stretching respectively and the band absorbed within the range (3177-3669 cm^{-1}) due to the O-H stretching , also the spectrum characterized by the absent of band for C=C group. Table (14) shows some spectral data of these compounds.

The reaction of chalconederivatives (1-4) with phenylthiourea offored pyrimidine thione derivatives Table (15) which shows absorption bands of compounds (25-27) at (1551- 1673 cm^{-1}) attributed to the stretching vibration of C=C group [23]. Also the bands at (1115-1166 cm^{-1}) are attributed to the C=S group. While the stretching vibration of O-H group appeared at (3347-3596 cm^{-1}), also the spectrum shows the absence of carbonyl groups.

The IR spectra for isoxazole compounds (28-31) shows absorption bands at (1614-1654 $cm^{-1)}$ attributed to the stretching vibration of C=N. The spectra also showed absorption bands at (1106-1091 cm^{-1}) & (1265-1272cm^{-1}) for symmetrical and asymmetrical C-O-C bonds stretching, while the bands at (750-784 cm^{-1}) are attributed to the N-O bonds. Also the spectrum shows the absent of C=C group. Table (16) shows some spectral data of these compounds.

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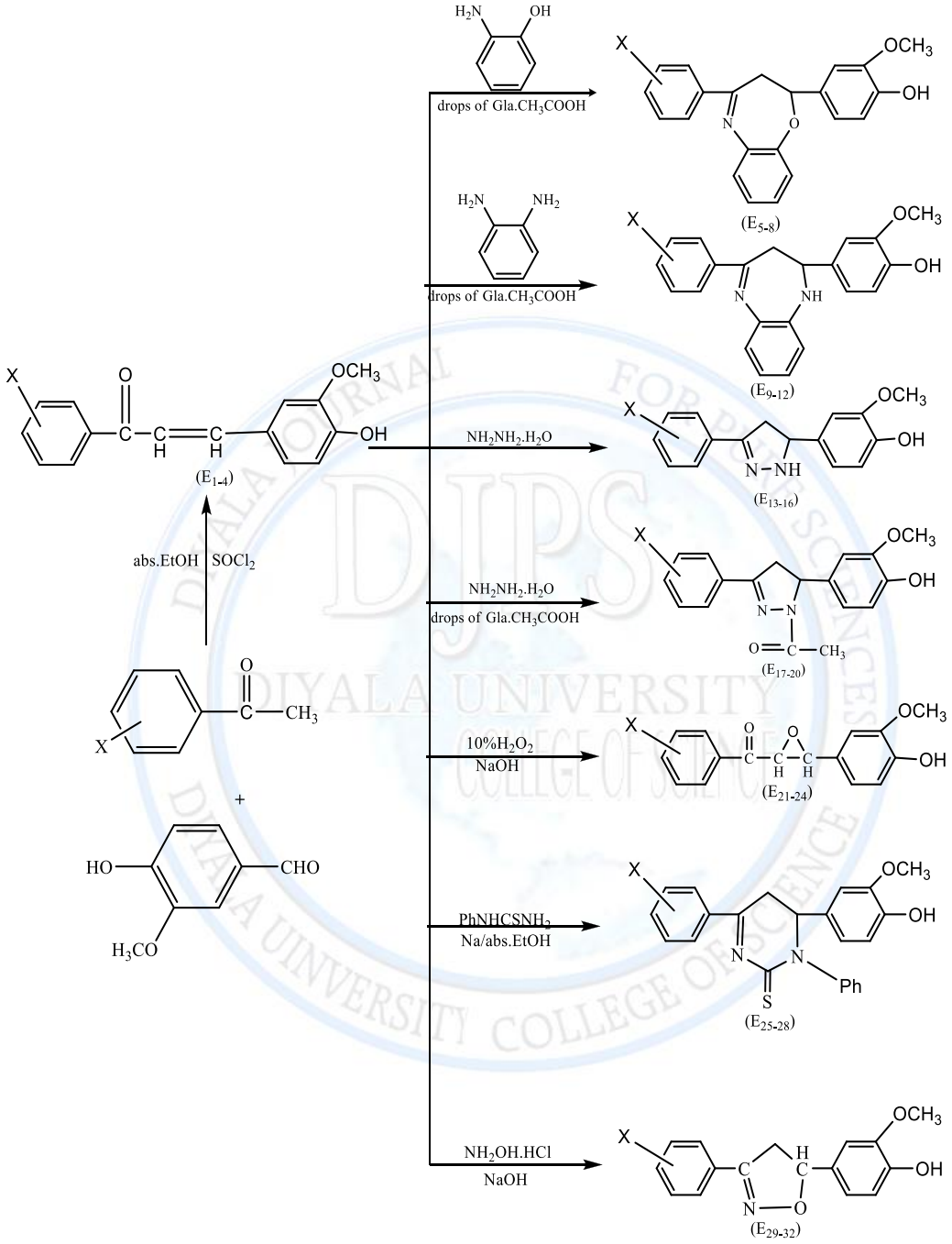

Scheme for general reactions

Synthesis of Some Heterocyclic Compounds Derived from 1-Aryl-3-(4-hydroxy-3-methoxyphenyl) propene-1-one

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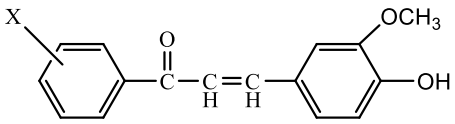
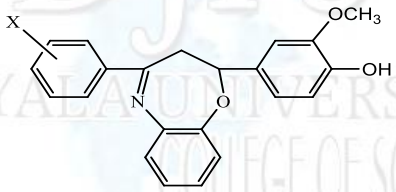
Table 1: Some physical constant for compounds (1-4)



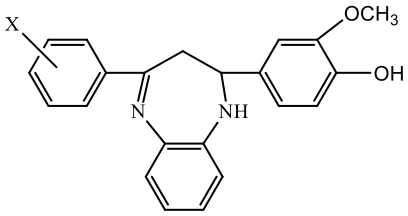
Comp. No	X	Molecular Formula	M.P (C°)	Yield (%)	Color
1	H	$C_{16}H_{14}O_3$	70-72	64	Green
2	2-Cl	$C_{16}H_{13}ClO_3$	117-119	79	Yellowish-green
3	OCH_3	$C_{17}H_{16}O_4$	131-133 (130)[24]	74	Pale yellow
4	4-NO_2	$C_{16}H_{13}NO_5$	62-63	80	Yellowish orange

Table 2: Some physical constant for compounds (5-8)



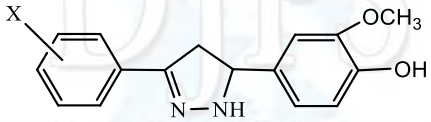
Comp. No.	X	Molecular Formula	M. P. (°C)	Yield (%)	Color
5	4-OCH_3	$C_{23}H_{19}NO_4$	140-142	88	Green
6	4-NO_2	$C_{22}H_{16}N_2O_5$	146-147	78	Dark yellow
7	H	$C_{22}H_{16}NO_3$	144-146	80	Brown
8	2-Cl	$C_{22}H_{15}NO_3$	48-50	68	Yellow

Table (3): Some physical constant for compounds (9-12)



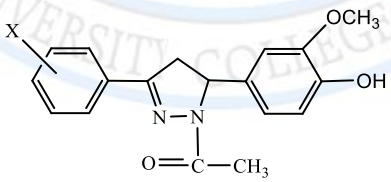
Comp. No.	X	Molecular Formula	M. P. (°C)	Yield (%)	Color
9	4-CH_3	$C_{23}H_{20}N_2O_3$	130-132	78	Orange
10	4-NO_2	$C_{23}H_{16}N_3O_4$	106-107	88	Yellow
11	H	$C_{22}H_{18}N_2O_2$	140-142	70	Green
12	2-Cl	$C_{22}H_{18}N_2O_2Cl$	98-99	78	Brown

Table 4: Some physical constant for compounds (13-16)



Comp. No	R	Molecular Formula	M.P (C^o)	Yield (%)	Color
13	H	$C_{16}H_{14}N_2O_2$	198-200	94	Dark yellow
14	2-Cl	$C_{16}H_{14}N_2O_2Cl$	126-127	78	White
15	4-OCH_3	$C_{17}H_{16}N_2O_3$	157-159	84	Brown
E_{44}	4-NO_2	$C_{16}H_{13}N_3O_4$	166-170	63	Yellow

Table 5: Some physical constant for compounds (17-20)



Comp. No	X	Molecular Formula	M.P (C^o)	Yield (%)	Color
17	H	$C_{18}H_{16}N_2O_3$	46-47	70	Yellow
18	4-NO_2	$C_{19}H_{15}N_3O_5$	193-195	77	Orange
19	4-OCH_3	$C_{19}H_{18}N_2O_4$	75-76	68	Green
20	2-Cl	$C_{18}H_{16}N_2O_3Cl$	130-131	65	White

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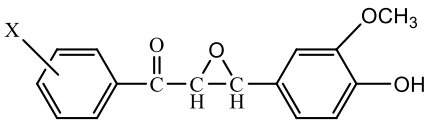
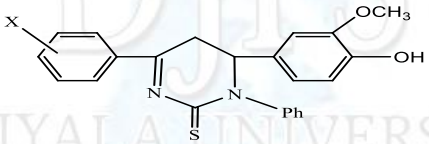
Table 6: Some physical constant for compounds (21-24)



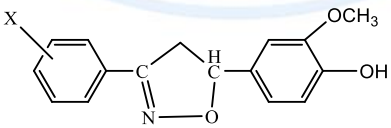
Comp. No.	X	Molecular Formula	M. P. (°C)	Yield (%)	Color
21	4-NO2	C15H13NO6	163-165	78	Yellow
22	4-OCH3	C17H15O5	80-82	70	Pale yellow
23	2-Cl	C15H13O4Cl	70-71	60	Pink
24	H	C15H13O4	170-172	65	Green yellow

Table 7: Some physical constant for compounds (25-28)



Comp. No.	X	Molecular Formula	M. P. (°C)	Yield (%)	Color
25	4-OCH_3	$C_{24}H_{20}N_2O_3S$	287-289d	84	Orange yellow
26	H	$C_{23}H_{18}N_2O_2S$	303-304	89	Orange
27	2-Cl	$C_{23}H_{17}N_2O_2SCl$	75-77	80	Brown
28	4-NO_2	$C_{23}H_{17}N_3O_4S$	96-97	78	Reed

Table 8: Some physical constant for compounds (29-31)



Comp. No.	X	Molecular Formula	M. P. (°C)	Yield (%)	Color
29	4-OCH_3	$C_{17}H_{15}NO_3$	278-280	68	Leady
30	4-NO_2	$C_{16}H_{12}N_2O_5$	170-171	70	Orang
31	2-Cl	$C_{16}H_{13}ClNO_3$	78-80	53	White
32	H	$C_{16}H_{13}NO_3$	98-99	50	Brown

Table 9: IR spectral data for compounds (1-4)

Comp no.	X	IR υ cm^{-1} (KBr)					
		O-H	(C-H)Ar	C=O	C=C	$C=C_{Ar}$	Other
1	H	3315	3062	1683	1653	1581	As(C-O-C) (1168) Sy(C-O-C) (1035)
2	2-Cl	3318	3184	1654	1590	1557	As(C-O-C) (1348) Sy(C-O-C) (1082)
3	4-OCH_3	3420	3076	1670	1650	1583	As(C-O-C) (1239) Sy(C-O-C) (1021)
4	4-NO_2	3525	3107	1678	1573	1573	As(C-O-C) (1261) Sy(C-O-C) (1076)

Table 10: IR spectral data for compounds (5-8)

Comp no.	X	IR υ cm-1 (KBr)							
		N-H	O-H	$C-H_{Ar}$	C=N	C---C	C-O-C		Other
							As	Sy	
5	4-OCH_3	3204	3566	3007	1649	1584	1261	1154	
6	4-NO_2	3435	3535	3076	1650	1558	1253	1124	As(C-NO_2) (1505) Sy(C-NO_2) (1341)
7	H	3385	3493	3114	1645	1556	1285	1136	
8	2-Cl	3480	3522	3076	1693	1580	1245	1160	C-Cl(746)

Table 11: IR spectral data for compounds (9-12)

Comp no.	X	IR υ cm^{-1} (KBr)						
		N-H	O-H	$(C-H)_{Ar}$	C=N	$C=C_{Ar}$	C-N	Other
9	4-OCH_3	3287	3367	3075	1649	1566	1277	
10	4-NO_2	3236	3360	3093	1646	1558	1265	As(C-NO_2) (1505) Sy(C-NO_2) (1341)
11	H	3118	3366	3053	1609	1514	1270	
12	2-Cl	3189	3275	3073	1655	1552	1241	(C-Cl) (739)

Table 12: IR spectral data for compounds (13-16)

Comp no.	X	IR υ cm^{-1} (KBr)								
		O-H	N-H	C-H Ar	C=N	N-N	C═C	C-O-C		Other
								As	Sy	
13	H	3587	3216	3072	1637	1027	1507	1236	1118	
14	2-Cl	3574	3330	3090	1685	1029	1509	1240	1036	(767)C-Cl
15	4-OCH_3	3574	3332	3093	1605	1020	1506	1249	1035	
16	4-NO_2	3524	3166	3076	1695	1033	1508	1260	1033	As(C-NO_2) (1455) Sy(C-NO_2) (1336)

Table 13: IR spectral data for compounds (17-20)

Comp no.	X	IR υ cm^{-1} (KBr)					
		O-H	$(C-H)_{Ar}$	C=O	C=N	N-N	Other
17	H	3612	3084	1635	1558	1426	
18	4-NO_2	3483	3084	1596	1558	1471	As(C-NO_2) 1508 Sy (C-NO_2) 1361
19	4-OCH_3	3499	3128	1646	1557	1507	
20	2-Cl	3480	3076	1620	1554	1446	(C-Cl) (743)

Table 14: IR spectral for compounds (21-24)

Comp no.	X	IR υ cm^{-1} (KBr)					
		O-H	$C-H_{Ar}$	C=O	C-O-C		Other
					As	Sy	
21	4-NO_2	3177	3030	1651	1285	1130	As(C-NO_2) (1559) Sy(C-NO_2) (1340)
22	4-OCH_3	3669	3348	1649	1287	1076	
23	2-Cl	3496	3118	1640	1280	1154	C-Cl(749)
24	H	3315	3119	1653	1282	1168	

Table 15: IR spectral data for compounds (25-28)

Comp no.	X	IR υ cm^{-1} (KBr)							
		O-H	C-H	C=N	C=C	C=S	C---C	C-O-C	
								As	Sy
25	4-OCH_3	3596	3212	1683	1637	1115	1601	1318	1036
26	H	3466	3118	1636	1551	1166	1505	1291	1123
27	2-Cl	3347	3128	1635	1557	1155	1539	1287	1071
28	4-NO_2	3487	3218	1669	1636	1161	1577	1269	1124

Table 16: IR spectral data for compounds (29-32)

Comp no.	X	IR υ cm^{-1} (KBr)				
		O-H	C-H	C=N	N-O	Other
29	4-OCH_3	3272	3072	1654	750	
30	4-NO_2	3419	3079	1614	784	As(C-NO_2) (1505) Sy(C-NO_2) (1338)
31	2-Cl	3420	3079	1624	775	821 (C-Cl)
32	H	3419	3072	1635	797	

References

1. M.J.Elarfi and H.A.Al-Difar ; Appl.Chem.42,6243-6245 (2012)
2. P.J.Jainey and K.I.ShwarBhat; Asian J of Bio. Chem. and Pharma. Res.3,2231-2560 (2013).
3. P. Sudhakar, and S. S. Bhale, "Organic Chemistry", 4(1), 35-39, (2014) (IVSL).
4. A. Kumar, J. Fernandes and P-Kumar, World Journal of pharmacy and pharmaceutical Sciences, 3(2), 1267-1277, (2014).
5. M.Verma, M.Tripathi, A.K. Saxena, Eur.J.Med.Chem. 29,941-949, (1994).
6. C.A.Winter, E.A.Risely, C.W.Nuss, ProcSocExp.Biol.Med. , Vol.111, 544-547, (1962).
7. A. Deep, S-Jain and P. C. Sharma, Actapoloniaepharma-Drug Res, 67(1), 63-67, (2010).
8. A. Burger, "In Burgers Medicinal Chemistry and Drug Discovery" 5th ed. Practical and principal, 1970-2000. (2003).
9. C.Gopinath,R.Nadendla,Lakshmi,Vijaya, M.K.Prahllad, K.B.N.Rao, Journal of Global Trends in Pharmaceutical Sciences, 1(1), P.26-41, (2011).

10. N. Garg, T. Chandra, Archana, A. Jain, A. Kumar, European Journal of Medicinal Chemistry, 45, 1529–1535, (2010) (IVSL).

11. J . S. Yadar, Y. K. Srivastava, Der Pharmacia Letter, 3(2), 284-291, (2011) .

12. A . Levia, J . Jozesf, Arkivoc, 1, 134-145, (2007).

13. A . C. Rana, A . Singh, J. Chem. Pharm. Res, 2 (1), 505-511, (2010).

14. N. H. Cromwel, R. E . Bamlurg and R. P. Bakly, J. Am. Chem. 1

15. أيوب، مقداد توفيق ؛ زكريا ، مروان محمود ؛ سعيد ، عبدالقادر سعيد ؛ مجلة علوم الرافدين ، 11(4) ، 36-43 ، (2000).

16. S.Tammoto,Y.Maghraby,R.Oda. Jap Chem.Soc, Kyoto, Japan, 66,48-50, (1963).

17. P . C . Sharma. S . V . Sharma, S . Jain,D. Singh and B. Suresh,ActaPolinaePharmaceutice – Drug Research, 66 (1), 101-104 ,(2009).

18. A.Sehlinger,O.Kreye, ,M.A.R. Meier,. Tunable polymers obtained from passerinMulticompound reaction derived acrylate monomers. Macromolecules, (2013).

19. K.M.Amrit, G.Sujay, C.Suchandra, B.Samita,. Chandan, Journal of Luminescence, 143, 693-703, (2013).

20. في ام بأرخ ، ترجمة الشربة ، عبد الحسين خضر ، الراوي، جاسم ، محمد عليالعراقي ، محمد احمد " اطياف امتصاص الجزيئات العضوية " ص176، مديرية مطبعة جامعة الموصل،(1985).

21. I.R.Dim,A.Sahin,. Bioactive volatile content of the stem and root of centaureaCarduiformis DC. Subsp. Carduiformis var. Carduiformis .J. Chem, 10, 1-6, (2013).

22. V. M. Barot and B. G. Rathod, Asian Journal of Biochemical and Pharmaceutical Research Issue, 4 (2), (2012).

23. K.Shuna,N.Joseph,H.philippe and J. N. Vishwakarma" Organic Research Lab., Department of Chemical Sciences", Assam Don Bosco University, 4(1), 137-145, (2014)(IVSL).

24. V.L.Fleisher, M.V.Andryukhova Chemistry, Technology of Organic Substances Technology and Biotechnology, (2012).