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Synthesis of some new maleimide derivatives

Ahmed Shehab Hamad* and Fatima Saheb Abed

*College of Pharmacy – University of karbala – **IRAQ**

Email: Fatimasaheb38@yahoo.com

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ABSTRACT

A series of derivatives of maleamic acid (A1-10) have been prepared and converted to new maleimide derivatives (B1-10), through the reaction of maleamic acid derivatives and acetic anhydride in presence of anhydrous sodium acetate as the dehydration agent. These compounds were characterized by the FT – IR and UV – VIS. spectroscopictechniques and some of these by H^1 NMR spectra.

Keywords: maleimides, amic acids, acetic anhydride.

INTRODUCTION

Maleimide derivatives are very attractive compound in terms of chemical reactivity. They give rise to some interesting reactions such as Diels – Alder reaction with dienes(1) and the nucleophilic Michael – type addition of thiols or amines to the vinylene moiety (2) .in fact, the maleimide derivatives have been utilized as modifying reagents of proteins (3,4) and materials for immobilization of enzymes (5,6). Maleimide are an important class of substrates for biological, pharmacological and chemical application (7,8). Many method used to synthesis of maleimides, by dehydration of water molecule from amic acids such as using of acetic anhydride and sodium acetate (9), by using the molting method (10), crushing heat method to malic acid salt (11), by Diels – Alder reactions (8), by phase transfer catalysis (12), and by using trifluroacetic acid (13).

Meanwhile, the vinylene group of a maleimide moiety having 1,2-disubstituted ethylene structure can be polymerized with radical or anionic initiators to yield the polymer having high thermostability or heat-resisting property (14) and can be copolymerization with vinyl acetae(15) .

MATERIALS AND METHODS

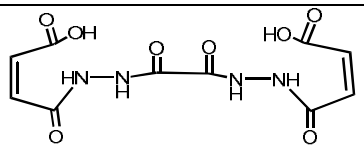
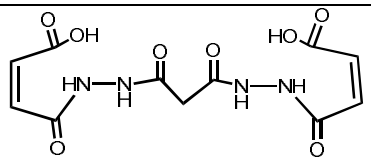
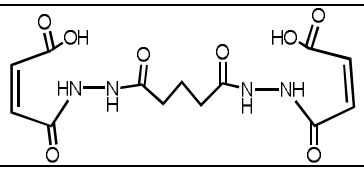
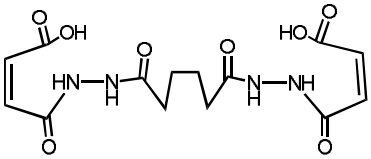
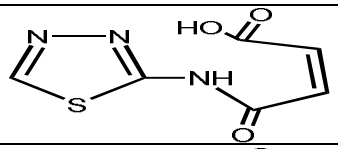
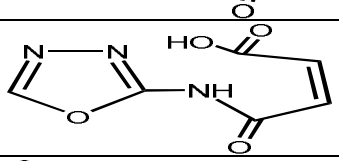
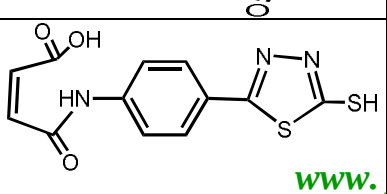
Chemical materials which used in this work were purchased from BDH, Merck and Fluka. And the instruments which used is melting point measurement is Electro thermal Engineering LTD S – N 10853, IR spectroscopy analyses were recorded on Perkin-Elmer FT-IR Spectrophotometer, KBr disk, Scale 400 – 4000(cm^{-1}) . The UV.Visible spectra were recorded on SHIMADZU, UV PROBE, VERSION 1.11 in the wave length range 200 – 800 nm, and some of these by H1 NMR were recorded on BRUKER 400 MHz.

Preparation of maleamic acids derivatives (A1-10): The method used same in literature (16) with some modification. Amine derivatives (0.05 mole) were dissolved in dioxane. To this solution malic anhydride

(0.05 mole) for mono amine derivatives and (0.1 mole) of it for diamine was dissolved in methanol or diethyl ether was added drop wise wih constant stirring. The mixture was stirred at (0-5 C°) for 2 hrs. The precipitate was filtered off and washed with diethyl ether.collected the crystals and recrystallized from ethanol or dioxane .when the crystallization of maleamic acid was not successful, the amic acid was dissolved in dilute sodium bicarbonate solution. The solution was filtered and acidified with dilute hydrochloric acid, the maleamic acid was precipitate and then washed with cold water, ethanol and then dried.

Preparation of N-substituted maleimides (B 1-10) : The method used same in literature [9] with some modification, where maleamic acid derivatives was dissolved in some of acetic anhydride and 8% by wt. ofanhydrous sodium acetate , the mixture was refluxed on water bath until the color was changed then cooled the solution and poured in ice bath with vigorously stirred where the N-substituted maleimide is precipitate then filtered and washed with sodium bicarbonate solution and dried and recrystallization with suitable solvent.

Table 1. The physicals properties of maleamic acid derivatives.

Comp. No.	Structures	M.F	M.Wt (gm/mol)	Yield %	M.P (C°)	Color
A1		$C_{10}H_{10}N_4O_8$	314	80	184-186	White
A2		$C_{11}H_{12}N_4O_8$	328	77	188-190	White
A3		$C_{13}H_{16}N_4O_8$	356	82	194-196	White
A4		$C_{14}H_{18}N_4O_8$	370	81	218-220	White
A5		$C_6H_5N_3O_3S$	199	78	208-210	Pale yellow
A6		$C_6H_5N_3O_4$	183	72	218-220	White
A7		$C_{12}H_9N_3O_3S_2$	307	69	266-268	Yellow

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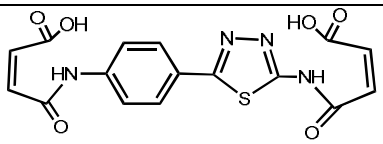
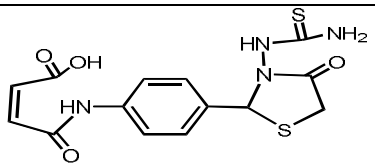
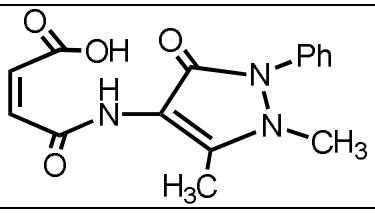
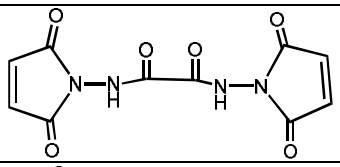
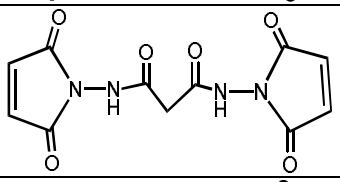
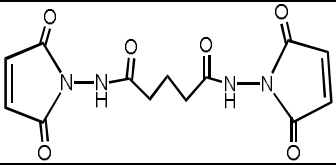
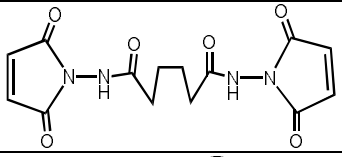
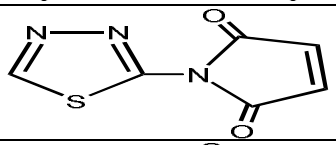
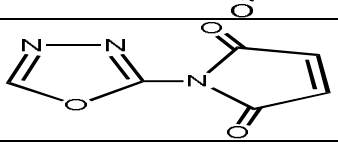
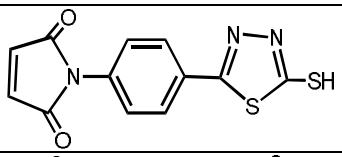
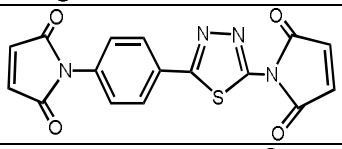
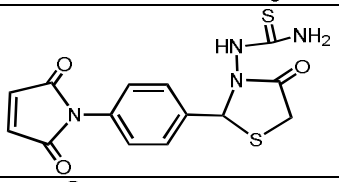
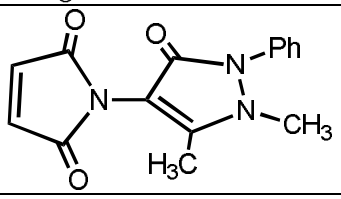
A8		$C_{16}H_{12}N_4O_6S$	388	65	137-139	Pale Brown
A9		$C_{14}H_{14}N_4O_4S_2$	366	62	230-232	Brown
A10		$C_{15}H_{15}N_3O_4$	301	88	193-195	Yellow

Table 2. The physicals properties of maleimide.

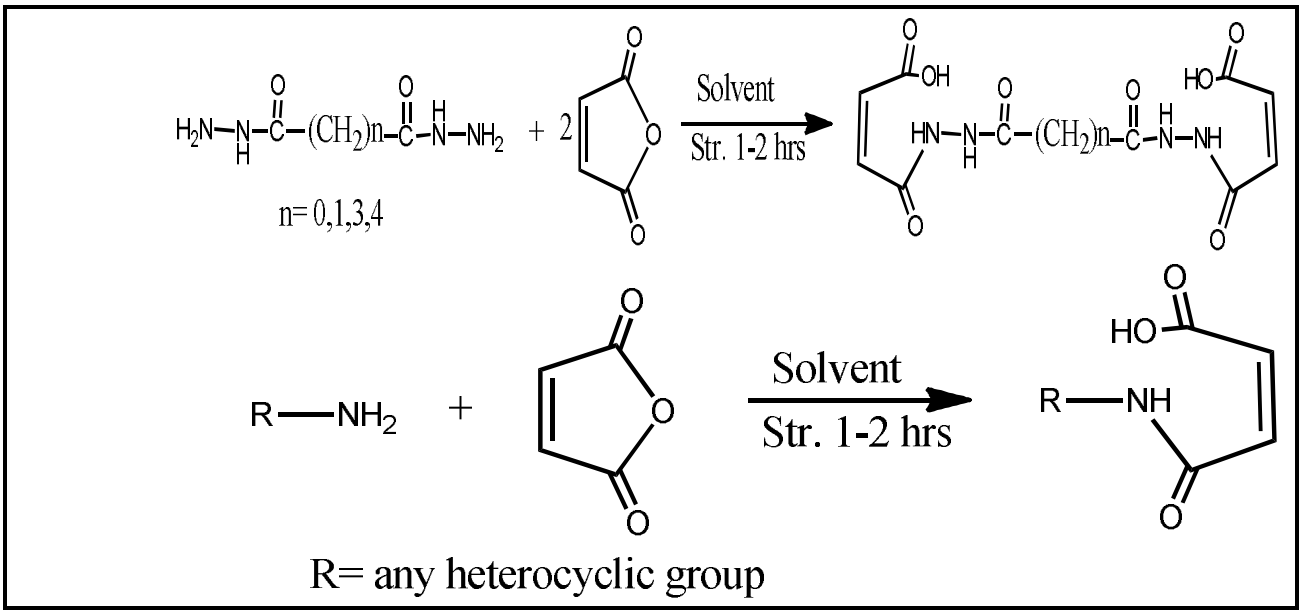
Comp. No.	Structure	M.F	M.Wt gm/mol	Yield %	M.P (C°)	Color
B1		$C_{10}H_6N_4O_6$	278	71	213-215	Pale Brown
B2		$C_{11}H_8N_4O_6$	292	63	219-221	Pale Brown
B3		$C_{13}H_{12}N_4O_6$	320	68	244-245	Brown
B4		$C_{14}H_{14}N_4O_6$	334	73	273-275	Brown
B5		$C_6H_5N_3O_3S$	199	61	261-263	Green
B6		$C_6H_5N_3O_4$	183	65	245-246	Dark Brown

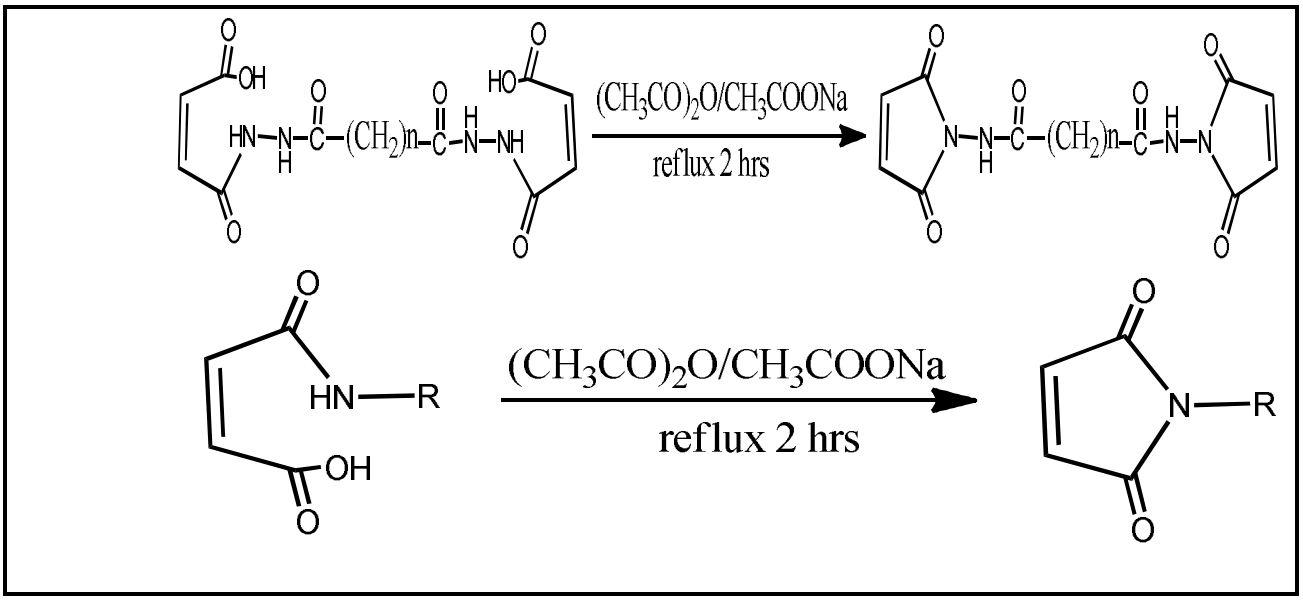
B7		$C_{12}H_9N_3O_3S_2$	307	76	294-296	Yellow
B8		$C_{16}H_{12}N_4O_6S$	388	57	300	Brown
B9		$C_{14}H_{14}N_4O_4S_2$	366	60	254-256	Dark Orange
B10		$C_{15}H_{13}N_3O_3$	283	80	230-233	Orange

RESULTS AND DISCUSSION

This research includes preparation of some mono and di aliphatic and heterocyclic maleamic acid (A1-10) by the reaction of amine derivatives with maleic anhydride in suitable solventand than flowed by the dehydration of it to N-substituted maleimide (B1-10) by using acetic anhydride and sodium acetate as dehydration agent.

The synthesis process of N-substituted maleamic acids then maleimides are shows in the followed reaction.





FT-IR spactra of the prepared maleamic acid derivatives showed disappeared of the Sy. and Asy. Absorption band of NH2 group in amine derivatives and showed appeared a clear characteristic absorption bands at (1604-1724 cm-1) belong to C=O carboxylic acid and amide.
The spectra showed also absorption bands at (3489-3053 cm-1) belong to N-H amide.

Table (3): The mean FT-IR frequencies of maleamic acid.

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No.	(O-H)Str. (O-H) ben.inp (O-H) ben.oop	(N-H)Str. (N-H) ben.inp (N-H) ben.oop	(C=O)Str. (C-O)Str. Acid	(C=O) amide (C-N)Str.	(C=C)Vinyl (=C-H)Vinyl (=C-H) Vinyl	(C-H)ali. Str. Ben.	(C-H)ali.in plane (C-H)oop.	Note
A1	3212 1341 862	3167 1543 730	1724 1166	1657 1247	1601 3061 672	--	--	--
A2	3271 1336 899	3190 1529 721	1733 1162	1630 1220	1603 3045 680	2960 1427	--	--
A3	3182 1327 850	3053 1550 731	1710 1173	1668 1230	1608 3009 636	2861 1415	1041 952	--
A4	3196 1322 848	3057 1546 728	1716 1165	1678 1269	1604 3003 647	2872 1414	1110 933	--
A5	3279 1344 878	3278 1563 725	1719 1172	1669 1345	1647 3091 646	2825	1181 913	--
A6	3265 1309 956	3155 1570 763	1708 1180	1691 1437	1680 3095 640	2839	1076 893	--
A7	3342 1344	3203 1543	1707 1168	1624 1350	1602 3061	--	--	(C=C)Ar. 2864,2769

	958	732			642			(=C-H)Str.Ar. 3034
A8	3489 1319 972	3317 1591 773	1695 1288	1695 1408	1591 3003	--	--	(C=N) 1027 (C=C)Ar. 2879,2837 (=C-H)Str.Ar. 3064
A9	3385 1369 900	3180 1570 617	1690 1298	1604 1176	1690 3001 658	2875 1454	1093 821	(NH2) 3271,3180 (C=C)Ar. 1518,1411 (=C-H)Str.Ar. 3090
A10	3208 1369 974	3208 1561 736	1712 1143	1651 1218	1640 3010 769	2870	1069 854	(C=C)Ar. 1570,1448 (=C-H)Str.Ar. 3041

The structure of new prepared imide derivatives were confirmed by FT-IR spectra showed disappear once of O-H , C=O carboxylic acid, N-H, C=O amide absorption bands indicating success of dehydration reaction .
The FT-IR spectra showed clear bands at (1649-1688) due to imide.

Table (4): The mean FT-IR frequencies of maleimide.

No.	(=C-H) Str.vinyl	(=C-H) cis. ben.	(C=O) Str.amide	(C-N)	(C=C) Str. Ar.	(=C-H) Str.Ar.	(C=C) Str.vinyl	(C-H) Str.	Note
B1	3077	686	1669	1288	--	--	1606	--	
B2	3084	648	1674	1274	--	--	1597	2950 2881	(N-H)amid (3186) (CH_2)ben (1423)
B3	3057	702	1677	1279	--	--	1611	2911 2849	(N-H)amid (3172) (CH_2)ben (1415)
B4	3068	699	1682	1270	--	--	1617	2904 2835	(N-H)amid (3153) (CH_2)ben (1433)
B5	3017	842	1680	1264	--	3079	1631	--	(C=N) 1562
B6	3005	949	1688	1255	--	3086	1661	--	(C=N) 1566
B7	3035	703	1677	1291	1551 1466	3098	1612	--	(C=N) 1574 1,4-disub. (843)
B8	3022	698	1674	1298	1523 1427	3100	1610	--	(C=N) 1595 1,4-disub. (840)
B9	3066	651	1672	1288	1579 1519	3108	1602	2973 2901	(CH_2)ben (1410) NH_2.Str. (3265,3303)
B10	3034	696	1649	1303	1587 1494	3198	1612	--	CH_3)ben.(1454)

From UV-Vis spectrum of maleimide compound is shown in table (5) , C=C usually give its absorption wavelength at range from (215 – 240 nm) , this absorption due to the $\pi \rightarrow \pi$ transitions for this group and carbonyl group and for C=N in some compound , the sheft of the value to up because the bathochromic shift which result from the polar solvent (methanol) which used in solvent of maleimides.

Table (5) : Electronic spectral data (max of maleimides).

Comp. No.	Wavelength (nm)	Wavelength (nm)
B1	220	233
B2	215	230
B3	217	234
B4	222	232
B5	227	237
B6	225	240
B7	219	231
B8	223	235
B9	228	240
B10	224	139

The H1 NMR spectram of amic acid compound (A2) fig 1.showed singlet at 6.5 ppm belong to two vinylic protons , singlet at 10.9 ppm belong to OH group carboxylic acid, and singlet at 8.3 ppm to NH amide and the singlet at 3.4 ppm absorption of CH_2 group.

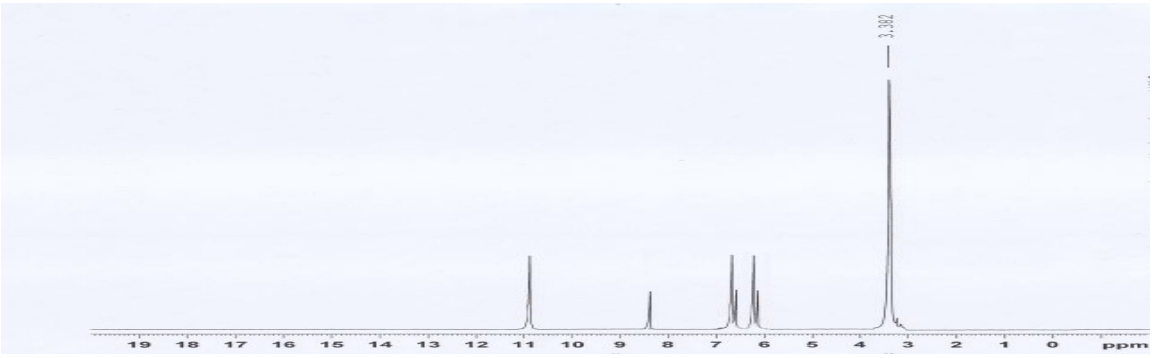

Figure 1 H^1 NMR spectrum of compound A2.

The H1 NMR spectram of maleimide compound (B8) fig 2. Compound B8 fig 2, showed signal at 6.3 ppm to two vinylic proton and the final as dd at 7.5 ppm belong to phenyl group.

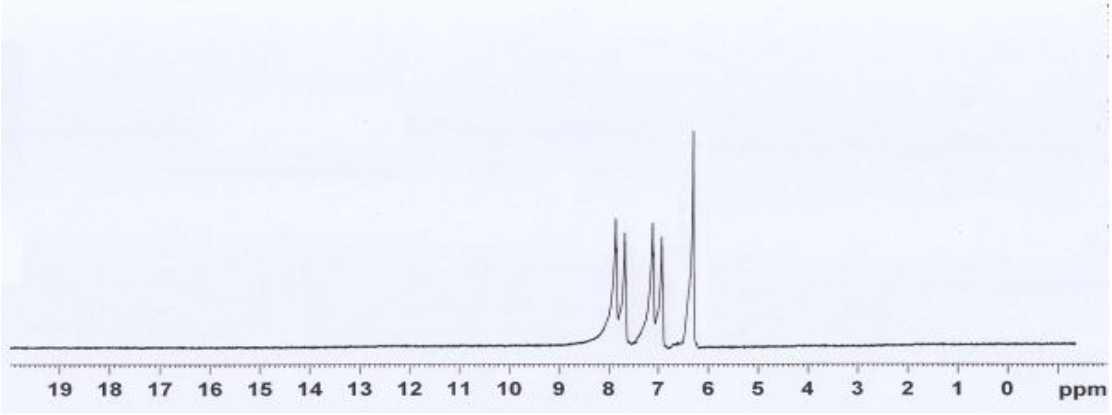

Figure 2 H^1 NMR spectrum of compound A2.

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