

Synthesis a new series of azo compounds containing oxadiazole rings

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(NJC)

(Received on 27 /4 /2005)

(Accepted for publication on 4 / 3 /2006)

Abstract

Some new 2,5-disubstituted-1,3,4-oxadiazole derivatives with azo group were synthesized by known reactions sequence . The structure of the synthesized compounds were confirmed by physical and spectral means .

- 4,3,1

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Introduction

The azo compounds class accounts for 60-70 of all dyes, they all contain an azo group, -N=N- which links two sp² hybridised carbon atoms . Often, these carbons are part of aromatic systems. Most azo dyes contain only one azo

group, but some contain two (diazo) or more.

The azo compounds possess antibacterial ⁽¹⁾, pesticidal ⁽²⁾ activities. Several methods have been used to synthesize azo compounds. Among these ,(i) Oxidation of hydrazine derivatives using HgO ⁽³⁾, or urea derivatives

using t-butyl hypochlorite ⁽⁴⁾, or amines using MnO₂ ⁽⁵⁾. (ii) Reaction of diazonium salt with phenol in the presence of NaOH at 0°C ⁽⁶⁾. This method seems to be the best because of the high yield of the azo compounds.

The 2,5-disubstituted-1,3,4-oxadiazole showed different biological activity ⁽⁷⁻⁹⁾. The azo compounds containing 1,3,4-oxadiazole unit are very important in the drug synthesis, in the medical and industrial applications. Therefore a novel series of azo compounds containing 1,3,4-oxadiazole unit are synthesized.

Experimental

Chemicals : Most of chemicals used were supplied from Aldrich, and BDH Chemicals Co. and were used without further purification.

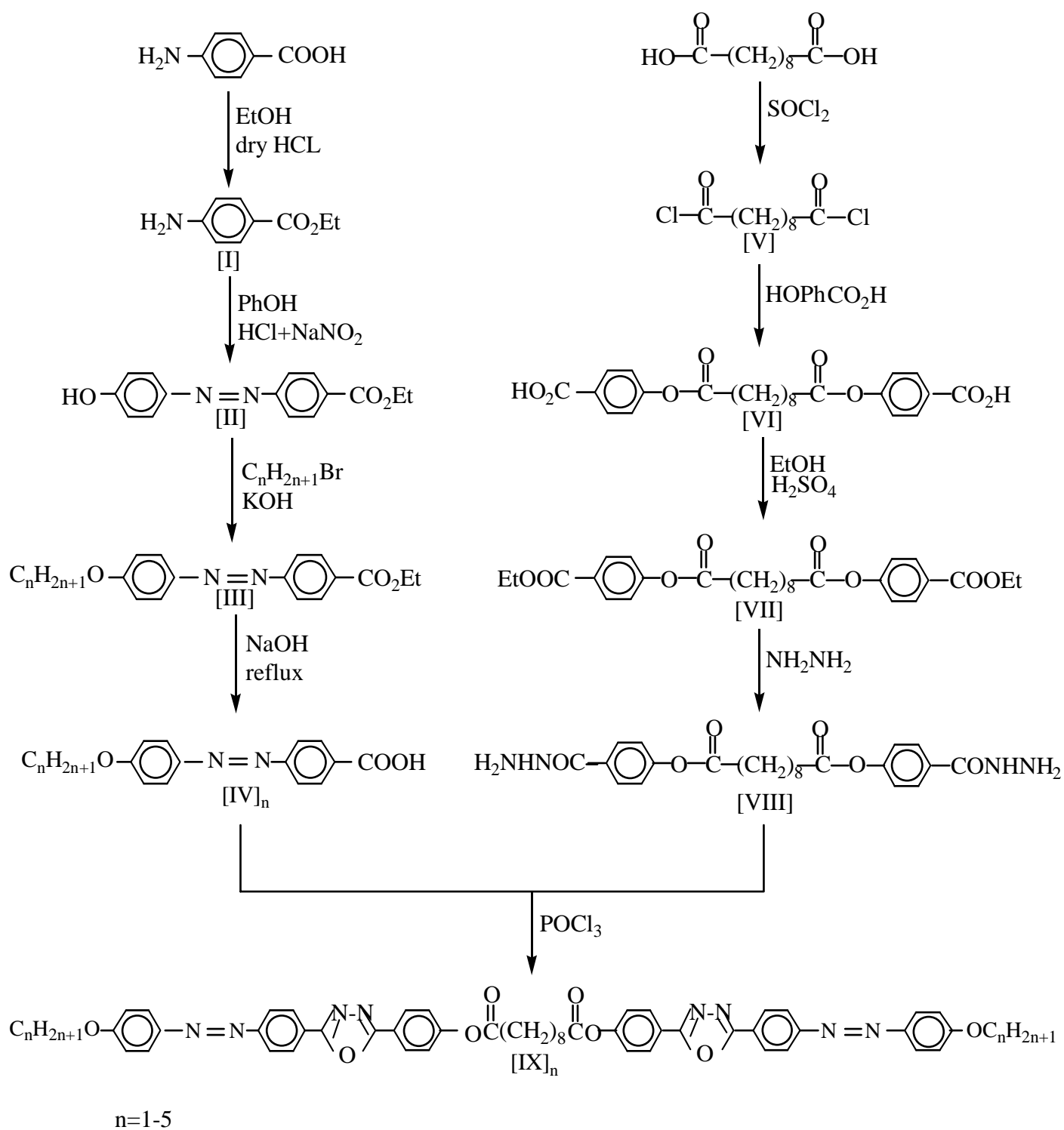
Techniques : Melting points were determined by using an (Electro thermal) melting point apparatus and

are uncorrected. IR spectra were recorded on a Shimadzu 408 infrared spectrophotometer (KBr disc). The UV spectra were performed on a Shimadzu UV-visible- 160 spectrophotometer.

Synthesis

The reaction sequence leading to the formation of different title compounds are outlined in Scheme 1.

Ethyl-4-aminobenzoate [I] was prepared following the procedure described by Vogel ⁽⁶⁾, m.p. 91 °C, yield 99%.



Schem 1

Ethyl-4-(4⁻-hydroxyphenyl)azobenzoate [III]

Diazonium salt was prepared from dissolved (4.46g, 0.03mol) ethyl 4-amino benzoate in 8 mL of 50% HCl . Then added a solution of (2.1g, 0.03mol) sodium nitrite in 10 mL water, the resulting solution cooled to 0-5 °C . The diazonium salt was added to a solution of (2.8g, 0.03mol) phenol in 25mL (10% NaOH). The mixture was left for 2hours with cooling then acidified with hydrochloric acid. The precipitate obtained was filtered and washed with cold water ⁽⁶⁾.
m.p. 165-167 °C, yield 95% .

Ethyl-4-(4⁻-alkoxyphenylazo)benzoate [III]_n .

A mixture of compound [II] (0.01 mol) and KOH (0.01 mol) was dissolved in 10 mL acetone . To this solution was added n-alkyl bromide (0.01 mol) and refluxed for 6 hrs. The reaction mixture was filtered and the solvent removed to give crystals ⁽¹⁰⁾. Melting points and yields of this compound are given in Table 1 .

4-(4⁻-alkoxyphenylazo)benzoic acid [IV]_n .

compounds [III]_n (0.06 mol) were dissolved in 25mL of (10% NaOH). The mixture was refluxed for 4 hrs and cooled . The solution was acidified with 10% H₂SO₄ , the resulting mixture was extracted with ethyl acetate and the solvent removed to give solid. Melting points and yields of this compounds are given in Table1.

Table (1): The physical properties of the azo compounds [III]_n.

Comp.No	m.p.(°C)	Yield(%)	Comp.No.	m.p. (°C)	Yield (%)
[III] ₁	107	88	[IV] ₁	213	75
[III] ₂	125	80	[IV] ₂	184 (dec.)	70
[III] ₃	112	75	[IV] ₃	161 (dec.)	65
[III] ₄	94	85	[IV] ₄	223 (dec.)	80
[III] ₅	96	90	[IV] ₅	251 (dec.)	85

Dicarboxylic acid chloride [V].

Diacid chloride was prepared by refluxing the corresponding dicarboxylic acid with excess of thionyl chloride. The unreacted thionyl chloride was removed under reduced pressure⁽⁶⁾.

Di-4-carboxyphenylsebasoate [VI]

To a stirred solution of 4-hydroxy benzoic acid (0.02 mol) in 10 mL of dry pyridine at 5°C sebasoyl dichloride (0.01mol) was added dropwise. The mixture was stirred for 4 hrs at room temperature. The precipitate was filtered and washed succesively with 10% HCl, 10% NaHCO₃ solutions and water several times, dried and recrystalized from dioxane⁽¹¹⁾, (yield 88%), m. p. =249°C Calc .C.H.N. for C₂₄H₂₆O₈ : C,65.15 ; H,5.88 : Found ; C, 65.46 ; H , 6.10

Diethylester [VII] was prepared according to the literature procedure⁽⁶⁾.

Sebasic 4,4'-diphenyl hydrazide [VIII]

A solution of the diethylester [VII] (0.06mol) and hydrazine hydrate (15ml) in ethanol (25ml) was heated to reflux during 2hrs. The mixture was then cooled to room temperature, and the solid obtained was filtered and

recrystallized from ethanol⁽¹²⁾, yield = 95%, m. p. = 204 °C

Bis-1,8-{4-[5-(4'-(p-n-alkoxyphenyl)azophenyl)-1,3,4-oxadiazole-2-yl]carboxyphenyl}octane [IX]_n.

A mixture of diacid hydrazide [VIII] (0.01mol) and appropriate carboxylic acid compound [IV]_n (0.02 mol) in phosphorus oxychloride (5mL) was refluxed for (6 hrs.). The mixture was poured in ice-water, the resulting solid was filtered and the crude product was stirred for 15 minutes with 5mL of 5% aqueous NaOH solution and then washed with water several times, dried and recrystallized from ethanol. yields (68-84%) , melting point of all the compounds of this series more than 300 °C.

Results and Discussion

Ethyl-4-aminobenzoate [I] was obtained by esterification of the 4-aminobenzoic acid. Ethyl-4-(4'-hydroxyphenyl)azobenzoate [II] was confirmed by IR spectrum, which shows absorption stretching bands at 3150 cm⁻¹(OH) , 1710 cm⁻¹ (C=O , ester) , 1595 cm⁻¹(C=C , aromatic), a weak band at 1430 cm⁻¹ (N=N) and, 840cm⁻¹ due to para subsituted benzene ring.

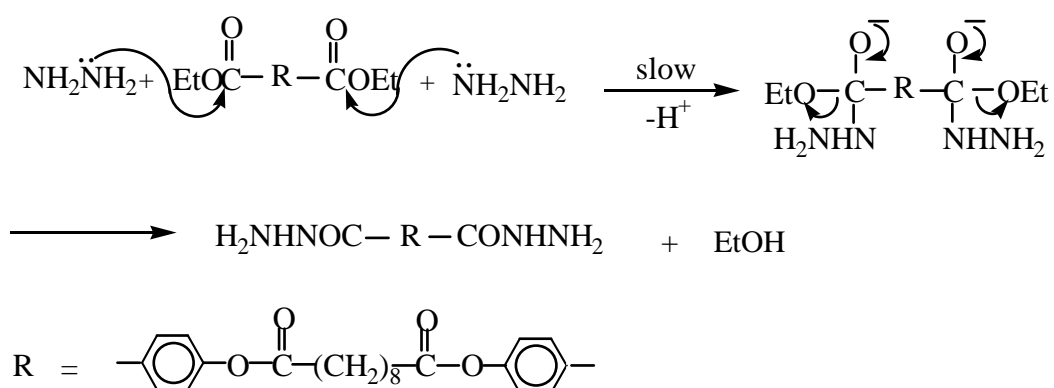
The compound [III] converted to the corresponding alkoxy compounds [III] by reaction with alkyl bromide in basic medium (KOH). Their structures were established on the basis of physical and spectral data. IR spectra showed absorptions bands at 2950 cm^{-1} (aliphatic CH_2), 1725 cm^{-1} ($\text{C}=\text{O}$, ester), 1600 cm^{-1} ($\text{C}=\text{C}$, aromatic) and disappearance OH stretching band.

Hydrolysis of ester [III] by base-catalysed leads to the formation of the corresponding carboxylic acid [IV]. This reaction is found to be kinetically second order [13]. The IR spectra of these compounds appearance a broad stretching band in the region $(2500-3200)\text{ cm}^{-1}$ due to OH group of carboxylic moiety and band at 1680 cm^{-1} ($\text{C}=\text{O}$, carboxylic acid).

Treatment of 4-hydroxybenzoic acid (2 mol) with sebacyl chloride (1mole) in dry pyridine leads to the formation of the

bis-1,8 (4-carboxyphenoxy carbonyl)octane [VI], which is characterized by its melting point (249°C) (Lit, m. p. $249-249.5^\circ\text{C}$)⁽¹²⁾, elemental analysis and infrared spectrum.

The IR spectrum show the disappearance of absorption band due to O-H stretching of 4-hydroxybenzoic acid and appearance of two bands at 1695 cm^{-1} , 1755 cm^{-1} due to carbonyl groups of the carboxylic acid and the ester, respectively. It also show two strong bands in the region $(1190-1235)\text{ cm}^{-1}$ due to C-O bending of the ester. Diethylester [VII] was obtained by esterification of the diacid [VI], using absolute ethanol/sulfuric acid. Condensation of this ester [VII] with hydrazine hydrate in ethanol yielded the diacid hydrazide [VIII]. The mechanism of this reaction may be outlined as follows in Scheme 2⁽¹⁴⁾:



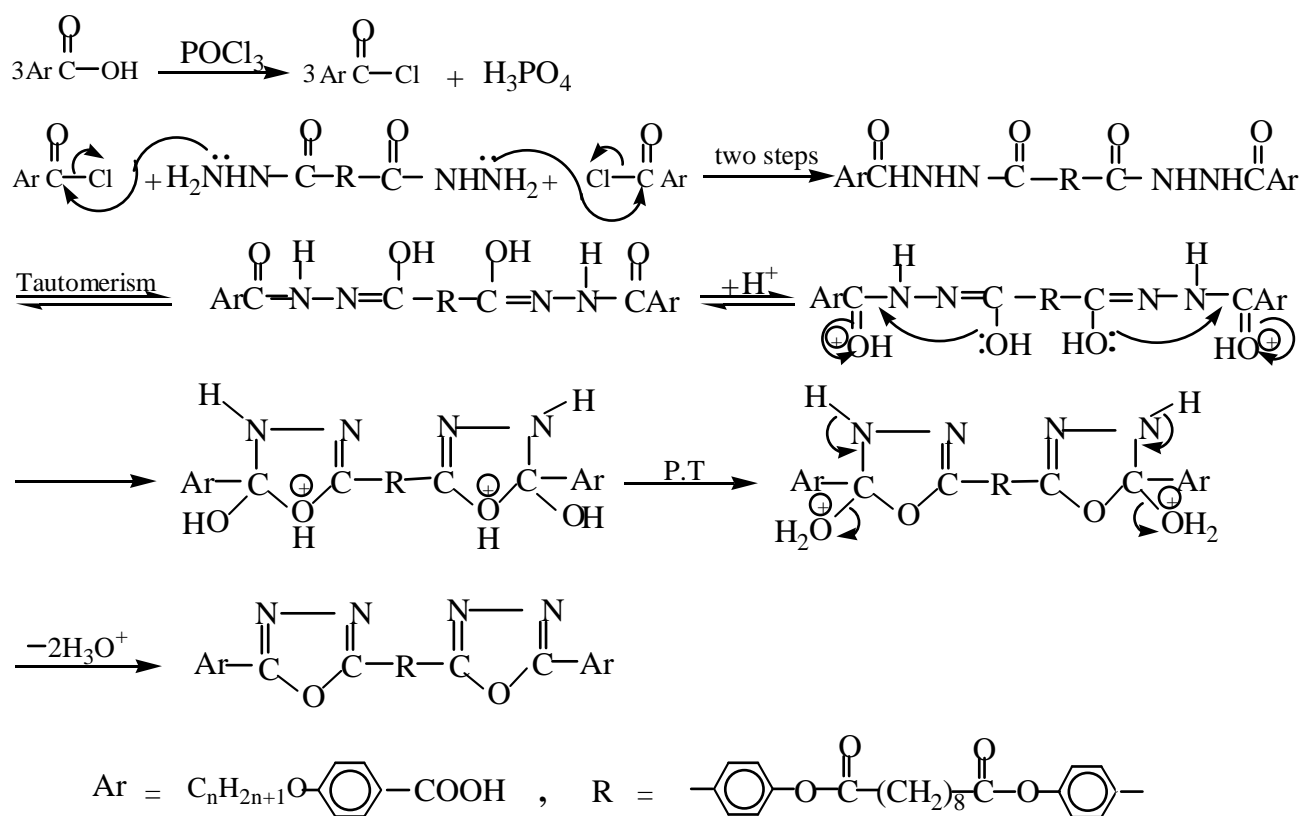
Scheme 2

The structure of this compound was confirmed by its melting point (204 °C), infrared and ultraviolet spectroscopy. The IR spectrum of this compound shows absorption bands at 1650cm^{-1} due to C=O group of amide and at 3190cm^{-1} assigned to NH stretching.

Ultraviolet spectrum of diacid hydrazide shows a broad absorption with the maximum occurring at $\lambda_{\text{max}} = 302\text{nm}$ ($A=1.801$).

A new series of bis-1,8-{4-[5-(4-(p-n-alkoxyphenyl)azophenyl)-1,3,4-oxadiazole-2-yl]carboxyphenyl}octane [IX]_n was

synthesized according to a method described by Dutta⁽¹⁵⁾, in which diacid hydrazide is condensed with the appropriate aromatic acid in the presence of phosphorus oxychloride. The suggested mechanism of this reaction is depicted in Scheme 3.



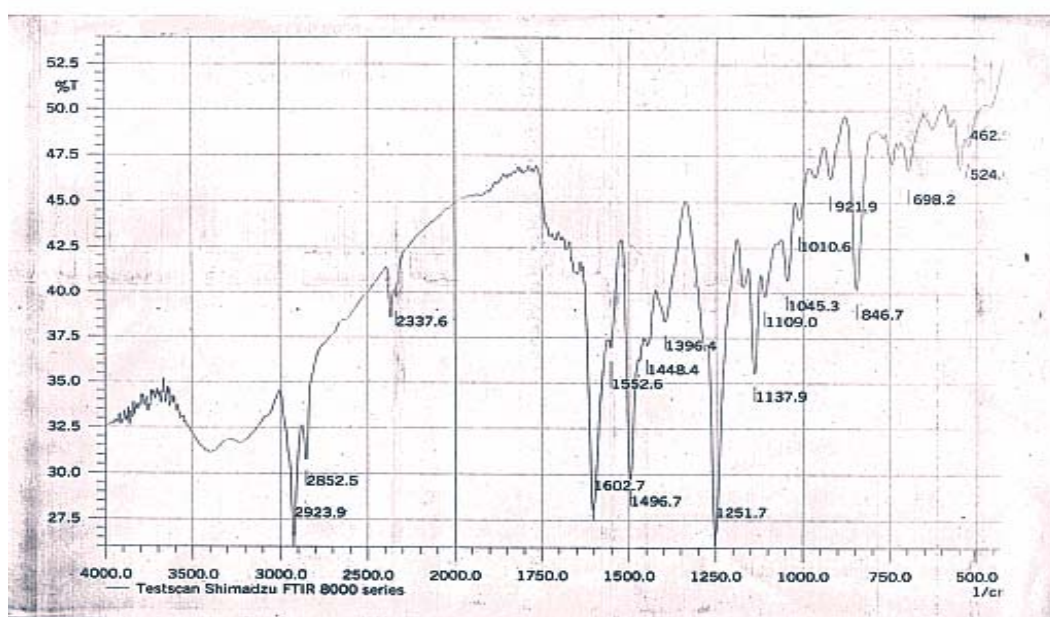
Scheme 3

The compounds of this series was identified by IR and FTIR spectra . The IR show the disappearance of two absorption bands of the C=O (amide) and N-H stretching of hydrazide together with the appearance of three stretching bands around 1605cm⁻¹ , 1250cm⁻¹ and 1045cm⁻¹ , which are assigned for C=N and C-O-C (asymmetric and symmetric stretching bands) of oxadiazole rings . It also show a stretching band at 1720cm⁻¹ which is attributed to the carbonyl of the ester group. Table 2 shows the characteristic absorption bands of these compounds.

FTIR-spectrum of compound [IX]₂ , (Figure 1) showed two peaks in the region (2852.5-2923.9) cm⁻¹ due to aliphatic CH₂ group, a weak peak at 1720 cm⁻¹ which is attributed to the carbonyl of the ester group, a sharp peak at 1602.7 cm⁻¹ could be attributed to the C=N of oxadiazole ring .

Table 2 : Characteristic IR absorption bands of series [IX]_n .

Comp. No.	Characteristic bands IR spectra (cm ⁻¹)				
	vC-H Aliph.	vC=O Ester group	vC=N Oxadiazole ring	vC=N Azomethine group	vO-C-O asym. , sym.
[VI] ₁	2850-2915	1715	1605	1655	1245 , 1045
[VI] ₂	2850-2920	1720	1605	1660	1250 , 1045
[VI] ₃	2855-2915	1715	1605	1655	1250 , 1050
[VI] ₄	2860-2925	1720	1605	1655	1245 , 1045
[VI] ₅	2855-2925	1720	1605	1660	1250 , 1050

**Fig. 1: FTIR spectrum of compound [IX]₂ .**

Refereneces

- 1-Wilson and Givolds ,“ A Text Book of Organic Medical and Pharmaceutical Chemistry ” , 8th , ed., Wiley, New York(1982) .
- 2-S. Samadhiya and A. Halve , *Orient J . Chem.*, 2001, **17(1)** , 119.
- 3-S. G. Cohen , S . J. Groszos , and D. B. Sparrow , *J .Am. Chem. Soc.*, 1950, **72** , 3947.
- 4-J. S. Fowler , *J . Org. Chem.*, 1972 , **37** , 510.
- 5-L. R. Morgan and C. C. Aubert , *Proc. Chem. Soc.*, 1962 , 73.
- 6-A. I. Vogel , “ A Text Book of Practical Organic Chemistry ” , Logman group Limited London , (1973) p. 620.
- 7-V. K. Mishra and S. C. Bahel , *J . Indian Chem. Soc. , Vol. LX* , 1983 , 867.
- 8-A. H. El-Masry , H. H. Fahmy , and S. H. Abdelwahed , *Molecules* , 2000 , **5** , 1429.
- 9-A. T. Atto , M. J. Mohmoud and A. S. Hameed , *Iraqi J.Chem.* , 2000 , **26(1)** , 86.
- 10-N. H. Karam , *Ibn Al-Haitham , J . for Pure and Appl. Sci.* , 2004, **Vol. 17(1)** , 64.
- 11-J. I. Jin and J. H. , Park , *J . Polym.*, 1987 , **Vol. 23(12)** , 973.
- 12-J. H. Tomma , *Ibn Al-Haitham , J . for Pure and Appl. Sci.*, 2004 , **Vol. 17(2)** , 61.
- 13-P. Sykes , “ Advanced Organic Chemistry ” , 4th ., ed., Logman group Limited , London (1975) .
- 14-J. March , “ A Guide Book to Mechanism in Organic Chemistry ” , 2nd .,ed., Mc Graw-Hill. Inc., London , (1975) p.386.
- 15-M. M. Dutta , B. N. Goswami and J. S. Katakya , *J . Heterocyclic Chem.*, 1986 , **23** , 793.