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5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones의 One-pot 합성

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One-pot Synthesis of 5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones

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요 약. sodium ethoxide의 존재하에서 3,5-diaryl-cyclohex-2-en-1-one와 methyl vinyl ketone로부터 5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones가 합성되었다. 이 생성물은 IR, UV-Visible, ^{1}H-NMR, ^{13}C-NMR 그리고 mass spectral techniques로 구조를 규명하였다. ^{1}H과 ^{13}C signals의 피크들은 HSQC spectrum을 찍어 정확히 규명하였다.

주제어: 3,5-Diarylcyclohex-2-en-1-ones, Methyl vinyl ketone, Sodium ethoxide, One-pot, 5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones.

ABSTRACT. 5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones have been synthesized from 3,5-diaryl-cyclohex-2-en-1-ones and methyl vinyl ketone in the presence of sodium ethoxide. The products were characterized by IR, UV-Visible, ^{1}H-NMR, ^{13}C-NMR and mass spectral techniques. To confirm ^{1}H and ^{13}C signals, HSQC spectrum was recorded and analyzed.

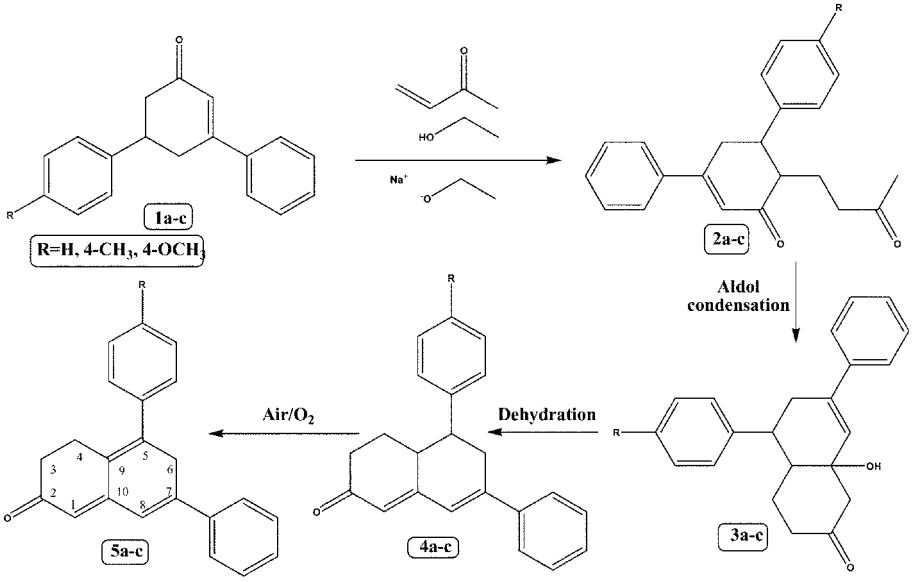
Keywords: 3,5-Diarylcyclohex-2-en-1-ones, Methyl Vinyl Ketone, Sodium Ethoxide, One-pot, 5,7-Diaryl-3,4,6-trihydronaphthalen-2-ones

INTRODUCTION

Michael reaction[1] is the nucleophilic addition of a carbanion, formed from compounds containing active methylene group to an alpha-beta unsaturated ketone[2], ester[3], nitrile[3], etc. There is a general interest in the synthesis of bicyclic ketone because this structural unit is the main function of various natural fragments. It is a versatile intermediate in the synthesis of various steroids and hormones. A tandem reaction comprising a Michael addition step followed by an aldol condensation to produce a cyclic compound is Robinson annulation[4-9]. It is an useful method for the synthesis of natural products consisting of fused ring systems such as terpenes and alkaloids[10]. Robinson annulation can be performed under catalytic conditions using La(OiPr)$_3$-MS 4A[11], Al_2O_3[12], S-proline[13], and AB38C2[14]. Moreover, solvent-free Robinson annulation with sodium ethoxide[15] was also performed. It can also be effected in one-pot using acid catalysts[16,17]. In this paper, we report synthesis of some 5,7-diaryl-3,4,6-trihydronaphthalen-2-ones.

RESULTS AND DISCUSSION

Some 5,7-diaryl-3,4,6-trihydronaphthalen-2-ones were synthesized from 3,5-diarylcyclohex-2-en-1-ones and methyl vinyl ketone in the presence of sodium ethoxide. The products were characterized on the basis of their IR, UV-visible, ^{1}H NMR, ^{13}C NMR and Mass spectral studies. To confirm the ^{1}H



Scheme 1. Synthesis of some 5,7-diaryl-3,4,6-trihydronaphthalen-2-ones.

and ^{13}C NMR spectral assignments, HSQC spectrum was recorded for **5a** and analyzed. All the spectral studies along with TLC indication bear evidence that the formed products are **5a-c**. The compounds were isolated by column chromatography using petroleum ether-benzene (1:4) mixture as an eluent system. Attempts to isolate **3a-c** and **4a-c** were unsuccessful. The schematic representation describing the route of synthesis is furnished in *Scheme* 1.

The IR-spectrum of **5a** showed one strong carbonyl absorption at 1638 cm^{-1} assignable to a cyclic α,β-unsaturated ketone stretching frequency. The IR spectrum of **1a** showed carbonyl absorption at 1653 cm^{-1}. **5a** is also a α,β-unsaturated ketone but it has a frequency of 1638 cm^{-1}, which is lower than the stretching frequency of **1a**, is due to extended conjugation.

In the GC-MS spectrum of **5a**, the observed single peak confirms its formation as a sole product. In the mass spectrum the molecular ion peak observed at 298 is also an additional evidence for the formation of **5a**. The other important fragment peaks are 270, 229, 144, 116, 115, 91, 76 and 54, which agree with the fragment pattern of 2-naphthol. The plausible fragmentation pattern is given in *Chart* 1.

The UV-visible spectrum of **5a** shows two major absorptions at 248 nm and 288 nm. The λ_{max} at 248 nm is due to π-π* transition of phenyl substituent. The other λ_{max} at 288 nm may be due to the unsaturated ketone. The calculated λ_{max} value 297 nm is almost equivalent to the observed λ_{max} value. If the compound **5a** is a saturated one, then the λ_{max} value should be around 250 nm. But in the case under study λ_{max} is 288 nm which is adequate confirmation of the fact that **5a** is unsaturated.

The complete ^{1}H and ^{13}C NMR spectral assignments for the products **5a-c** are given in the experimental section.

Analysis of HSQC Spectrum

To confirm the ^{1}H-NMR and ^{13}C-NMR signals of **5a**, HSQC spectrum was recorded and is given in *Plate* 1. It shows eight cross peaks, which are analyzed as follows: The cross peaks 1 and 2 reveal that the protons are connected to carbon signal at 36 ppm. The signal for the C-4 carbon appears as two signals at 3 and 2.9 ppm. The third cross peak is connected to a carbon signal at 41.5 ppm. C-3 carbon, which appeared at 41.5 ppm, is connected

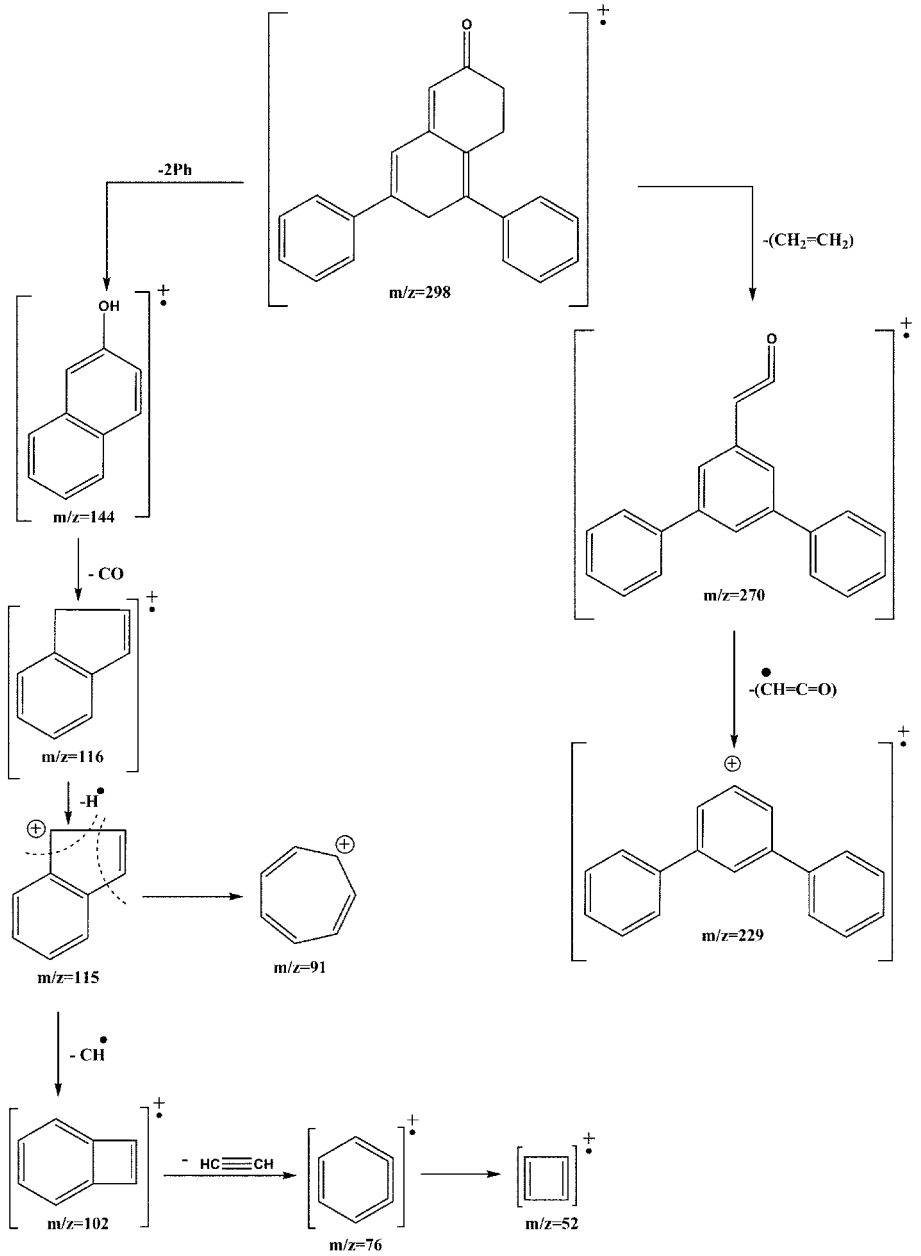


Chart 1. Fragmentation pattern for 5,7-diphenyl-3,4,6-trihydronaphthalen-2-one.

to proton at 3.4 ppm. Hence the signal at 3.4 ppm is conveniently assigned to H-3 proton.

The fourth cross peak is connected to a carbon signal at 44.3 ppm, which is connected to C-6 carbon and two proton signals at 2.9 and 2.7 ppm. Hence the signals at 2.9 and 2.7 ppm are assigned to two H-6 protons.

The fifth cross peak is connected to 7.01 ppm of ^{1}H signal and 113.6 ppm of ^{13}C signal. The seventh cross peak is connected to 6.47 ppm of ^{1}H signal and 125.4 ppm of ^{13}C signal. The fifth and seventh cross peaks may be due to C-8 and C-1 carbons and

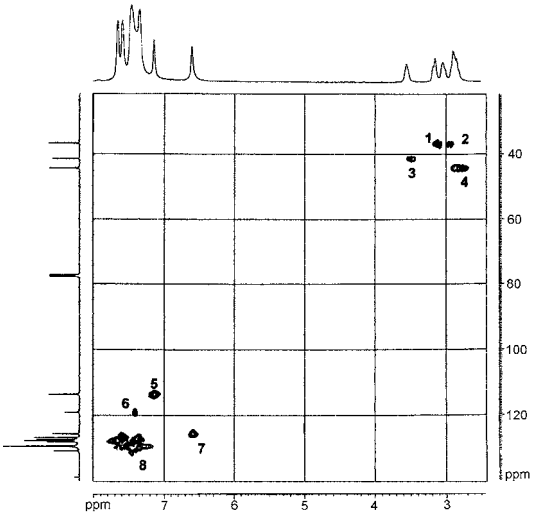


Plate 1.

its protons respectively. The proton signals at 7.01 and 6.47 ppm are assigned to H-1 and H-8, respectively. The eighth cross peak appears as a cluster that is connecting the carbon signals at aromatic region and its protons.

Experimental Section

Melting points of the compounds were recorded on an electro-thermal apparatus and are uncorrected. IR-spectra in KBr were recorded in NICOLET AVATAR-330-FT-IR spectrophotometer. UV-visible spectrum was recorded on HITACHI-U-2001 double beam spectrophotometer. ^{1}H NMR spectra were recorded on BRUKER AMX-400 spectrometer operating at 400 MHz. ^{13}C NMR spectra were recorded on BRUKER AMX-400 spectrometer at operating frequency 100 MHz. The mass spectra were recorded on VG-MICROMASS-7070F double mass spectrometer. The HSQC was recorded on BRUKER AMX-400 spectrometer. The purity of the compounds was checked on TLC.

The chalcones were prepared according to the literature[18]. 3,5-Diaryl-cyclohex-2-en-1-ones [**1a-c**] were prepared by adopting the literature procedure[19].

Preparation of 5,7-Diaryl-3,4,6-trihydronaphthalen-2-one 5a:

A solution of sodium ethoxide was prepared from 0.01 g of freshly cut sodium and 10 ml ethanol in a round-bottomed flask. To this, 3,5-Diphenylcyclohex-2-en-1-one (0.248 g) **1a** in absolute ethanol (20 ml) was added and stirred for one hour at room temperature. To this mixture methyl vinyl ketone (0.1 ml) in absolute alcohol (10 ml) was added and the stirring was continued for over night. To the reaction mixture, 100 ml of $CHCl_3$ followed by ice water were added. The organic phase was separated, washed with brine and dried over anhydrous sodium sulphate. The residue, obtained after evaporation of the solvent was subjected to column chromatography using petroleum ether-benzene (1:4) as an eluent mixture to afford **5a**. Yield: 55%; m.p. 96-98°C; MS: $C_{22}H_{18}O$; m/z: 298 ($M^{+\bullet}$), 270, 229, 144, 116, 115, 102, 91, 76, 52; IR cm^{-1}: 3052, 1638, 1590, 1573, 1495, 1446, 761, 697; UV nm: 248, 288; ^{1}H NMR, $CDCl_3$, δ ppm: 2.60-2.78 (m, 2H, H_6); 2.83-2.91 (m, 1H, H_{4a}); 3.01 (dd, 1H, H_{4e}); 3.36-3.44 (m, 2H, H_3); 6.47 (s, 1H, H_1); 7.01 (s, 1H, H_8); 7.21-7.56 (m, 10H, Ar-H's); ^{13}C-NMR, $CDCl_3$ δ ppm: 200.2 (C-2); 159.7 (C-7); 157.2 (C-5); 113.6 (C-8); 125.4 (C-1); 44.3 (C-6); 41.5 (C-3); 36.7 (C-4); 138.7-143.7 (C-9, C-10 and two *ipso* carbons); 125.4-130.7 Ar-C's.

Compounds **5b** and **5c** were synthesized similarly.

5-(4'-Methylphenyl)-7-phenyl-3,4,6-trihydronaphthalen-2-one 5b:

Yield: 50%; m.p.: 102-104°C; MS: $C_{23}H_{20}O$; m/z: 312 ($M^{+\bullet}$), 284, 243, 144, 116, 115, 102, 91, 76, 52; IR cm^{-1}: 3050, 2973, 1630, 1585, 1570, 1490, 1440, 1375, 756, 693; ^{1}H NMR, $CDCl_3$, δ ppm: 2.62-2.88 (m, 2H, H_6), 3.02 (dd, 1H, H_{4e}), 2.86-2.99 (m, 2H, H_{4a}), 3.38-3.49 (m,2H,H_3), 2.40 (s, 3H, CH_3 at phenyl ring), 6.52 (s, 1H, H_1), 7.08 (s, 1H, H_8); 7.60-7.24 (m, 10H, Ar-H's); ^{13}C NMR $CDCl_3$ δ ppm: 124.5 (C-1); 201.4 (C-2); 42.1 (C-3); 37.3 (C-4); 160.3 (C-5); 44.5 (C-6); 157.8 (C-7); 114.1 (C-8); 21.5 (CH_3 at Phenyl ring); 137.6 (C-CH_3); 139.2-144.2 (C-9, C-10 and two *ipso* carbons); 129.7-125.9 (Ar-C's).

5-(4'-Methoxyphenyl)-7-phenyl-3,4,6-trihydronaphthalen-2-one 5c:

Yield: 52%; m.p.: 106-108°C; MS: $C_{23}H_{20}O_2$; m/z: 328 ($M^{+\bullet}$), 300, 259, 144, 116, 115, 102, 91, 76, 52.; IR cm^{-1}: 3042, 1632, 1587, 1572, 1492, 1446, 1265,

1248, 759, 695; ^{1}H NMR $CDCl_3$ δ ppm: 2.55-2.72 (m, 2H, H_6), 2.78-2.85 (m, 2H, H_{4a}), 2.97 (dd, 1H, H_{4e}), 3.31-3.38 (m, 2H, H_3), 3.95 (s, 3H, OCH_3 at phenyl ring); 6.41 (s, 1H, H-1), 7.12 (s, 1H, H_8) 7.10-7.56 (m, 9H, Ar-H's); ^{13}C NMR $CDCl_3$ δ ppm: 200.9 (C-2); 124.7 (C-1); 41.0 (C-3); 36.2 (C-4); 159.3 (C-5); 43.9 (C-6); 55.4 (OCH_3 at phenyl ring); 156.7 (C-7); 113.9 (C-8); 143.1-138.1 (C-9, C-10 and two *ipso* carbons); 159.2 (C-OCH_3); 124.9-128.9 (Ar-C's).

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