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Regioselective Alkylations of Cyclic 1,3-Diketones *via* Metalated Dimethylhydrazones

Ayhan S. Demir

Ankara (Turkey), Middle East Technical University, Department of Chemistry

Dieter Enders

Aachen, Institut für Organische Chemie, Rheinisch-Westfälische Technische Hochschule

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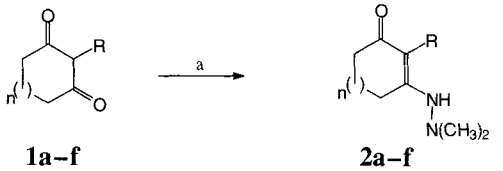
Abstract. Cyclic 1,3- diketones **1** are transformed into their 2,2-dimethylhydrazones **2**, which can be alkylated regioselectively at different positions after mono-, di-, tri-, and tetrametalation. Monometalated C-2 unsubstituted hydrazones afford C-2 and *N*- alkylation, monometalated C-2 substituted hydrazones afford only C-2 alkylation.The regioselectivity of the alkylation of the polymetalated hydrazones follows Hauser's rule according to the sequence: NH- > C-4 Ha > C-5 > C-4 Hb. Hydrolysis of the product hydrazones **3–5** afforded mono- and polyalkylated 1,3- diketones **7** in good yields.

Cyclic1,3-diketones are valuable intermediates in natural product and other syntheses. Functionalizations of 1,3-diketones have been extensively investigated. The major reaction of 1,3-diketones is mono- or di-alkylation at C-2 *via* the enolate ion. Clean C-2 alkylation of many 1,3-diketones is achieved using methyl iodide or other reactive iodides, with potassium carbonate as the base and acetone as the solvent. Alkali metal alkoxides or hydroxides are the usual alternative bases. If one, or more than one, equivalent of base is used, some dialkylation can occur, and the use of excess potassium carbonate and alkyl halide gives excellent yields of C-2 dialkyl products. Two different groups can be introduced in sequential reactions. Alkylation of the kinetic lithium enolates of enol ethers of symmetrical cyclic 1,3-diketones gave the C-6 substituted derivatives. In contrast, the alkylation and aldol condensation of lithium enolates of enaminoketones takes place at C-4 [1–6]. However published methods either constitute the functionalization for some special cyclic 1,3-diketones via carbanion chemistry or work only with a few electrophiles [7–11]. Thus, there is still a need for generally applicable, regio and stereoselective methods to functionalize these compounds.

In this paper, an efficient and flexible procedure for the preparation of mono- and polyfunctionalized cyclic 1,3-diketones *via* their mono- and polymetalated dimethylhydrazones is described. The cyclic 1,3-diketones **1** are converted into the dimethylhydrazones which according to spectroscopic data (IR, NMR) exist as tautomeric enehydrazinones **2** (Scheme 1).



1a–f **2a–f**

a) $H_2NN(CH_3)_2$, *p*-TsOH, reflux

Enehydrazinone **2**	n	R	yield (%)
a	1	H	98
b	1	CH_3	96
c [a]	1	H	98
d	0	H	97
e	0	CH_3	96
f	0	C_2H_5	98

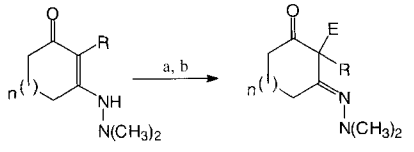
[a] 5,5-dimethyl-1,3-cyclohexanedione

Scheme 1

The metalation of C-2 unsubstituted hydrazones **2a,c,d** with different bases followed alkylation with

alkyl halides gave a mixture of C-2 and N-alkylated products. The C-2 substituted hydrazones **2b**,**e**,**f** gave regioselectively only C-2 alkylation [12–14]. The yield and ratio of alkylation products varied with the temperature, with the nature of the alkyl group, with the halide, with the metal cation associated with the enolate, with the ring size of diketones and with the use of HMPA and TMEDA.

Highest yields of the C-alkylated products (kinetic control) were obtained when the metalation was carried out at –100 °C (C:N ratio 76:24) by using *n*-BuLi/HMPA (C:N ratio 80:20) or KH (C:N ratio 82:18) as bases. Other primary alkyl halides afforded similar C:N alkylation ratios. Highest yields were obtained for the alkylation of the C-2 substituted hydrazones when KH was used as a base. Furthermore, the ring size of the hydrazones does not seem to have much influence on the ratio of C:N-alkylation. Similar results were obtained for the five membered hydrazones **2d–f**. The yield of the alkylations and C-alkylations by using *n*-BuLi as a base increases by addition of 1 equivalent of HMPA (Scheme 2).



2a–f **3a–m**

a) *n*-BuLi, THF, –78 °C; b) EX

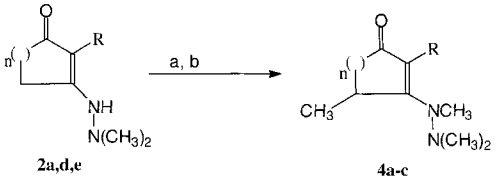
H [a])	Base	Electrophile	Yield(%)	Product
2a	*n*-BuLi/HMPA(1:1)	CH_3I	66	**2b**
2a	*n*-BuLi/HMPA(1:1)	C_2H_5I	76	**3a**
2a	*n*-BuLi/HMPA(1:1)	$HC{\equiv}CCH_2Br$	73	**3b**
2a	*n*-BuLi/HMPA(1:1)	$C_6H_5CH_2Br$	74	**3c**
2c	*n*-BuLi/HMPA(1:1)	C_2H_5I	75	**3d**
2d	*n*-BuLi/HMPA(1:1)	CH_3I	66	**2e**
2d	*n*-BuLi/HMPA(1:1)	C_2H_5I	63	**2f**
2d	*n*-BuLi/HMPA(1:1)	$HC{\equiv}CCH_2Br$	63	**3e**
2b	KH,LDA or *n*-BuLi/HMPA	CH_3I	88, 81, 84	**3f**
2b	KH	C_2H_5I	96	**3g**
2b	KH or *n*-BuLi	$HC{\equiv}CCH_2Br$	90, 83	**3h**
2b	*n*-BuLi/HMPA	$BrCH_2CO_2C_2H_5$	92	**3i**
2b	KH or *n*-BuLi	$C_6H_5CH_2Br$	92, 88	**3j**
2e	KH or *t*-BuLi	C_2H_5I	91, 88	**3k**
2e	*n*-BuLi/HMPA	$HC{\equiv}CCH_2Br$	78	**3l**
2f	*n*-BuLi/HMPA	CH_3I	84	**3k**
2f	*n*-BuLi/HMPA	$HC{\equiv}CCH_2Br$	76	**3m**

[a]) Hydrazone

Scheme 2

Alkylation at the C-4 of 1,3-diketones is achieved *via* dienolate, which is traditionally made using two or more equivalents of bases. Such compounds are accessible *via* the procedure of Stork and Danheiser, in which the monoanion of the monoenolether, derived from the diketone, is successively alkylated and hydrolyzed [11]. Harwood *et al.* reported direct C-4 alkylation of 1,3-cyclohexanedione *via* dianion species [15]. Mellor and Pattenden have reported instances of direct alkylation of 1,3-cyclopentanedione *via* the dianion [16]. By the generation and alkylation of dianions of cyclic 1,3-diketones mono- and dialkylation products were obtained, but in all cases either the yields were low or only special derivatives were used [15–18].

We generated a dianion of the dimethylhydrazone **2a** by deprotonation at –78 °C with 2 equivalents of *n*-BuLi in THF. Subsequent alkylation with 2 equivalents of methyl iodide gave **4a** methylated at both), C-4 and N (71%; NMR, IR, MS). Similar results were obtained by using hydrazones **2d**, **2e** and dimethylated products **4b** and **4c** were isolated in good yield. Generation of the dianions was also possible by using KDA, *s*-BuLi and *t*-BuLi. Reactions with *n*-BuLi were improved by addition of TMEDA. The azaenolate could not be trapped by dibromo ethane to give a cyclic product (Scheme 3).



2a,d,e **4a-c**

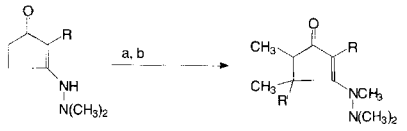
a) 2 eq. base, THF, – 78 °C; b) 2 eq. CH_3I

Hydrazone	Base	Yield (%)	Product
4a	*n*-BuLi	71	**4a**
2a	*n*-Buli, TMEDA(1 eq.)	76	**4a**
2a	KDA	73	**4a**
2d	*n*-BuLi	61	**4b**
2d	*n*-BuLi, TMEDA(1 eq.)	73	**4b**
2d	*n*-BuLi, TMEDA(4 eq.)	75	**4b**
2d	KDA	71	**4b**
2d	*s*-BuLi	64	**4b**
2e	*n*-BuLi	63	**4c**
2e	*n*-BuLi, TMEDA(4 eq.)	69	**4c**
2e	*t*-BuLi	73	**4c**
2e	KDA	76	**4c**

Scheme 3

The treatment of **2d**, **2e** with 3.1 equivalents of *s*-BuLi/HMPA (1:1), *t*-BuLi/HMPA (1:1) or KDA in THF at –100 °C followed by addition of three equivalents of methyl iodide gave the trimethylated products **5a** and **5b** with a methyl group in 5-position (NMR, IR, MS) in 59–63% yield. Trianions of 5-membered ring hydrazones **2** can be regarded as donor substituted cyclopentadienyl anions with aromatic character. Thus the abstraction of a further proton from dianion leading to a trianion should be thermodynamically favorable. Even a tetraanion could be prepared by metalation of **2d** with

4.2 equivalents of *t*-BuLi/HMPA (1:1) or KDA in THF at –100 °C. Quenching with four equivalents of methyl iodide at –100 °C, afforded tetramethylated product **5c**



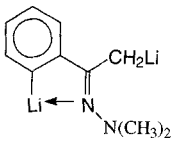
2d R=H
2e R=CH_3
2d

5a R=H, R'=H
5b R=CH_3, R'=H
5c R=H, R'=CH_3

a) For **5a,b**: 3eq. *s*-BuLi, HMPA (1:1), *t*-BuLi, HMPA(1:1) or KDA, THF, –100 °C; for **5c**:4.2 eq. *t*-BuLi, HMPA (1:1) or KDA, THF, –100 °C; b) for **5a,b**: 3 eq. CH_3I (59–63%); for **5c**: 4 eq. CH_3I (51–53%).

Scheme 4

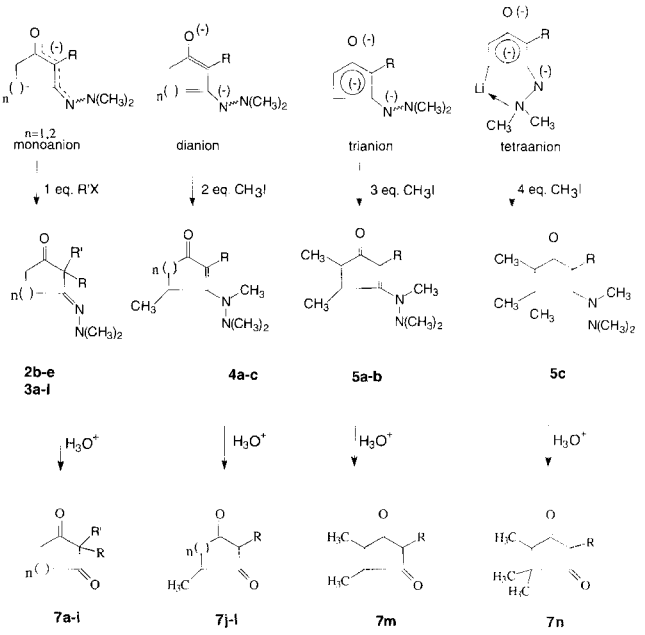
in 51–53% yield (Scheme 4). Omission of the HMPA from the sequence by the formation of trianion and tetraanion with *s*-BuLi and *t*-BuLi resulted in none of the desired products, indicating the absence of trianion and tetraanion under these conditions. The ^1H NMR spectrum of **5c** showed two singlets at 0.98 and 1.11 ppm for protons of two methyl groups and a doublet (J = 7 Hz) at 1.45 ppm for the C-5 methyl protons.The ^{13}C NMR spectroscopic data were also in agreement with the structure **5c**. It is proposed that lithium in 4-position is stabilized by chelation by the dimethylhydrazone group (Formula D) [19].



D

Trapping of the tetraanion with D_2O furnished the expected tetradeuterated product which could be identified by MS and ^1H NMR spectroscopy. Quenching the tetraanion with 4 equivalents of methyl iodide at –100 °C and warming the reaction mixture to room temperature led to a mixture of alkylated products not containing **5c** (GLC). Thus, the reaction was not regioselective. This is another indication for the existence of the tetralithiated species. The proposed tetraanion would be one of the most highly charged small molecules known. The results of the polymetalated hydrazones are summarized in scheme 5 .

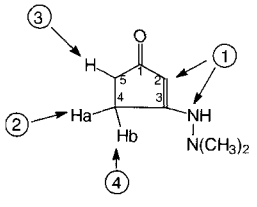
For the control of the regioselectivity by polymetalated hydrazones we tried the alkylation reaction of di-, tri-, and tetraanion with one and two equivalents of methyl iodide. The mono-, di-, tri-, and tetrametalated hydrazone **2d** with one equivalent of methyl iodide afforded a mixture of C-2, and N, C-4 (**6a**), C-5 (**6b**), and C-4 (**6a**) (main product) methylated products. The



Scheme 5

alkylation of the trianion with two equivalents of methyl iodide afforded a mixture of C-4 and C-5 (**6c**) methylated products (Scheme 6).

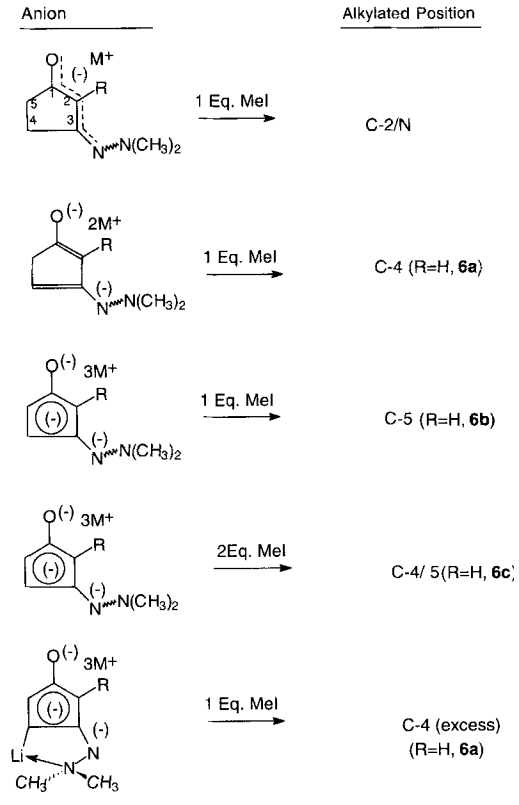
After formation of polyanions, the electrophiles attack specifically at highly basic and nucleophilic carbon first, allowing alkylation at this center. The results show that the deprotonation sequence is in agreement with Hauser's rule [20] (E).



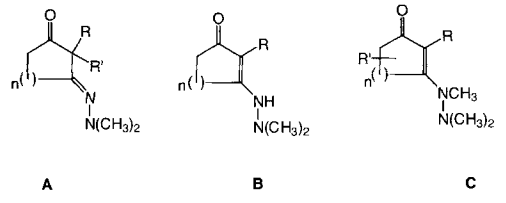
E

1. Mono metalated C-2 unsubstituted hydrazones afford C-2 and N- alkylated products.
2. Mono metalated C-2 substituted hydrazones give C-2 alkylated products.
3. Polymetalation and alkylation occur according to the following sequence:
NH- > C-4 Ha > C-5 H > C-4 Hb

For the regeneration of alkylated ketones **7** from the product hydrazone **3–5** with different structures, different cleavage procedures were used. The products with the structure **A** and **B** are *cleaved under mild conditions* in good yield using oxidative cleavage by ozonolysis (68–98%) and hydrolysis of their trimethylhy-



Scheme 6

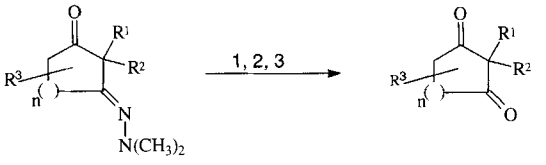


Cleavage of dimethylhydrazone derivatives

Method	Reaction conditions	Structure
1	a. Excess CH_3I, reflux, 3–6 h b. Two layer system (5% HCl solution , *n*-pentane or ether) 20–25 °C , < 1h	A,B
2	Ozone, *n*-pentane or dichloro methane, –78 °C, 10–30 min.	A
3	a. 6N HCl, reflux 3–10 h b. b. Conc. HBr, reflux 3–5 h	B,C

droxonium iodide derivatives in two phase system (66–82%). The products with the structure **B** an **C** were hydrolyzed by heating with acid to give desired ketones (Scheme 7).

In conclusion, the alkylations of cyclic 1,3-diketones described in this paper open a flexible entry to important starting materials for syntheses of natural and bioactive compounds.



2b,e,f; 3a-l; 4a-c; 5a,c 1b,e,f; 7an

Hydrazone	Cleavage method	Yield (%)	Ketone
2b	1	68	**1b**
2e	1	71	**1e**
2f	3	72	**1f**
3a	3	63	**7a**
3b	3	66	**7b**
3c	3	72	**7c**
3f	2	68	**7d**
3g	2	98	**7e**
3h	1	66	**7f**
3j	1	82	**7g**
3k	2	77	**7h**
3l	1	81	**7i**
4a	3	62	**7j**
4b	3	58	**7k**
4c	3	52	**7l**
5a	3	63	**7m**
5c	3	43	**7n**

Scheme 7

This work was supported by the Fonds der Chemischen Industrie, the Deutsche Forschungsgemeinschaft and the Middle East Technical University (AFP 1995). We thank BASF AG, Bayer AG and Hoechst AG for providing chemicals.

Experimental

^{1}H NMR spectra were recorded on a Varian EM-390 and Bruker 80 AC FT spectrometers. IR spectra were measured with a Beckman Acculab 4 instrument. Mass spectra were obtained on Kratos MS-30 and MS-50 spectrometers at an ionization energy of 70 eV. The elemental analyses were carried out with a Carlo Erba type 1104 and a Heraeus Mikro U/D apparatus. For analytical TLC Merck TLC plates silica gel 60 F254 were used. All reaction solvents were dried and distilled according to standard procedures. Melting points are uncorrected.

Hydrazones 2 (General Procedure)

A solution of 1,3- diketone (25 mmol), *N,N*-dimethylhydrazine (25 mmol) and 0.1 g of *p*-toluenesulfonic acid in benzene (50 ml) was refluxed while the reaction water was removed with a Dean Stark trap. When the reaction was complete (TLC), the benzene layer was concentrated *in vacuo*, and the residue was purified by crystallization.

Cyclohexane-1,3-dione dimethylhydrazone (**2a**)

From 2.80 g (25 mmol) of cyclohexane-1,3-dione and 1.8 ml (25 mmol) of *N,N*-dimethylhydrazine. Yield 3.70 g (98%) of a colorless solid, *m.p.* 142–143 °C. The spectroscopic

data were identical with those given in the literature [19].

2-Methylcyclohexane-1,3-dione dimethylhydrazone (**2b**)

From 1.26 g (10 mmol) of 2-methylcyclohexane-1,3-dione and 0.96 ml (12mmol) of *N,N*-dimethyl hydrazine. Yield 1.62 g (96%) of a yellow solid; *m.p.* 112–114 °C [19].

2-Methylcyclohexane-1,3-dione dimethylhydrazone (**2b**) and *3-(trimethylhydrazino)cyclohex-2-ene-1-one* (**2g**)

a) A solution of 1.54 g (10 mmol) of **2a** in 40 ml THF under argon 0.28 g (1.16 mmol) of NaH (washed with pentane before use) was added to a cold (–5 °C) solution. After stirring at –5 °C for 30 min. methyl iodide (1.42 g, 10 mmol) was added. The reaction mixture was stirred at –5 °C for 6 h. A saturated NH_4Cl solution was added (20 ml). Extraction with EtOAc, washing with brine, drying ($MgSO_4$) and evaporation of the solvent gave 1.30 g (78%) of a yellow oil. The separation of the mixture of regioisomers by column chromotography (silica gel/EtOAc) gave yellow oils of **2b** (0.12 g, 7.2%), of **2g** (1.08 g, 64.8%). – IR (neat): ν = 3010–2890 cm^{-1} (CH), 1650 (C=O), 1590 (C=C). – ^1H NMR ($CDCl_3$): δ/ppm = 1.95–2.4 (m, 6H, $3CH_2$), 2.52 (s, 6H, NMe_2), 2.71 (s, 3H, NMe), 5.1 (s, 1H, olef. H). – MS (70 eV) *m/z* (%): 168 (90) [M^+], 153 (20) [M^+–CH_3], 126 (18), 125 (60), 124 (100) [M^+–NMe_2], 109 (3), 98 (25), 94 (10).

$C_9H_{16}N_2O$:	calcd.:	C	64.20	H	9.58	N 16.65
(168.2)	found:	C	64.32	H	9.41	N 16.37.

b) To a solution of 1.54 g (10 mmol) of **2a** in 40 ml of THF (0 °C) was added 10 mmol of BuLi dropwise. The reaction mixture was stirred at 0 °C for 10 min. then methyl iodide (1.42 g, 10 mmol) was added and purification, according to the procedure described above before, yielded 1.21 g (73%) of **2b** and **2g** in a 30:70 ratio.

c) Repeating the same reaction at –20 °C (metallation at –20 °C, 30 min., methylation at –20 °C 1 h) gave **2b** and **2g** in a 55:45 ratio.

d) Repeating the same reaction at –78 °C (metallation at –78 °C 30 min., methylation at –78 °C 1 h) gave **2b** and **2g** in a 70:30 ratio.

e) Repeating the same reaction at –100 °C (metallation at –78 °C, 30 min., methylation at –100 °C, 1 h) gave **2b** and **2a** in a 76:24 ratio.

f) The procedure described for the preparation of **2b** and **2g** with BuLi at –78 °C was repeated with 1.54 g (10 mmol) of **2a**, 10 mmol of *t*-BuLi and 1.42 g (10 mmol) of methyl iodide and afforded 1.38 g (83%) of **2b**, **2a** mixture in a 60:40 ratio.

g) 1.54 g (10 mmol) of **2a** was transformed by treatment with 10 mmol of *n*-BuLi/10 mmol of HMPA and 1.42 g (10 mmol) of methyl iodide into 1.36 g (82%) of the **2a**, **2b** mixture (ratio 80:20) by the same procedure as described before (e).

h) To 11 mmol of LDA in 40 ml of THF at –78 °C was added 1.54 g (10 mmol) of **2a**. After warming to 0 °C and stirring for 6 h at this temperature, the reaction mixture was cooled to –78 °C, and 1.42 g (10 mmol) of methyl iodide was added. After stirring at this temperature for 3 h the reaction mixture was allowed to warm to room temperature. The reaction mixture was poured into diethyl ether/water (2:1), and the aqueous layer was extracted twice with diethyl ether. Drying of the combined organic phases with Na_2SO_4 and evaporation of the solvent yielded 1.26 g (76%) of **2b** and **2g** (ratio 60:40).

i) To 11 mmol of KDA in 40 ml of THF at –78 °C was added 1.54 g (10 mmol) of **2a**. After warming to –5 °C and stirring for 1 h at this temperature, the reaction mixture was cooled to –78 °C and 1.42 g (10 mmol) of methyl iodide was added. After stirring at this temperature for 3 h, the reaction mixture was allowed to warm to room temperature. The reaction mixture was poured into diethyl ether/water (2:1) and the aqueous layer was extracted with diethyl ether twice. After drying the combined organic phases with Na_2SO_4 1.14 g (68%) of the **2b**, **2g** mixture was isolated (ratio 65:35).

j) 1.54 g (10 mmol) of **2a** was transformed with 11 mmol of KH and 1.42 g (10 mmol) of methyl iodide into 1.18 g (71%) of **2b** and **2g** (ratio 82:18) by the same procedures described for the KDA reaction.

5,5-Dimethyl-cyclohexane-1,3-dione-dimethylhydrazone (**2c**)

The reaction of 7.0 g (50 mmol) of 5,5-dimethyl-cyclohexane-1,3-dione with 4.0 ml (50 mmol) of *N,N*-dimethylhydrazine afforded 8.90 g (98 %) of **2c** as a yellow solid, *m.p.* 162–163 °C. The spectroscopic data were identical with those given in the literature [19].

Cyclopentane-1,3-dione-dimethylhydrazone (**2d**)

Reaction of 0.50 g (5 mmol) of cyclopentane-1,3-dione and 4.0 ml (50 mmol) of *N,N*-dimethylhydrazine afforded 0.68 g (97%) of **2d** as a yellow solid, *m.p.* 165–157 °C. – IR (KBr): ν = 3180 cm^{-1} (NH), 3010–2800 (CH), 1660 (C=O), 1570 (C=C) . – ^1H NMR ($CDCl_3$): δ/ppm = 2.31– 2.52 (m, 4H, CH_2, C-4, C-5), 2.69 (s, 6H, NMe_2), 5.41 (s, 1H, olef. H), 6.89 (s, 1H, NH). – ^{13}C NMR ($CDCl_3$): δ/ppm = 25.8 (C-4), 33.6 (C-5), 47.0 (NMe_2), 99.2 (C-2), 176.3 (C-3), 204.2 (C-1). – MS (70 eV) : *m/z* (%): 140 (100) [M^+], 125 (13) [M^+–CH_3], 111 (13), 98 (20), 97 (25), 96 (20), 83 (20), 82 (10), 81 (10), 69 (20), 68 (32), 44 (45) [NMe_2], 43 (35), 42 (40), 41 (15).

$C_7H_{12}N_2O$	calcd.:	C	59.97	H	8.62	N 19.91
(140.2)	found:	C	60.01	H	8.50	N 19.7.

2-Methyl-cyclopentane-1,3-dione-dimethylhydrazone (**2e**)

Reaction of 1.12 g (10 mmol) of 2-methyl-cyclopentane-1,3-dione with 0.88 ml (11 mmol) of *N,N*-dimethylhydrazine afforded 1.50 g (96%) of **2e** as a yellow solid, *m.p.* 136–138 °C. – IR (KBr): ν = 3110 cm^{-1} (NH), 2910–2800 (CH), 1610 (C=O), 1560 (C=C). – ^1H NMR ($CDCl_3$): δ/ppm = 1.58 (s, 3H, CH_3), 2.40–2.62 (m, 4H, CH_2, C-4,C-5), 2.68 (s, 6H, NMe_2), 6.22 (s, 1H,NH). – ^{13}C NMR ($CDCl_3$): δ/ppm = 16.5 (CH_3), 24.6 (C-4), 32.7 (C-5), 48.5 (NMe_2), 106.0 (C-2), 173.2 (C-3), 203.4 (C-1). – MS (70 eV) *m/z* (%): 154 (75) [M^+], 139 (10) [M^+–CH_3], 112 (15), 111 (30), 110 (50) [M^+–NMe_2], 95 (5), 83 (15), 82 (35), 80 (10), 67 (20), 59 (25), 56 (20), 55 (28), 53 (18), 44 (100) [NMe_2], 42 (48), 41 (30).

$C_8H_{14}N_2O$	calcd.:	C	62.30	H	9.15	N 18.16
(154.21)	found:	C	62.65	H	9.05	N 17.78.

The synthesis of 2e from 2d

1.40 g (10 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.42 g (10 mmol) of methyl iodide into 1.0 g (66%) of **2e** by the same procedure as described for **2b**.

2-Ethylcyclopentane-1,3-dione-dimethylhydrazone (**2f**)

Reaction of 3.36 g (20 mmol) of 2-ethylcyclopentane-1,3-dione with 1.8 ml (22.3 mmol) of *N,N*-dimethylhydrazine afforded 3.34 g (98 %) of **2f** as a colorless solid, *m.p.* 121–122 °C. – IR (KBr): ν = 3200 cm^{-1} (NH), 3010–2800 (CH), 1650 (C=O), 1570 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 0.91 (t, 3H,CH_3), 1.79–2.48 (m, 6H, $3CH_2$), 2.58 (s, 6H, NMe_2), 5.61 (s,1H, NH). – MS (70 eV) *m/z* (%): 168 (100) [M^+], 153 (40) [M^+–CH3], 137 (10), 125 (96), 124 (92), 121 (45), 113 (75), 95 (23), 81 (70), 80 (50), 68 (38), 67 (40), 59 (50), 54 (40), 44 (60) [NMe_2], 42 (20).

$C_9H_{16}N_2$	calcd.:	C 64.25	H 9.58	N 16.56
(168.24)	found:	C 64.23	H 9.61	N 16.11.

Synthesis of 2f from 2d

1.40 g (10 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.56 g (10 mmol) of ethyl iodide into 1.05 g (63%) of **2f** by the same procedure as described for **2b**.

2-Ethylcyclohexane-1,3-dione-dimethylhydrazone (**3a**)

1.54 g (10 mmol) of **2a** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.56 g (10 mmol) of ethyl iodide into 1.38 g (76%) of **3a** as a yellow oil by the same procedure as described for **2b**; *b.p.* 120–135 °C/0.01 Torr. – IR (Neat): ν = 3310–3200 cm^{-1} (NH), 3000–2820 (CH), 1630 (C=O), 1560 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 0.82 (t, J =7 Hz, 3H, CH_3), 1.52–2.79 (m, 8H, CH_2, C-4,5,6, Ethyl), 2.48 (s, 6H, NMe_2), 5.22 (s, 1H, NH). – MS (70 eV) *m/z* (%): 182 (100) [M^+], 167 (10), 154 (30), 153 (40), 139 (45), 138 (18) [M^+–NMe_2], 126 (20), 124 (18), 111 (34), 110 (23), 96 (30), 87(20), 83 (30), 69 (20), 67 (22), 44 (56) [NMe_2], 43 (30).

$C_{10}H_{18}N_2O$	calcd.:	C 65.89	H 9.95	N 15.36
(182.14)	found:	C 65.63	H 9.82	N 15.57.

2-(1-Propyn-3-yl)cyclohexane-1,3-dione-dimethylhydrazone (**3b**)

1.54 g (10 mmol) of **2a** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.19 g (10 mmol) of propargyl bromide into 1.41 g (73 %) of **3b** (yellow oil) by the same procedure as described for **2b**; *b.p.* 175–185 °C/0. 1 Torr. IR (Neat): ν = 3250 cm^{-1} (alkynyl CH), 3200 (NH), 3010–2900 (CH), 2100 (C=C), 1610 (C=O), 1560 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 1.51–2.01 (m, 2H, CH_2, C-5), 2.01– 2.92 (m, 6H, CH_2, C-4,6, propargyl CH_2), 2.50 (s, 6H, NMe_2), 3.22 (s, 1H, CH), 5.48 (s, 1H, NH). – MS (70eV) *m/z* (%): 192 (25) [M^+], 191 (8), 165 (10), 155 (20), 148 (27) [NMe_2], 135 (45), 121 (30), 108 (10), 94 (15), 82 (10), 45 (45), 44 (100) [NMe_2], 42 (40).

$C_{11}H_{16}N_2O$	calcd.:	C 68.75	H 8.33	N 14.58
(192.25)	found:	C 68.52	H 8.68	N 15.32.

2- Benzylcyclohexane-1,3- dione-dimethylhydrazone (**3c**)

0.84 g (5 mmol) of **2a** was transformed by treatment with 5 mmol of BuLi/5 mmol of HMPA and 0.85 g (5 mmol) of benzyl bromide into 0.95 g (74%) of **3c** by the same procedure as described for **2b**; *m.p.* 43–45 °C. – IR (KBr): ν = 3350 cm^{-1} (NH), 3051–2800 (CH), 1690 (C=O), 1570 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 1.51– 2.43 (m, 6H, CH_2, C-4,5,6), 2.48 (s, 6H, NMe_2), 3.2 (s, 2H, Benzyl CH_2), 6.8 (s, 1H, NH), 7.2 (s, 5H, C_6H_5). – MS (70 eV) *m/z* (%): 244 (20) [M^+], 243 (90), 200 (55) [M^+– NMe_2, 198 (15), 172 (10) [NMe_2], 153 (10) [M^+– Benzyl], 125 (15), 91(100) [$C_6H_5CH_2$], 77 (13), 64 (21), 58 (22), 54 (25) 44 (45) [NMe_2].

$C_{15}H_{20}N_2O$	calcd.:	C 73.72	H 8.26	N 11.47
(244.15)	found:	C 73.76	H 8.12	N 11.71.

5,5-Dimethyl-2-ethylcyclohexane-1,3-dione-dimethylhydrazone (**3d**)

1.82 g (10 mmol) of **2c** was transformed by treatment with10 mmol of BuLi/10 mmol of HMPA and 1.56 g (10 mmol) of ethyl iodide into 1.57 g (75%) of **3d** by the same procedure as described for **2b**; *b.p.* 145–160 °C/0.02 Torr. – IR (KBr): ν =3200 cm^{-1} (NH), 3010–2820 (CH), 1620 (C=O), 1560 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 0.88–1.18 (m, 9H, $3CH_3$), 2.01–2.32 (m, 4H, CH_2, C-4,6), 2.32–2.61 (m, 2H, CH_2), 2.58 (s, 6H, NMe_2), 5.13 (s, 1H, NH). – MS (70 eV): *m/z* (%): 210 (100) [M^+], 195 (30) [M^+–CH_3], 182 (22), 180 (15), 167 (40), 166 (60) [M^+–NMe_2], 152 (70), 138 (25), 126 (23), 111 (50), 98 (40), 87 (30), 83 (65), 69 (50), 59 (25), 55 (35), 44 (76) [NMe_2], 43 (40), 42 (47).

$C_{12}H_{22}N_2O$	calcd.:	C 68.53	H 10.54	N 13.32
(210.32)	found:	C 68.81	H 10.41	N 13.63.

2-(1-Propyn-3-yl)cyclopentane-1,3-dione-dimethylhydrazone (**3e**)

1.40 g (10 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.99 g (10 mmol) of propargyl bromide into 1.10 g (63%) of **3e** by the same procedure as described for **2b**; *b.p.* 170–185 °C/0.02 Torr. IR (Neat): ν = 3250 cm^{-1} (alkynyl CH), 3200 (NH), 3010–2820 (CH), 2100 (C=C), 1640 (C=O), 1550 (C=C). – ^{1}H NMR ($CDCl_3$): δ/ppm = 1.31–2.60 (m, 6H, CH_2, C-4,5, propargyl-CH_2), 2.58 (s, 6H, NMe_2), 4.01 (s, H, acetylenic H), 5,2 (s, 1H, NH). – MS (70 eV) *m/z* (%): 178 (38) [M^+], 177 (25), 176 (10), 143 (46), 127 (100), 85 (30), 82 (10), 71 (25), 69 (27), 57 (40), 55 (25), 44 (30) [NMe_2], 42 (25).

$C_{10}H_{14}N_2O$	calcd.:	C 67.39	H 7.92	N 15.72
(178.23)	found:	C 67.59	H 7.66	N 15.51.

2,2-Dimethylcyclohexane-1,3-dione-dimethylhydrazone (**3f**)

a) 1.68 g (10 mmol) of **2b** was transformed by treatment with 10 mmol of BuLi/10 mmol of HMPA and 1.42 g (10 mmol) of methyl iodide into 1.52 g of **3f** by the same procedure as described for **2b**, *b.p.* 92–100 °C/10^{-3} Torr. – IR (Neat): ν = 3000–2780 cm^{-1} (CH), 1710 (C=O), 1610 (C=N), 1550, 1460. – ^{1}H NMR ($CDCl_3$): δ/ppm = 1.25 (s, 6H, $2CH_3$), 1.55–2.10 (m, 2H, CH_2, C-5), 2.15–3.0 (complex area, 6H, CH_2, C-4,6), 2.40 (s, 6H, NMe_2). – MS (70 eV) *m/z* (%): 182 (12) [M^+], 164 (15), 138 (21), 124 (17), 115 (50), 110 (35), 96 (32), 87 (50), 71 (30), 55 (21), 45 (62), 44 (100) [NMe_2], 43 (71).

$C_{10}H_{18}N_2O$	calcd.:	C 65.89	H 9.95	N 15.36
(182.14)	found:	C 65.54	H 10.07	N 15.17.

b) 1.68 g (10 mmol) of **2b** was transformed by treatment with 11 mmol of KH and 1.42 g (10 mmol) of methyl iodide into 1.60 g of **3f** by the same procedure as described for **2b**.

c) 1.68 g (10 mmol) of **2b** was transformed by treatment with 11 mmol of LDA and 1.42 g (10 mmol) of methyl iodide into 1.47 g of **3f** by the same procedure as described for **2b**.

2-Ethyl-2-methylcyclohexane-1,3-dione-dimethylhydrazone (**3g**)

0.84 g (5 mmol) of **2b** was transformed by treatment with 6 mmol of KH and 0.78 g (5 mmol) of ethyl iodide into 0.94 g of **3g** by the same procedure as described for **2b**; *b.p.* 110–118 °C/0.1 Torr. – IR (Neat): ν = 3010–2850 cm^{-1} (CH), 1710 (C=O), 1610 (C=N). – ^1H NMR ($CDCl_3$): δ/ppm = 0.71 (t, *J*=7 Hz, 3H, CH_3), 1.20 (s, 3H, CH_3), 1.68–1.72 (m, 4H, CH_2, ethyl, C-5), 2.29–2.36 (m, 4H, CH_2, C-4,6), 2.41 (s, 6H, NMe_2). –MS (70 eV) *m/z* (%): 196 (63) [M^+], 152 (45), [M^+–NMe_2], 138 (32), 124 (64), 110 (24), 59 (41), 45 (50), 44 (100) [NMe_2], 43 (20), 42 (28).

$C_{11}H_{20}N_2O$	calcd.:	C 67.49	H 10.21	N 14.20
(196.15)	found:	C 67.32	H 10.39	N 14.622.

2-Methyl-2-(1-propyn-3-yl)cyclohexane-1,3-dione dimethylhydrazone (**3h**)

a) 0.84 g (5 mmol) of **2b** was transformed by treatment with 11 mmol of KH and 0.61 g (5 mmol) of propargyl bromide into 0.91 g of **3h** by the same procedure as described for **2b**; *b.p.*115–120 °C/0.1 Torr. – IR (Neat): ν = 3270 cm^{-1} (CH), 2980–2800 (CH), 2100 (C=C), 1700 (C=O), 1620 (C=N). – ^1H NMR ($CDCl_3$): δ/ppm = 1.19 (s, 3H, CH_3), 1.62–1.90 (m, 3H, CH_2, C-5, Acetylenic H), 2.41 (s, 6H, NMe_2), 2.30–2.70 (m, 6H, propargyl-CH_2, CH_2, C-4,6). – MS (70 eV) *m/z* (%): 206 (20) [M^+], 162 (100) [M^+–NMe_2], 148 (55), 134 (30), 120 (22), 108 (70), 94 (22), 79 (15), 66 (15), 58 (35), 44 (98) [NMe_2], 39 (30).

$C_{12}H_{18}N_2O$	calcd.:	C 69.86	H 8.79	N 13.50
(206.14)	found:	C 70.01	H 8.78	N 13.62.

b) 0.84 g (5 mmol) of **2b** was transformed by treatment with 10 mmol of *n*-BuLi and 0.91 g (5 mmol) of propargyl bromide into 0.83 g of **3h** by the same procedure as described for **2b**.

2-Ethoxycarbonyl-methyl-2-methylcyclohexane-1,3-dione-dimethylhydrazone (**3i**)

0.84 g (5 mmol) of **2b** was transformed by treatment with 5 mmol of BuLi/5mmol of HMPA and 0.83 g (5 mmol) of ethyl bromoacetate into 1.10 g of **3i** by the same procedure as described for **2b**; *b.p.* 135–145 °C/0.1 Torr. – IR (Neat): ν = 3000–2890 cm^{-1} (CH), 1730 (COOEt, C=O), 1710 (C=O), 1600 (C=N). – ^1H NMR ($CDCl_3$): δ/ppm = 1.21 (*s* and *t*, 6H, $2CH_3$), 1.69–1.93 (m, 2H, CH_2, C-5), 2.42 (s, 6H, NMe_2), 2.20–2.61 (m, 4H, CH_2, C-4,6), 3.12 (s, 2H, CH_2, OEt), 3.90 (q, 2H, OCH_2). – MS (70 eV) *m/z* (%): 254 (80) [M^+], 225 (5), 210 (21) [M^+–NMe_2], 204 (40), 185 (45), 181 (5), 165 (50), 122 (18), 164 (65), 139 (30), 138 (80), 136 (40), 125 (20), 122 (18), 110 (70), 96 (25), 85 (20), 69 (45), 59 (30), 56 (32), 44 (100) [NMe_2], 41 (60).

$C_{13}H_{22}N_2O_3$	calcd.:	C 61.39	H 8.71	N 11.01
(256.14)	found:	C 61.26	H 8.84	N 9.65.

2-Benzyl-2-methylcyclohexane-1,3-dione-dimethylhydrazone (**3j**)

a) 0.84 g (5 mmol) of **2b** was transformed by treatment with 6 mmol of KH and 0.85 g (5 mmol) of benzyl bromide into 1.18 g of **3j** by the same procedure as described for **2b**; *b.p.* 175–185 °C/0.01Torr. – IR (Neat): ν = 3050–2850 cm^{-1} (CH), 1990 (C=O), 1570 (C=N), 1470–1440. – ^1H NMR ($CDCl_3$): δ/ppm = 1.30 (s, 3H, CH_3), 1.39–1.72 (m, 2H, CH_2, C-5), 2.12–2.70 (m, 4H, CH_2, C-4,6), 2.50 (s, 6H, NMe_2), 2.89–3.18 (m, 2H, CH_2-benzyl), 7.2 (m, 5H, C_6H_5). – MS (70 eV) *m/z* (%): 258 (48) [M^+], 257 (30), 214 (28) [M^+–NMe_2], 209 (31), 186 (27), 184 (20), 168 (50), 167 (96), 124 (85), 123 (70), 115 (68), 97 (50), 91 (100) [C_6H_5], 77 (55), 71 (50), 68 (60), 64 (10), 57 (68), 44 (96) [NMe_2].

$C_{16}H_{22}N_2O$	calcd.:	C 74.38	H 8.58	N 10.84
(258.36)	found:	C 74.68	H 8.41	N 10.98.

b) 0.84 g (5 mmol) of **2b** was transformed by treatment with 5 mmol of BuLi and 0.85 g (5 mmol) of benzyl bromide into 1.12 g of **3j** by the same procedure as described for **2b**.

2-Ethyl-2-methylcyclopentane-1,3-dione-dimethylhydrazone (**3k**)

a) 1.54 g (10 mmol) of **2e** was transformed by treatment with 11 mmol of KH and 1.56 g (10 mmol) of ethyl iodide into 1.65 g of **3k** by the same procedure as described for **2b**; *b.p.* 120–130 °C/0.1Torr. – IR (Neat): ν = 3000–2920 cm^{-1} (CH), 1730 (C=O), 1630 (C=N), 1550. – ^1H NMR ($CDCl_3$): δ/ppm = 0.81 (t, *J*=7 Hz, 3H, CH_3), 1.19 (s, 3H, CH_3), 1.01–2.10 (m, 4H, CH_2, C-4 and C_2H_5), 2.30–2.38 (m, 2H, CH_2, C-5), 2.40 (s, 6H, NMe_2). – MS (70 eV) *m/z* (%): 182 (38) [M^+], 167 (10), 166 (20), 153 (18), 139 (22), 138 (20), 135 (35), 124 (16), 112 (20), 110 (25), 92 (15), 82 (25), 72 (28), 68 (13), 58 (20), 55 (23), 45 (50), 44 (100), 44 (100) [NMe_2].

$C_{10}H_{18}N_2O$	calcd.:	C 65.76	H 9.96	N 15.30
(182.26)	found:	C 65.51	H 10.23	N 14.94.

b) 1.54 g (10 mmol) of **2e** was transformed by treatment with 10 mmol of *t*-BuLi and 1.56g (10 mmol) of ethyl iodide into 1.60 g of **3k** by the same procedure as described for **2b**.

Synthesis of 3k from 2f

0.84 g (5 mmol) of **2f** was transformed by treatment with 5 mmol of *t*-BuLi/5mmol HMPA and 0.71g (5 mmol) of methyl iodide into 0.76 g of **3k** by the same procedure as described for **2b**.

2-Methyl-2-(1-propyn-3-yl)cyclopentane-1,3-dione-dimethylhydrazone (**3l**)

1.54 g (10 mmol) of BuLi/10 mmol HMPA and 1.99 g (10 mmol) of propargyl bromide into 1.48 g of **3l** by the same procedure as described for **2b**; *b.p.* 145–150 °C/0.01Torr. – IR (Neat): ν = 3250 cm^{-1} (Acetylenic H), 3000–2850 (CH), 2100 (C=C), 1740 (C=O), 1640 (C=N), 1590. – ^1H NMR ($CDCl_3$): δ/ppm = 1.21(s, 3H, CH_3), 1.69–2.58 (m, 6H, CH_2, C-4,5, propargyl CH_2), 2.48 (s, 6H, NMe_2), 2.91 (s, 1H, CH). – MS (70 eV) *m/z* (%): 192 (10) [M^+], 186 (33), 146 (30), 77 (10), 65 (68), 45 (60), 44 (100) [NMe_2].

$C_{11}H_{16}N_2O$	calcd.:	192.12626
(192.1)	found:	192.12622 (MS).

2-Ethyl-2-(1-propyn-3-yl)cyclopentane-1,3-dione-dimethylhydrazone (**3m**)

0.84 g (5 mmol) of **2f** was transformed by treatment with 5 mmol of BuLi/5 mmol of HMPA and 1.0 g (5 mmol) of propargyl bromide into 0.75 g of **3m** by the same procedure as described for **2b**; *b.p.* 140–155 °C/0.01Torr. – IR (Neat): ν = 3250 cm^{-1} (Acetylenic H), 3000–2810 (CH), 2100 (C=C), 1750 (C=O), 1640 (C=N), 1560, 1450. – ^1H NMR ($CDCl_3$): δ/ppm = 0.81(t, *J*=7 Hz, 3H CH_3, C_2H_5), 1.71–2.60 (m, 10H, CH_2, C-4,5, CH2, C_2H_5, CH_2 and CH from propargyl), 2.50

(s, 6H, NMe_2). – MS (70 eV) *m/z* (%): 206 (6) [M^+], 205 (22), 172 (35), 167 (20), 162 (22) [$M^+ - NMe_2$], 160 (18), 134 (32), 124 (21), 77 (21), 65 (20), 45 (72), 44 (100) [NMe_2].
$C_{12}H_{18}N_2O$ calcd.: 206.141913
(206.1) found: 206.141925 (MS).

4-Methyl-3-(N,N',N'-trimethylhydrazino)cyclohex-2-en-1-one (**4a**)

a) 0.80 g (5 mmol) of **2a** was transformed by treatment with 10 mmol of BuLi/10 mmol of TMEDA and 1.42 g (10 mmol) of methyl iodide into 0.60 g of **4a** by the same procedure as described for **2b**; *b.p.*102–104 °C/0.01Torr. – IR (Neat): ν = 3010–2820 cm^{-1} (CH), 1620 (C=O), 1550, 1450, 1400. – ^1H NMR ($CDCl_3$): δ/ppm = 1.20 (d, J = 7 Hz, 3H, CH_3), 1.65–2.45 (m, 5H, CH, C-4, CH_2, C-5,6), 2.48 (s, 6H, NMe_2), 2.78 (s, 3H, NCH_3), 5.05 (s, 1H, olefinic H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 22.01 (C-6), 25.66 (C-5), 26.44 (C-4), 36.09 (C-6), 42.56 (NMe and NMe_2), 167.14 (C-3), 196.99 (C-2), 197.43 (C-1). – MS (70 eV) *m/z* (%): 182 (20) [M^+], 167 (100), 153 (10), 125 (30), 96 (43), 95 (21), 82 (40), 73 (88), 68 (28), 55 (30), 44 (26) [NMe_2].
$C_{10}H_{18}N_2O$ calcd.: C 65.89 H 9.95 N 15.36
(168.23) found: C 66.00 H 9.90 N 15.13.

b) 0.80 g (5 mmol) of **2a** was transformed by treatment with 10 mmol of BuLi and 1.42 g (10 mmol) of methyl iodide into 0.61 g of **4a** by the same procedure as described for **2b**.

c) 0.80 g (5 mmol) of **2a** was transformed by treatment with 11 mmol of KDA and 1.42 g (10 mmol) of methyl iodide into 0.63 g of **4a** by the same procedure as described for **2b**.

4-Methyl-3-(N,N',N'-trimethylhydrazino)cyclopent-2-en-1-one (**4b**)

a) 0.70 g (5 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi and 1.42 g (10 mmol) of methyl iodide into 0.50 g of **4b** by the same procedure as described for **2b**. The product was purified by column chromatography (silica gel, diethylether). – IR (Neat): ν = 3010–2780 cm^{-1} (CH), 1650 (C=O), 1590, 1560, 1420. – ^1H NMR ($CDCl_3$): δ/ppm = 1.25 (d, J = 7Hz, 3H, CH_3), 1.70–2.20 (m, 3H, CH_2, C-5, CH, C-4), 2.50 (s, 6H, NMe_2), 2.85 (s, 3H, NCH_3), 4.78 (s, H, olefinic H). –MS (70 eV) *m/z* (%): 168 (80) [M^+], 153 (10) [$M^+ - CH_3$], 138 (7), 125 (35), 124 (35), 110 (30), 97 (40), 69 (25), 55 (70), 44 (60) [NMe_2], 43 (25). HR of M^+: calcd. for $C_9H_{18}N_2O$: 168.1260 found: 168.1260.
$C_9H_{18}N_2O$ calcd.: C 64.25 H 9.58 N 16.65
(168.23) found: C 63.96 H 9.72 N 16.42.

b) 0.70 g (5 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi/10 mmol of TMEDA and 1.42 g (10 mmol) of methyl iodide into 0.55 g of **4b** by the same procedure as described for **2b**.

c) 0.70 g (5 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi/40 mmol of TMEDA and 1.42 g (10 mmol) of methyl iodide into 0.61 g of **4b** by the same procedure as described for **2b**.

d) 0.70 g (5 mmol) of **2d** was transformed by treatment with 11 mmol KDA and 1.42 g (10 mmol) of methyl iodide into 0.58 g of **4b** by the same procedure as described for **2b**.

e) 0.70 g (5 mmol) of **2d** was transformed by treatment with 10 mmol *s*-BuLi and 1.42 g (10 mmol) of methyl iodide into 0.53 g of **4b** by the same procedure as described for **2b**.

2,4-Dimethyl-3-(N,N',N'-trimethylhydrazino)cyclopent-2-ene-1-one (**4c**)

a) 0.80 g (5 mmol) of **2e** was transformed by treatment with 10 mmol of BuLi and 1.42 g (10 mmol) of methyl iodide into 0.55 g of **4c** by the same procedure as described for **2b**. The product was purified by column chromatography (silica gel, diethylether); *b.p.* 150–160 °C/0.01Torr. – IR (Neat): ν = 3000–2880 cm^{-1} (CH), 1650 (C=O), 1560, 1460, 1420. – ^1H NMR ($CDCl_3$): δ/ppm = 1.15 (d, J = 7 Hz, 3H, C-4, CH_3), 1.82 (s, 3H, C-2, CH_3), 1.65–2.45 (m, 3H, CH_2, C-5, CH, C-4), 2.50 (s, 6H, NMe_2), 3.05 (s, 3H, NCH_3). – MS (70 eV) *m/z* (%): 182 (100) [M^+], 167 (15) [M^+ CH_3], 139 (30), 138 (72) [$M^+ - NMe_2$], 126 (30), 134 (20), 111 (15), 96 (65), 84 (30), 82 (35), 73 (30), 68 (32), 67 (50),44 (70) [NMe_2], 43 (60), 42 (70).
$C_{10}H_{18}N_2O$ calcd.: C 65.90 H 9.95 N 15.36
(182.16) found: C 66.01 H 9.84 N 15.00.

b) 0.80 g (5 mmol) of **2e** was transformed by treatment with 10 mmol of BuLi/40 mmol TMEDA and 1.42 g (10 mmol) of methyl iodide into 0.61 g of **4c** by the same procedure as described for **2b**.

c) 0.80 g (5 mmol) of **2e** was transformed by treatment with 10 mmol of *t*-BuLi and 1.42 g (10 mmol) of methyl iodide into 0.64 g of **4c** by the same procedure as described for **2b**.

d) 0.80 g (5 mmol) of **2e** was transformed by treatment with 10 mmol of KDA and 1.42 g (10 mmol) of methyl iodide into 0.67 g of **4c** by the same procedure as described for **2b**.

4,5-Dimethyl-3-(N,N',N'-trimethylhydrazino)cyclopent-2- en-1-one (**5a**)

a) 0.70 g (5 mmol) of **2d** was dissolved in 20 ml of THF and the solution cooled to – 100 °C. To this solution 15 mmol of HMPA and 18 mmol of *s*-BuLi was added. To complete the methylation the reaction mixture was stirred at – 100 °C for 30 min. To this mixture was given 2.13 g (15 mmol) of methyl iodide and stirred at this temperature for 30 min. then quenched with saturated NH_4Cl solution. The mixture was extracted with 30 ml of diethyl ether, washed with brine and dried over $MgSO_4$. Evaporation of solvent gave brown oil. Purification by distillation and chromatography (PTLC; silica gel, diethyl ether) yielded 0.56 g (61%) of **5a** as a yellow oil; *b.p.* 160–162 °C/0.02 Torr. – IR (Neat): ν = 2990–2780 cm^{-1} (CH), 1600 (C=O), 1570 (C=C), 1460, 1400. – ^1H NMR ($CDCl_3$): δ/ppm = 1.15 and 1.30 (2d, J = 7 Hz, 2 CH_3), 1.65–2.10 (m, 2H, CH, C-4,5), 2.50 (s, 6H, NMe_2), 2.85 (s, 3H, NMe), 4.78 (s, 1H, olef. H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 21.33 (C-6), 27.77 (C-7), 33.92 (C-4), 43.17 (C-5), 43.37 (NMe), 43.66 (NMe_2), 98.33 (C-2), 182.71 (C-3), 202.88 (C-1). – MS (70 eV) *m/z* (%): 196 (10) [M^+], 167 (96) [$M^+ - CH_3$], 154 (6), 153 (18), 138 (15), 125 (25), 124 (22), 111 (10), 110 (18), 98 (25), 82 (100), 73 (20), 55 (40), 44 (30) [NMe_2].
$C_{10}H_{18}N_2O$ calcd.: C 65.89 H 9.95 N 15.30
(182.34) found: C 65.69 H 9.82 N 14.90.

b) 0.70 g (5 mmol) of **2d** was transformed by treatment with 18 mmol of *t*-BuLi/15 mmol of HMPA and 2.13 g (15 mmol) of methyl iodide into 0.57 g (63%) of **5a** by the same procedure as described before.

c) 0.70 g (5 mmol) of **2d** was transformed by treatment with 18 mmol of KDA and 2.13 g (15 mmol) of methyl iodide into

0.55 g (60%) of **5a** by the same procedure as described before.

2,4,5-Trimethyl-3-(N,N',N'-trimethylhydrazino)cyclopent-2-en-1-one (**5b**)

0.80 g (5 mmol) of **2e** was transformed by treatment with 18 mmol of *t*-BuLi/15 mmol of HMPA and 2.13 g (15 mmol) of methyl iodide into 0.57 g (59%) of **5b** by the same procedure as described for **5a**; *b.p.* 152–154 °C/0.01 Torr. – IR (Neat): ν = 3000–2780 cm^{-1} (CH), 1610 (C=O), 1580 (C=C), 1560, 1460. – ^1H NMR ($CDCl_3$): δ/ppm = 1.14 and 1.38 (2d, J = 7Hz, 6H, $2CH_3$), 1.60 (s, 3H, CH_3),1.70–2.05 (m, 2H, CH, C-4,5), 2.48 (s, 6H, NMe_2), 3.06 (s, 3H, NMe). – MS (70 eV) *m/z* (%): 196 (5) [M^+], 181 (88) [M^+-CH_3], 168 (30), 167 (20), 139 (45), 130 (100), 126 (15), 125 (16), 124 (42), 110 (20), 96 (45), 84 (25), 81 (22), 73 (17), 69 (26), 67 (36), 45 (62), 44 (72) [NMe_2], 42 (55).

$C_{11}H_{20}N_2O$ calcd.: C 67.31 H 10.27 N 14.27
(196.29) found: C 67.59 H 10.41 N 14.11.

4,4,5-Trimethyl-3-(N,N',N'-trimethylhydrazino)cyclopent-2-en-1-one (**5c**)

a) 0.70 g (5 mmol) of **2d** was dissolved in 20 ml of THF and the solution cooled to – 100 °C. To this solution 21 mmol of HMPA and 21 mmol of *t*- BuLi was added. The reaction mixture was stirred at – 100 °C for 45 min. To this mixture was given 2.84 g (20 mmol) of methyl iodide and stirred at this temperature for 20 min. The product was purified by the procedure described for **5a** yielding 0.5 g (51%) of a yellow oil; *b.p.* 170–172 °C/0.01 Torr. – IR (Neat): ν = 3020–2800 cm^{-1} (CH), 1610 (C=O), 1580 (C=C), 1560, 1470. – ^1H NMR ($CDCl_3$): δ/ppm = 0.98 (s, 3H, CH_3), 1.11 (s, 3H, CH_3), 1.45 (d, J = 7Hz, 3H, CH_3), 2.15 (m, 1H, CH, C-5), 2.50 (s, 6H, NMe_2), 2.88 (s, 3H, NMe), 4.82 (s, 1H, olef. H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 17.70 and 18.09 (2 C-4, CH_3), 27.60 (C-4), 28.12 (C-5, CH_3), 42.62 (C-5), 43.14 (NMe) 43.34 (NMe_2), 101.53 (C-2), 181.26 (C-3), 206.31 (C-1). – MS (70 eV) *m/z* (%): 196 (8) [M^+], 182 (34), 168 (43), 153 (18), 139 (30), 138 (38), 125 (31), 124 (37), 110 (21), 97 (22), 96 (21), 82 (100), 69 (35), 56 (45), 44 (40) [NMe_2], 42 (48).

$C_{11}H_{20}N_2O$ calcd.: 196.1576
(196.1) found: 196.1608 (MS).

b) 0.70 g (5 mmol) of **2d** was transformed by treatment with 21 mmol of KDA and 2.84 g (20 mmol) of methyl iodide into 0.52 g (53%) of **5c** by the same procedure as described for **5a**.

4-Methylcyclopentane-1,3-dione-dimethylhydrazone (**6a**)

a) 0.70 g (5 mmol) of **2d** was transformed by treatment with 10 mmol of BuLi and 0.71 g (5 mmol) of methyl iodide into 0.43 g (56%) of **6a** by the same procedure as described for **4a**; yellow oil, purified by column chromatography (silica gel, ether). – IR (Neat): ν = 3200 cm^{-1} (NH), 3000–2800 (CH), 1660 (C=O), 1580 (C=C). – ^1H NMR ($CDCl_3$): δ/ppm = 1.12 (d, 6.8 Hz, 3H, CH_3), 2.28–2.46 (m, 3H, CH_2, C-5, CH, C-4), 2.68 (s, 6H, NMe_2), 5.38 (s, 1H, olef. H), 6.83 (s, 1H, NH). – ^{13}C NMR ($CDCl_3$): δ/ppm = 21.33 (CH_3), 26.11 (C-5), 31.92 (C-4), 43.66 (NMe_2), 98.38 (C-2), 181.12 (C-3), 202.12 (C-1).

$C_{18}H_{14}N_2O$ calcd.: C 62.31 H 9.15 N 18.17
(154.21) found: C 62.63 H 9.28 N 18.43.

b) 0.70 g (5 mmol) of **2d** was transformed by treatment with 20 mmol of *t*-BuLi/20 mmol of HMPA and 0.71 g (15 mmol) of methyl iodide into 0.39 g (51%) of **6a** by the same procedure as described for **5c**.

5-Methylcyclopentane-1,3-dione-dimethylhydrazone (**6b**)

0.70 g (5 mmol) of **2d** was transformed by treatment with 15 mmol of *t*-BuLi/15 mmol of HMPA and 0.71 g (5 mmol) of methyl iodide into 0.45 g (58%) of **6b** by the same procedure as described for **5a**; yellow oil, purified by column chromatography (silica gel, ether). – IR (Neat): ν = 3200 cm^{-1} (NH), 3010–2850 (CH), 1650 (C=O), 1580 (C=C). – ^1H NMR ($CDCl_3$): δ/ppm = 1.21 (d, 7 Hz, 3H, CH_3), 2.24–2.52 (m, 3H, CH_2, C-4, CH, C-5), 2.71 (s, 6H, NMe_2), 5.41 (s, 1H, ole. H), 6.86 (s,1H, NH). – ^{13}C NMR ($CDCl_3$): δ/ppm = 22.82 (CH_3), 25.96 (C-4), 41.22 (C-5), 43.78 (NMe_2), 96.78 (C-2), 182.21(C-3), 202.22 (C-1).

$C_8H_{14}N_2O$ calcd.: C 62.31 H 9.15 N 18.17
(154.21) found: C 62.13 H 9.26 N 17.93.

4,5-Dimethylcyclopentane-1,3-dione-dimethylhydrazone (**6c**)

0.70 g (5 mmol) of **2d** was transformed by treatment with 15 mmol of *t*-BuLi/15 mmol of HMPA and 1.42 g (10 mmol) of methyl iodide into 0.42 g (51%) of **6c** by the same procedure as described for **6b**; yellow oil purified by column chromatography (silica gel, ether). – IR (Neat): ν = 3180 cm^{-1} (NH), 3000–2800 (CH), 1660 (C=O), 1570 (C=C). – ^1H NMR ($CDCl_3$): δ/ppm = 1.06–1.29 (m, 6H, $2CH_3$), 1.63–2.05 (m, 2H, CH, C-4,5), 2.53 (s, 6H, NMe_2), 5.43 (s, 1H, olef. H), 6.62 (s, 1H, NH). – ^{13}C NMR ($CDCl_3$): δ/ppm = 21.38 (C-4, CH_3), 22.63 (C-5, CH_3), 33.15 (C-4), 40.82 (C-5), 44.01 (NMe_2), 96.11 (C-2), 182.26 (C-3), 202.22 (C-1).

$C_9H_{16}N_2O$ calcd.: C 64.24 H 9.59 N 16.66
(168.12) found: C 64.47 H 9.66 N 16.32.

Cleavage of Hydrazones to form Ketones (General Procedure)

Method 1 ("Salt Method"). 1 Equivalent of hydrazone is dissolved in 5 equivalent of methyl iodide and the solution is heated to 60 °C. After 20–48 h the reaction is completed (TLC control), and excess methyl iodide is removed *in vacuo*. The remaining brown oil is dissolved in 3–4 n HCl (50 ml/10 mmol) and stirred for 5 min at room temperature. Pentane (200 ml/10 mmol) is then added and the two phase system is vigorously stirred for 10 min. The organic layer is separated, washed with a few ml of $NaHSO_3$ solution and pH 7-buffer solution, and dried over Na_2SO_4. The solvent is removed and the crude product is purified by distillation or flash chromatography.

Method 2 (Ozonolysis). 1 Equivalent of hydrazone is dissolved in CH_2Cl_2 (30 ml/10 mmol) and cooled to –78 °C. A gentle stream of O_3 is flashed through the solution. The color of the solution turns green to blue (indicating excess O_3) when the reaction has run to completion. Argon is then flashed through the solution as it warms up to room temperature. The solution is concentrated *in vacuo*, and the ketone is separated by either distillation or flash chromatography.

Method 3 ("Acid Method"). 1 Equivalent of hydrazone is refluxed in 6N HCl (25 ml/10 mmol) or in conc. HBr and refluxed for 3–10 h. The mixture cooled to room temperature.

CH_2Cl_2 (150 ml/10 mmol) is then added and the two phase system is stirred for 30 min. The organic layer is separated, washed with a few ml of $NaHSO_3$ solution and pH 7-buffer solution, and dried over Na_2SO_4. The solvent is removed and the crude product is purified by distillation or flash chromatography.

2-Methylcyclohexane-1,3-dione (**1b**)

According to the general procedure (salt method) 0.84 g (5 mmol) of **2b** was refluxed with methyl iodide and cleaved with 6n HCl. Yield: 0.43g (68%). The commercial available product is isolated as colorless solid.

2-Methylcyclopentane-1,3-dione (**1e**)

1.54 g (10 mmol) of **2e** was refluxed with methyl iodide and cleaved with 6n HCl according to the general procedure (salt method), yielding 0.80g (71%) as a colorless solid.

2-Ethylcyclopentane-1,3-dione (**1f**)

0.84 g (5 mmol) of **2f** was cleaved with 6N HCl according to the general procedure (acid method), yielding 0.45 g (72%) of a colorless solid.

2-Ethylcyclohexane-1,3-dione (**7a**)

0.91 g (5 mmol) of **3a** was cleaved with 6N HCl according to the general procedure (acid method), yielding 0.44 g (63%) of a colorless solid [7, 21].

2-(1-Propyn-3-yl)cyclohexane-1,3-dione (**7b**)

0.48 g (2.5 mmol) of **3b** was cleaved with 6N HCl according to the general procedure (acid method), yielding 0.24 g (66%) of a colorless solid (*m.p.* 180–183 °C) [22].

2-Benzylcyclohexane-1,3-dione (**7c**)

0.61 g (2.5 mmol) of **3c** was cleaved with 6N HCl according to the general procedure (acid method), yielding 0.36 g (72%) of a colorless solid (*m.p.* 182–183 °C) [23].

2,2-Dimethylcyclohexane-1,3-dione (**7d**)

0.91 g (5 mmol) of **3f** was oxidatively cleaved with ozone according to the general procedure, yielding 0.47 g (68%) of a colorless solid (*m.p.* 38–39 °C) [24].

2-Ethyl-2-methylcyclohexane-1,3-dione (**7e**)

0.20 g (1 mmol) of **3g** was oxidatively cleaved with ozone according to the general procedure, yielding 0.15 g (98%) of a colorless oil [25].

2-Methyl-2-(1-propyn-3-yl)cyclohexane-1,3-dione (**7f**)

0.20 g (1 mmol) of **3h** was refluxed with methyl iodide and cleaved with 6n HCl according to the general procedure (salt method). Reduced pressure distillation yielded 0.15 g (66%) of a colorless oil; *b.p.* 108–110 °C/1 Torr [26].

2-Benzyl-2-methylcyclohexane-1,3-dione (**7g**)

0.64 g (2.5 mmol) of **3j** was refluxed with methyl iodide and cleaved with 6n HCl according to the general procedure (salt method) yielding 0.44 g (82%) of a colorless solid [7].

2-Ethyl-2-methylcyclopentane-1,3-dione (**7h**)

0.91 g (5 mmol) of **3k** was oxidatively cleaved with ozone according to the general procedure, yielding 0.53 g (77%) of a colorless oil [25].

2-Methyl-2-(1-propyn-3-yl)cyclopentane-1,3-dione (**7i**)

0.48 g (2.5 mmol) of **3l** was refluxed with methyl iodide and cleaved with 6N HCl according to the general procedure (salt method), yielding 0.30 g (81%) of a colorless oil [27].

4-Methylcyclohexane-1,3-dione (**7j**)

According to the general procedure (acid method) 1.05 g (5 mmol) of **4a** was cleaved with conc. HBr (5h). Yield 0.38 g (62%). Colorless oil; *b.p.* 138–142 °C/2 Torr [28].

4-Methylcyclopentane-1,3-dione (**7k**)

According to the general procedure (acid method) 0.84 g (5 mmol) of **4b** was cleaved with conc. HBr (4h). The purification of the crude product by flash column chromatography (silica gel, EtOAc/hexane: 1:3) yielded 0.31 g (58%) of a colorless oil. – IR (neat): υ = 3400 (OH) cm^{-1}, 3020–2870 (CH), 1700 (CO), 1620–1550, 1460; – ^1H NMR ($CDCl_3$): δ/ppm = 1.25 (d, J = 6Hz, 3H, CH_3), 2.35–3.05 (m, 3H,CH_2, C-5, CH, C-4), 5.35 (s, 1H, olef.-H), 9.62 (s, 1H, OH); – MS (70eV) *m/z* (%): 112 (38) [M^+], 98 (85), 97 (47), 84 (30), 83 (38), 70 (30), 69 (45), 67 (38), 56 (64), 55 (45), 43 (55), 42 (82), 41 (100) [*b.p.*].

$C_6H_8O_2$	calcd.:	C 64.26	H 7.19
(112.1)	found:	C 64.52	H 7.22.

2,4-Dimethylcyclopentane-1,3-dione (**7l**)

According to the general procedure (acid method) 0.91 g (5 mmol) of **4c** was cleaved with conc. HBr (6h). The purification of the crude product by flash column chromatography (silica gel, EtOAc/hexane: 1:3) yielded 0.32 g (52%) of a colorless oil. IR (neat): υ = 3400 (OH) cm^{-1}, 2980–2840 (CH), 1690 (CO), 1600 (C=C), 1550, 1530; – ^1H NMR ($CDCl_3$): δ/ppm = 0.95–1.25 (m, 3H, C-4, CH_3), 1.55 (s, 3H, C-2, CH_3), 1.70–2.20 (m, 4H, C-5, CH_2, C-2, 4CH); – MS (70 eV) *m/z* (%): 126 (80) [M^+], 125 (35), 98 (10), 97 (32), 83 (60), 69 (45), 56 (50), 55 (42), 42 (52), 41 (100), [*b.p.*].

$C_7H_{10}O_2$	calcd.:	C 66.68	H 7.99
(126.1)	found:	C 66.71	H 8.13.

4,5-Dimethylcyclopentane-1,3-dione (**7m**)

According to the general procedure (acid method) 0.91 g (5 mmol) of **5a** was cleaved with conc. HBr (7h). The purification of crude product by flash column chromatography (silica gel, EtOAc/hexane: 1:4) yielded 0.39 g (63%) of a yellow oil [29].

4,4,5-Trimethylcyclopentane-1,3-dione (**7n**)

According to the general procedure (acid method) 1.0 g (5 mmol) of **5c** was cleaved with conc. HBr (7h). The purification of crude product by flash column chromatography (silica gel, EtOAc/hexane: 1:4) yielded 0.29 g (43%) of a yellow oil; *b.p.* 145–150 °C/10^{-3} Torr (kugelrohr). – IR (neat): ν = 2980–2840 (CH) cm^{-1}, 1690 (CO), 1590, 1460, 1370; – ^1H NMR ($CDCl_3$): δ/ppm = 1.11 and 1.15 (2s, 6H, $2CH_3$), 1.25 (d, J = 7Hz, 3H, CH_3), 2.18 (m, 1H, CH), 3.12 (m, 2H, CH_2). – MS (70 eV) *m/z* (%): 140 (10) [M^+], 139 (15), 137 (20), 133 (17), 125 (18), 123 (17), 111 (23), 109 (21), 97 (30), 85 (37), 83 (34), 71 (50), 69 (45), 57 (100) [*b.p.*], 43 (40).

$C_8H_{12}O_2$	calcd.:	C 68.54	H 8.62
(140.2)	found:	C 68.14	H 8.86.

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Address for correspondence:
Prof. Dr. Ayhan S. Demir
Department of Chemistry
Middle East Technical University
06531 Ankara, Turkey