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Abstract: A simple procedure is reported for the stereoselective debromination of *vic*-dibromides with nickel boride at ambient temperature. Debromination with concomitant reduction of *vic*-dibromides to give dihydro products in a one-pot reaction is also reported. α , β -Dibromoketones can also be converted to their corresponding alcohols.

Key words: debromination, vic-dibromides, stereoselective, reduction, E-alkenes.

Résumé : On a mis au point une méthode simple de débromuration stéréosélective de dibromures *vicinaux* impliquant l'utilisation du borure de nickel à la température ambiante. On rapporte aussi la réaction monotope de débromuration avec réduction concomitante des dibromures *vicinaux* qui conduit à la formation des produits dihydrogénés. On peut aussi transformer les α , β -dibromocétones en alcools correspondants.

Mots clés : débromuration, dibromures vicinaux, stéréosélective, réduction, E-alcènes.

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Introduction

The protection-deprotection of olefins via bromination and debromination (1) has been studied and different reagents and reaction conditions exist for debrominating *vic*dibromides (2–9). Solvolytic stereoselective debromination has also been reported by DMF (10) and HMPA (11) without the aid of any reagents. The efficiency of a reagent greatly depends upon its selectivity and compatibility with other functionalities present in the substrate. Nickel boride is a versatile reducing agent reported to bring about a number of transformations, e.g., reduction, deoxygenation, desulfurization (12). It is known to behave differently under different reaction conditions and therefore we decided to explore its application for the debromination and (or) reduction of *vic*dibromides.

Results and discussion

This is the first report on (i) stereoselective debromination of *vic*-dibromides to olefins and (ii) debromination with concomitant reduction of *vic*-dibromides in a one-pot reaction with nickel boride by changing the stoichiometric ratios and the solvent. Chalcone dibromides (benzylideneacetophenone dibromides/benzalacetophenone dibromides) also undergo chemoselective debromination to chalcones or undergo debromination with concomitant reduction to selectively give either dihydrochalcones or tetrahydrochalcones in methanol in one-pot reactions by changing the stoichiometric ratios.

A variety of stilbene dibromides and other *vic*-dibromides (Table 1, runs 1-16), soluble in tetrahydrofuran, undergo

quantitative debromination with nickel boride generated in situ from nickel chloride and sodium borohydride using a molar ratio of 1:2:6 (substrate-NiCl₂-NaBH₄) in THF to give the corresponding alkenes (eq. [1]). The reactions were complete in 30-120 min at ambient temperature as monitored by TLC. Chalcone dibromides and other α,β -dibromoketones did not undergo complete debromination under these conditions. Smooth debromination of different chalcone dibromides and other α,β -dibromoketones, which were soluble in methanol, was successfully achieved to afford the corresponding chalcones or enones (Table 2, runs 17-28) in quantitative yields using a molar ratio of 1:5:2 (substrate-NiCl₂-NaBH₄) in methanol at ambient temperature for 15-60 min (eq. [1]). The carbonyl, carboxylic, carbmethoxy, highly sensitive furan and benzopyrone rings remained unaffected under these conditions. Even steroidal derivatives could be readily debrominated. The debrominations are stereoselective as (E)-stilbene was obtained from meso- and dlstilbene dibromides, and fumaric acid was obtained from *meso-* and $dl - \alpha, \beta$ -dibromosuccinic acids. The possibility of any isomerization of (Z)-stilbene to (E)-stilbene or maleic acid to fumaric acid has been ruled out by independent reactions of (Z)-stilbene and maleic acid with nickel boride under identical conditions. The debrominations were undoubtedly due to the involvement of nickel boride generated in situ as starting meso-stilbene dibromide was recovered unchanged when treated with nickel chloride or sodium borohydride separately.

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[1] \frac{\text{RCHBr-CHBrR'}}{\text{Ia-Iq, IIIa-IIIk}} \xrightarrow{\text{NiCl}_2, \text{ NaBH}_4} \xrightarrow{\text{RCH} = \text{CHR'}} \text{RCH} = \text{CHR'}
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Run	Substrate	Time (min)	Isolated yield (II) (%)
1	<i>meso</i> -C ₆ H ₅ CHBrCHBrC ₆ H ₅ (Ia)	30	96
2	dl-C ₆ H ₅ CHBrCHBrC ₆ H ₅ (Ib)	40	94
3	<i>meso</i> -4-CH ₃ C ₆ H ₄ CHBrCHBrC ₆ H ₅ (Ic)	40	89
4	$meso-4-ClC_6H_4CHBrCHBrC_6H_5$ (Id)	40	88
5	<i>meso</i> -4-ClC ₆ H ₄ CHBrCHBrC ₆ H ₄ Cl-4 (Ie)	120	87
6	<i>meso</i> -4-OCH ₃ C ₆ H ₄ CHBrCHBrC ₆ H ₅ (If)	40	76
7	C ₆ H ₅ CHBrCHBrCOOH (Ig)	40	96
8	C ₆ H ₅ CHBrCHBrCOOCH ₃ (Ih)	60	84
9	meso-COOHCHBrCHBrCOOH (Ii)	45	89
10	dl-COOHCHBrCHBrCOOH (Ij)	60	90
11	$CH_2BrCHBr(CH_2)_3CH_3$ (Ik)	60	80
12	trans-CH ₂ BrCHBr(CH ₂) ₅ CH ₂ (II)	60	90
13	<i>trans</i> - $\overline{CH_2BrCHBr(CH_2)_3CH_2}$ (Im)	30	75
14	threo-CH ₃ (CH ₂) ₇ CHBrCHBr(CH ₂) ₇ COOH (In)	60	90
15	<i>threo</i> -CH ₃ (CH ₂) ₇ CHBrCHBr(CH ₂) ₇ COOCH ₃ (Io)	45	88
16	CH ₃ CHBrCHBrCOOCH ₃ (Ip)	35	90

Table 1. Debromination of vic-dibromides with nickel boride in THF at ambient temperature.

Note: Seventy-five millilitres of solvent were used per gram of substrate. Molar ratio is 1:2:6 (substrate-NiCl₂-NaBH₄).

Table 2. Debromination of chalcone dibromides and α,β -dibromoketones with nickel boride in MeOH at ambient temperature.

Run	Substrate	Time (min)	Isolated yield (IV) (%)
17	C ₆ H ₅ COCHBrCHBrC ₆ H ₅ (IIIa)	45	90
18	4-CH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₅ (IIIb)	35	88
19	4-ClC ₆ H ₄ CHBrCHBrCOC ₆ H ₅ (IIIc)	20	90
20	4-ClC ₆ H ₄ COCHBrCHBrC ₆ H ₄ Cl-4 (IIId)	15	92
21	4-OCH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₄ CH ₃ O-4 (IIIe)	25	88
22	4-BrC ₆ H ₄ CHBrCHBr COC ₆ H ₅ (IIIf)	40	90
23	C ₆ H ₅ CHBrCHBrCOCH ₃ (IIIg)	30	90
24	o Br Br	60	69
25	HO Br Br	20	92
26	CH(Br)CH(Br)COCH ₃ (IIIi)	45	88
27	Br Br Br O O O O	15	90
28	C ₆ H ₅ CHBrCHBrCOCHBrCHBrC ₆ H ₅ (IIIk)	35	85

Note: Thirty millilitres of methanol were used per gram of substrate. Molar ratio is 1:5:2 (substrate-NiCl₂-NaBH₄).

Run	Substrate	Time (min)	Isolated yield (V) (%)
29	$meso-C_6H_5CHBrCHBrC_6H_5$ (Ia)	10	92
30	dl-C ₆ H ₅ CHBrCHBrC ₆ H ₅ (Ib)	15	94
31	<i>meso</i> -4-CH ₃ C ₆ H ₄ CHBrCHBrC ₆ H ₅ (Ic)	15	90
32	<i>meso</i> -4-ClC ₆ H ₄ CHBrCHBrC ₆ H ₅ (Id)	10	94
33	<i>meso</i> -4-ClC ₆ H ₄ CHBrCHBrC ₆ H ₄ Cl-4 (Ie)	40	83
34	<i>meso</i> -4-OCH ₃ C ₆ H ₄ CHBrCHBrC ₆ H ₅ (If)	25	85
35	C ₆ H ₅ CHBrCHBrCOOH (Ig)	15	92
36	$C_6H_5CHBrCHBrCOOCH_3$ (Ih)	10	82
37	meso-COOHCHBrCHBrCOOH (Ii)	20	77
38	$CH_2BrCHBr(CH_2)_3CH_3$ (Ik)	15	85
39	trans-CH ₂ BrCHBr(CH ₂) ₅ CH ₂ (II)	15	85
40	trans- $\overline{CH_2BrCHBr(CH_2)_5CH_2}$ (Im)	20	86
41	<i>threo</i> -CH ₃ (CH ₂) ₇ CHBrCHBr(CH ₂) ₇ COOH (In)	15	88
42	<i>threo</i> -CH ₃ (CH ₂) ₇ CHBrCHBr(CH ₂) ₇ COOCH ₃ (Io)	15	91
43	CH ₃ CHBrCHBrCOOCH ₃ (Ip)	15	81
44	HO Br Br	15	85

Note: Fifty millilitres of solvent were used per gram of substrate. Molar ratio is 1:3:9 (substrate-NiCl₂-NaBH₄)

We also report herein the debromination with concomitant reduction of vic-dibromides with nickel boride generated in situ. Since the activity, selectivity, and the physical and chemical properties of nickel boride depend on its method of preparation, and the amount of H_2 adsorbed in the crystal lattice of nickel boride depends upon the metal-boron ratio (12), the stoichiometric ratios of substrate–NiCl₂–NaBH₄ were varied to achieve the goal. vic-Dibromides (Ia-Ii, Ik-Iq) can be debrominated and reduced concomitantly in a one-pot reaction with nickel boride using a molar ratio of 1:3:9 in methanol to give the corresponding reduced product (Table 3, runs 29-44) in high yields (eq. [2]). Reactions of meso- and dl-stilbene dibromides using molar ratios of 1:2:6 or 1:1:3 of substrate - nickel chloride - sodium borohydride in methanol resulted in the formation of a mixture of (E)stilbene and bibenzyl, implying that the reductions must be proceeding via the corresponding alkenes. The acid and ester groups were unaffected under these conditions.

$$[2] \qquad \begin{array}{c} \text{RCHBr-CHBrR'} \\ \textbf{Ia-Ii, Ik-Iq} \end{array} \xrightarrow[\text{MiCl}_2, \text{ NaBH}_4]{} \qquad \begin{array}{c} \text{RCH}_2\text{CH}_2\text{R'} \\ \textbf{MeOH, rt} \end{array} \xrightarrow[\text{Wa-Vi, Vk-Vq}]{} \\ \end{array}$$

Chalcone dibromides and other $\alpha_s\beta$ -dibromoketones gave corresponding alcohols (eq. [3]) rather than ketones under these conditions (Table 4, runs 45–53). Reactions of chalcone dibromide using molar ratios of 1:1:3 or 1:2:6 were incomplete and showed the presence of chalcone, dihydrochalcone, and tetrahydrochalcone. Selective debromination and reduction of the double bond could not be achieved under these conditions without affecting the carbonyl group. However, selective debromination was achieved using a molar ratio of 1:10:15 (substrate–NiCl₂–NaBH₄). High yields of dihydrochalcones were obtained under these conditions in methanol at ambient temperature (eq. [4]) (Table 5, runs 54–58). *p*-Bromochalcone dibromide (**IIIf**) also underwent competitive aryl debromination under these conditions.

$$[3] \qquad \bigcup_{\substack{\text{III} \text{A}-\text{III}e, \text{III}g-\text{III}j}}^{\text{OI}} \qquad \bigcup_{\substack{\text{NiCl}_2, \text{NaBH}_4 \\ \text{MeOH, rt}}}^{\text{NiCl}_2, \text{NaBH}_4} \qquad \bigcup_{\substack{\text{I} \\ \text{RCH}_2\text{CH}_2\text{-CH-R'} \\ \text{VIa-VIe, VIg-VIj}}}^{\text{OH}}$$

$$[4] \qquad \underset{\text{IIIa-IIIe}}{\overset{\text{OI}}{\text{IIIa-IIIe}}} \qquad \bigcup_{\substack{\text{NiCl}_2, \text{NaBH}_4 \\ \text{MeOH, rt}}}^{\text{OI}} \qquad \underset{\text{RCH}_2\text{CH}_2\text{-C-R'}}{\overset{\text{OI}}{\text{IIIa-VIe}}}$$

We conclude that nickel boride is an efficient and versatile reagent for debromination of *vic*-dibromides to the corresponding (*E*)-olefins and for debromination with concomitant reduction to give dihydro products at ambient temperature. Chalcone dibromides and other α , β -dibromoketones undergo debromination with complete reduction to give alcohols or undergo debromination with selective reduction to give dihydrochalcones.

Experimental

General procedure for reactions of stilbene dibromides with NiCl₂ and NaBH₄ (molar ratio 1:2:6, Table 1) in THF

In a typical general procedure, *meso*-stilbene dibromide (1 g, 2.94 mmol) was dissolved in THF (75 mL) in a 250 mL round-bottomed flask mounted over a magnetic stir-

Run	Substrate	Time (min)	Isolated yield (VI) (%)
45	C ₆ H ₅ COCHBrCHBrC ₆ H ₅ (IIIa)	15	91
46	4-CH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₅ (IIIb)	5	80
47	4-ClC ₆ H ₄ CHBrCHBrCOC ₆ H ₅ (IIIc)	10	96
48	4-ClC ₆ H ₄ COCHBrCHBrC ₆ H ₄ Cl-4 (IIId)	10	83
49	4-OCH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₄ CH ₃ O-4 (IIIe)	10	78
50	C ₆ H ₅ CHBrCHBrCOCH ₃ (IIIg)	15	82
51	O Bringer (IIIh)	10	83
52	CH(Br)CH(Br)COCH ₃ (IIIi)	45	75
53	C ₆ H ₅ CHBrCHBrCOCHBrCHBrC ₆ H ₅ (IIIj)	45	75

Table 4. Reduction of chalcone dibromides and α,β -dibromoketones with nickel boride in MeOH to their tetrahydro derivatives at ambient temperature.

Note: Forty millilitres of methanol were used per gram of substrate. Molar ratio is 1:3:9 (substrate-NiCl₂-NaBH₄).

Table 5. Reduction of chalcone dibromides with nickel boride in MeOH to their dihydrochalcones at ambient temperature.

Run	Substrate	Time (min)	Isolated yield (VII) (%)
54	C ₆ H ₅ COCHBrCHBrC ₆ H ₅ (IIIa)	10	87
55	4-CH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₅ (IIIb)	10	86
56	4-ClC ₆ H ₄ CHBrCHBrCOC ₆ H ₅ (IIIc)	15	83
57	4-ClC ₆ H ₄ COCHBrCHBrC ₆ H ₄ Cl-4 (IIId)	15	79
58	4-OCH ₃ C ₆ H ₄ COCHBrCHBrC ₆ H ₄ CH ₃ O-4 (IIIe)	10	82
59	4-BrC ₆ H ₄ CHBrCHBrCOC ₆ H ₅ (IIIf)	—	a

Note: Forty millilitres of methanol were used per gram of substrate. Molar ratio is 1:10:15 (substrate–NiCl₂–NaBH₄). ^{*a*}A mixture of dihydrochalcone (56%) and *p*-bromodihydrochalcone (28%) was obtained.

rer. NiCl₂ (1.39 g, 5.88 mmol) was added followed by the addition of NaBH₄ (0.67 g, 17.64 mmol) while vigorously stirring the solution. The progress of the reaction was monitored by TLC using petroleum ether as eluent. The reaction was found to be complete in 30 min. The reaction mixture was filtered through a Celite pad (~1 in, 1 in = 25.4 mm) and washed with THF (2 × 10 mL). The combined filtrate was reduced to half and diluted with water (~150 mL). The product was extracted with ethyl acetate (3 × 15 mL). The combined extract was dried over anhydr. MgSO₄, filtered, and concentrated on a rotary evaporator to afford a white solid, which was identified as (*E*)-stilbene (0.5 g, 96%) with a mp of 112 °C (lit. value (13*a*) mp 114 °C) as demonstrated by the mixed mp, IR, and NMR spectra.

General procedure for reactions of chalcone dibromides with $NiCl_2$ and $NaBH_4$ (molar ratio 1:5:2, Table 2) in methanol

In a 100 mL round-bottomed flask mounted over a magnetic stirrer was placed a mixture of chalcone dibromide (1 g, 2.71 mmol), methanol (30 mL), and NiCl₂ (3.22 g, 13.55 mmol). NaBH₄ (0.206 g, 5.43 mmol) was added with

continuous stirring. Disappearance of starting material was monitored by TLC using petroleum ether – benzene (50:50) as eluent. The reaction was complete after 45 min. The reaction mixture was filtered through a Celite pad (~1 in) and washed with methanol (2 × 15 mL). The combined filtrate was diluted with water (~150 mL) and extracted with ethyl acetate (3 × 15 mL). The combined extract was dried over anhydr. MgSO₄, filtered, and concentrated on a rotary evaporator to yield chalcone (0.508 g, 90%), confirmed with a mp of 55 °C (lit. value (13*b*) mp 56–58 °C) as demonstrated by the mixed mp, IR, and NMR spectra.

Reactions of stilbene dibromides with NiCl₂ and NaBH₄ (molar ratio 1:3:9, Table 3) in methanol

A mixture of *meso*-stilbene dibromide (1 g, 2.94 mmol), methanol (50 mL), and NiCl₂ (2.090 g, 8.82 mmol) was placed in a 100 mL round-bottomed flask and fitted with a reflux condenser and a guard tube. NaBH₄ (1.005 g, 26.46 mmol) was carefully added with continuous stirring. The progress of the reaction was monitored using petroleum ether as an eluent. The starting material disappeared in 10 min. The reaction was worked up as in previous procedures. The product obtained was identified to be 1,2diphenylethane (0.48 g, 92%) by IR and NMR spectra.

Reactions of chalcone dibromides with $NiCl_2$ and $NaBH_4$ (molar ratio 1:3:9, Table 4) in methanol

Chalcone dibromide (1 g, 2.71 mmol), NiCl₂ (1.926 g, 13 mmol), and methanol (40) mL were placed in a 100 mL conical flask fitted with a condenser. The flask was mounted over a magnetic stirrer. Sodium borohydride (0.929 g, 24.39 mmol) was added very cautiously while vigorously stirring the solution. The progress of the reaction was monitored by TLC using petroleum ether – benzene (50:50) as eluent. The starting material disappeared after 15 min and then the reaction was worked up as in previous procedures. The product obtained was identified to be tetrahydrochalcone (0.50 g, 91%) by IR and NMR spectra.

Reaction of chalcone dibromide with NiCl₂ and NaBH₄ (molar ratio 1:10:15, Table 5) in methanol

Chalcone dibromide (1 g, 2.71 mmol), NiCl₂ (6.422 g, 27.1 mmol), and methanol (40 mL) were added to a 100 mL round-bottomed flask fitted with a reflux condenser. The reaction mixture was stirred at room temperature and NaBH₄ (1.54 g, 40.65 mmol) was added very cautiously. The progress of the reaction was monitored by TLC using petroleum ether – benzene (50:50) as eluent. The starting material disappeared completely after 30 min and the reaction was worked up as in previous procedures. Dihydrochalcone (0.49 g, 87%) was isolated and identified with a mp of 70 to 71 °C (lit. value (13c) mp 72–75 °C) as demonstrated by IR, and NMR spectra.

In the case of aliphatic and cyclic *vic*-dibromides, because of high solubility in water, the reaction mixture was filtered through a Celite pad and washed with methanol or THF ($2 \times$ 15 mL). The combined extract was dried over anhydr. MgSO₄, filtered, and concentrated on a rotary evaporator. The product was extracted by triturating with dry ether.

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References

- M.B. Smith and J. March. Advanced organic chemistry: Reactions, mechanisms, and structures. 5th ed. McGraw Hill International, New York. 1996. p. 1343, and refs. citied therein.
- (a) R.C. Larock. Comprehensive organic transformations. 2nd ed. Wiley-VCH, New York. 1999. p. 259; (b) J. Vadecard, J.-C. Plaquevent, L. Duhamel, P. Duhamel, and L. Toupet. J. Org. Chem. 59, 2285 (1994); (c) V. Montanari and D.D. DesMarteau. J. Org. Chem. 57, 5018 (1992).
- 3. T. Norris, C. Dowdeswell, N. Johnson, and D. Daia. Org. Process Res. Dev. 9, 792 (2005), and refs. cited therein.
- D.A. Jackson, A. Edmunds, M.C. Bowden, and B. Brockbank. PCT Int. Appl. 143 459792 (2005).
- 5. B.C. Ranu and R. Jana. J. Org. Chem. 70, 8621(2005).
- 6. A. Marfat. US Patent 4 761 485, 2 August 1988.
- P.-H. Li, W.-P. Rao, M. Wang, and L. Wang. Chem. Res. Chin. Univ. 20, 598 (2004).
- 8. B.C. Ranu, S. Guchhait, and A. Sarkar. Chem. Commun. (Cambridge), **19**, 2113 (1998).
- 9. T.S. Butcher and M.R. Detty. J. Org. Chem. 63, 177 (1998).
- (a) J.M. Khurana and G.C. Maikap. J. Org. Chem. 56, 2582 (1991); (b) J.M. Khurana, G.C. Maikap, and P.K. Sahoo. Synthesis, 827 (1991).
- J.M. Khurana, G. Bansal, and S. Chauhan. Bull. Chem. Soc. Jpn. 74, 1089 (2001).
- 12. J.M. Khurana. J. Indian Chem. Soc. 81, 733 (2004).
- (a) Beilstein Institute. Handbuch Der Organischen Chemie. 5th Supp. p. 630; (b) 7th Supp. p. 478; (c) p. 2150.

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- 2. K. K. BanerjiOxidation and Reduction 91-152. [CrossRef]
- 3. Jitender M Khurana, Sanjay Kumar, and Bhaskara Nand. 2008. Facile reductive dehalogenation of organic halides with nickel boride at ambient temperature. *Canadian Journal of Chemistry* **86**:11, 1052-1054. [Abstract] [PDF] [PDF Plus]
- 4. Sandra Gemma, Gagan Kukreja, Pierangela Tripaldi, Maria Altarelli, Matteo Bernetti, Silvia Franceschini, Luisa Savini, Giuseppe Campiani, Caterina Fattorusso, Stefania Butini. 2008. Microwave-assisted synthesis of 4-quinolylhydrazines followed by nickel boride reduction: a convenient approach to 4-aminoquinolines and derivatives. *Tetrahedron Letters* 49:13, 2074-2077. [CrossRef]
- 5. Jitender M. Khurana, Vandana Sharma. 2008. A novel synthesis of 2-substituted 2H-imidazo[1,5-b]isoquinoline-1,5-diones by in situ desulfurization. *Chemistry of Heterocyclic Compounds* **44**:3, 309-313. [CrossRef]
- 6. Jitender M. Khurana, Bhaskar M. Kandpal, Gagan Kukreja, Purnima Sharma. 2007. Stereoselective Debromination and Selective Reduction of vic-Dibromides with Nickel Boride. *ChemInform* **38**:15. [CrossRef]