

## Preparation of (2-methoxycarbonyl)allylboronates from ( $\alpha$ -methoxycarbonyl)vinylalanate

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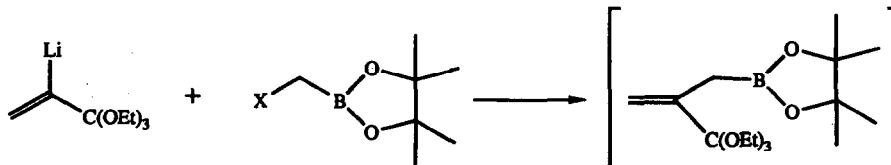
*Abstract*: The first successful preparation of (2-methoxycarbonyl)allylboronates from ( $\alpha$ -methoxycarbonyl)vinylalanate and halogenomethylboronate derivatives is described.

Recently we have described<sup>1</sup> the stereocontrolled preparation of chiral secondary  $\alpha$ -methylene  $\gamma$ -lactams by addition of organozinc reagents derived from 2-(bromomethyl)acrylates to imines using  $\beta$ -aminoalcohols as chiral auxiliaries. To avoid the problem of the carbon-nitrogen bond cleavage leading to the corresponding chiral secondary  $\alpha$ -methylene  $\gamma$ -lactams, we investigated introduction of chirality on the organometallic partner.

Over the past few decades<sup>2</sup>, asymmetric allylboration has proved to be an extremely useful method in diastereo- and enantioselective reactions. We wish to report herein the preparation of the first examples of (2-alkoxycarbonyl)allylboronates and their reactivity towards aldehydes.

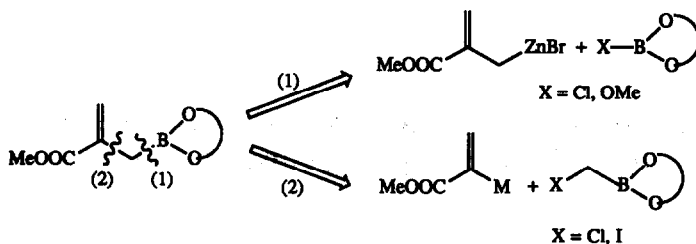
In general, allylboronates are most conveniently prepared either by addition of a suitable Grignard reagent<sup>3</sup> to borates and haloborates, of potassium<sup>4</sup> or lithium<sup>5</sup> reagents to chlorobis(dimethylamino)borane, or by transmetalation of allyl tin reagents with chloroborates<sup>6</sup>. Few examples of allylboronates preparation starting from triallylboron have also been reported<sup>7</sup>. In our case, however, the presence of the ester group did not allow us to use these methodologies.

Wuts and coll.<sup>8</sup> have synthesised different allylboronates from pinacol chloromethylboronate, and vinyl lithium reagents like the following orthoester :

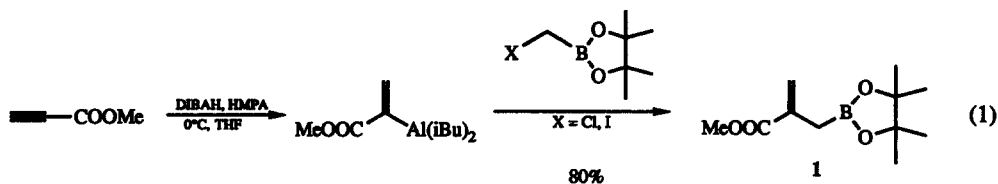


However this last reagent has been directly coupled with aromatic aldehydes without isolation.

We have based our study on two different pathways, using the transmetalation of allyl zinc reagent or the coupling of  $\alpha$ -functional vinyl organometallic reagent with halogenomethylboronates :



The first route only gave rise to duplication of acrylate moiety, while the alkylation of ( $\alpha$ -methoxycarbonyl)vinylaluminium reagent (generated from methyl propiolate<sup>9</sup>) with pinacol halogenomethylboronates led in 80% overall yield<sup>10</sup> to the expected corresponding (2-methoxycarbonyl)allylboronate **1** [Equation (1)].



The formation of the allylboronate derivative was confirmed by <sup>11</sup>B NMR spectrum (singlet at  $\delta = 32.5$  ppm).

2-chloromethyl-4,4,5,5-tetramethyl-1,3,2-dioxaborolane was prepared according the procedure described by Whiting<sup>11</sup> from reaction of chloromethyl lithium with trimethyl borate followed by transesterification with pinacol after reaction with trimethylsilyl chloride. We have prepared the chiral chloromethylboronates **2** and **3** using the same procedure (Table I)

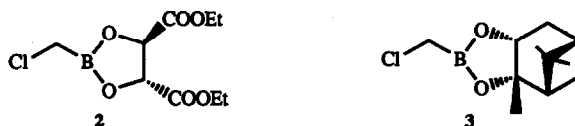
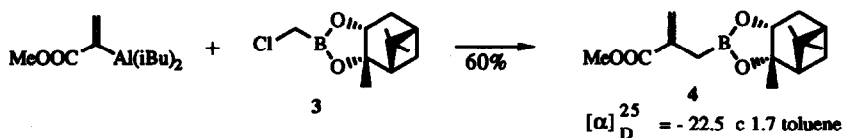


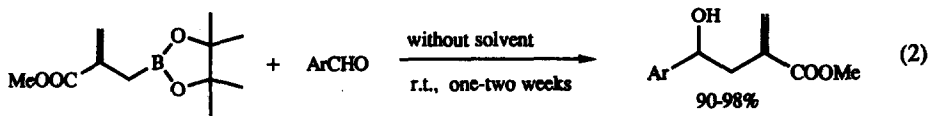
Table I: Chiral chloromethylboronates

Product	Yield %	Eb <sup>o</sup> C/mmHg	$[\alpha]_D^{25}$
<b>2</b>	75	118/0.5	- 57 c 1.8 toluene
<b>3</b>	76	128-130/13	+ 48 c 1.65 toluene (Litt. + 49 c 1.7 toluene)

The allyl compound from pinanediol **4** was prepared in 60% yield, while the corresponding diethyl tartrate derivative has not yet been isolated.



Condensation of allylboronate **1** with various aromatic aldehydes and isobutyraldehyde at room temperature gave directly <sup>13</sup> the corresponding alcohols in excellent yields [Equation (2)]. Results are summarised in Table II.

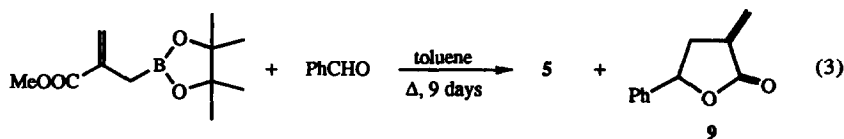


**Table II : Reaction of (2-carbomethoxy)allylboronate 1 with aldehydes**

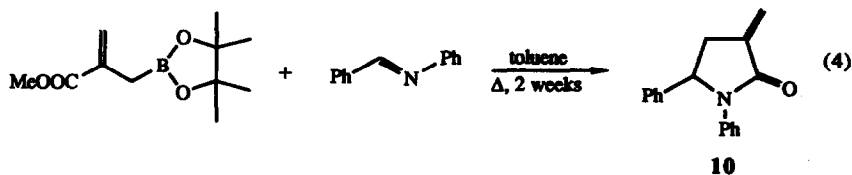
Aldehydes	Products	Time/days	Yield, % <sup>a</sup>
PhCHO		6	98
		14	98
		14	92
		9	80

*a - Isolated yield based on aldehyde used.*

In refluxing toluene the reaction led to the formation of a mixture of alcohol 5 and lactone 9 in variable ratio with 85 % overall yields [Equation (3)]



Condensation of allylboronate 1 with *N*-benzylideneaniline in refluxing anhydrous toluene under nitrogen atmosphere gave the  $\alpha$ -methylene  $\gamma$ -lactam 10 in a low yield (25%) [Equation (4)].



Despite the successful condensation reactions of **1** with aldehydes, the enantioselectivity observed with chiral allylboronate **4** was unsatisfactory (ee < 10%).

The *in situ* condensation of benzaldehyde with non-isolated allyl compound from diethyl tartrate at room temperature gave rise to the alcohol **5** and the lactone **9** in 20% overall yield. The enantiomeric excess (~20%) was slightly improved but still unsatisfactory.

In summary, we have developed a straightforward procedure for the preparation of (2-methoxycarbonyl)allylboronates. Further studies on modified allylboronates in order to improve stereo controlled condensations are still in progress.

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### References and notes

- (a) Dembélé, Y.A. ; Belaud, C. ; Hitchcock, P. ; Villiéras, J. *Tetrahedron Asymmetry* **1992**, *3*, 351-354. (b) Dembélé, Y.A. ; Belaud, C. ; Villiéras, J. *Tetrahedron Asymmetry* **1992**, *3*, 511-514.
- (a) Hoffmann, R.W. *Angew. Chem. Int. Ed. Engl.* **1982**, *21*, 555-566. (b) Hoffmann, R.W. *Pure & Appl. Chem.* **1988**, *60*, 123-130. (c) Jadhav, P. K. ; Bhat K.S. ; Perumal, P.T. ; Brown, H.C. *J. Org. Chem.* **1986**, *51*, 432-439. (d) Matteson, D.S. *Synthesis* **1986**, 973-985. (e) Brown, H.C. ; Jadhav, P.K. ; Bhat, K.S. *J. Am. Chem. Soc.* **1988**, *110*, 1535-1538. (f) Short, R.P. ; Masamune, S. *J. Am. Chem. Soc.* **1989**, *111*, 1892-1894. (g) Hoffmann, R.W. ; Ditrich, K. ; Köster, G. ; Stürmer, R. *Chem. Ber.* **1989**, *122*, 1783-1789. (h) Matteson, D.S. *Chem. Rev.* **1989**, *89*, 1535-1551. (i) Matteson, D.S. *Tetrahedron* **1989**, *45*, 1859-1885. (j) Roush, W.R. ; Ando, K. ; Powers, D.B. ; Palkowitz, A.D. ; Halterman, R.L. *J. Am. Chem. Soc.* **1990**, *112*, 6339-6348. (k) Hoffmann, R.W. ; Schlapbach, A. *Liebigs Ann. Chem.* **1991**, 1203-1206. (l) Matteson, D.S. *Pure & Appl. Chem.* **1991**, *63*, 339-344. (m) Brown, H.C. ; Ramachandran, P.V. *Pure & Appl. Chem.* **1991**, *63*, 307-316. (n) Brown, H.C. ; Racherla, U.S. *J. Org. Chem.* **1991**, *56*, 401-404. (o) Brown, H.C. ; Racherla, U.S. ; Liao, Y. ; Khanna, V.V. *J. Org. Chem.* **1992**, *57*, 6608-6614.
- (a) Favre, E. ; Gaudemar, M. *C.R. Acad. Sci Paris, Série C* **1966**, *262*, 1332-1334. (b) Blais, J. ; L'Honoré, A. ; Soulié, J. ; Cadiot, P. *J. Organomet. Chem.* **1974**, *78*, 323-337. (c) Hoffmann, R.W. ; Endesfelder, A. ; Zeiss, H.J. *Carbohydrate Research* **1983**, *123*, 320-325.
- Hoffmann, R.W. ; Zeiss, H.J. *Angew. Chem. Int. Ed. Engl.* **1979**, *18*, 306.
- Hoffmann, R.W. ; Kemper, B. *Tetrahedron* **1984**, *40*, 2219-2224.
- (a) Herold, T. ; Hoffmann, R.W. *Angew. Chem. Int. Ed. Engl.* **1978**, *17*, 768-769. (b) Herold, T. ; Schrott, U. ; Hoffmann, R.W. *Chem. Ber.* **1981**, *114*, 359-374. (c) Corey, E.J. ; Yu, C. ; Kim, S.S. *J. Am. Chem. Soc.* **1989**, *111*, 5495-5496. (d) Corey, E.J. ; Yu, C. ; Lee, D. *J. Am. Chem. Soc.* **1990**, *112*, 878-879.
- Hoffmann, R.W. ; Feussner, G. ; Zeiss, H.J. ; Schulz, S. *J. Organomet. Chem.* **1980**, *187*, 321-329.
- Wuts, P.G.M. ; Thompson, P.A. ; Callen, G.R. *J. Org. Chem.* **1983**, *48*, 5398-5400.
- Tsuda, T. ; Yoshida, T. ; Kawamoto, T. ; Saegusa, T., *J. Org. Chem.* **1987**, *52*, 1624-1627.
- Preparation of compound **1** : To a stirred solution of toluene (25 ml) and HMPA (3.13 ml, 18 mmol) cooled to 0°C was added a toluene solution of DIBAH (9 mmol). After 1h, methyl propiolate (0.53 ml, 6 mmol) was added. The reaction mixture was stirred for 5h at 0°C and the pinacol chloromethylboronate (7.2 mmol) was added. The mixture was allowed to warm to room temperature and stirred for one night. The mixture was worked up according to<sup>9</sup>. The residue purified by distillation gave 80% yield of the desired product **1** (b.p. 114-115°C/13 mmHg) <sup>1</sup>H NMR (90MHz, CDCl<sub>3</sub>) δ : 1.24 (s, 12H, 4CH<sub>3</sub>), 1.91 (s, 2H, CH<sub>2</sub>B), 3.73 (s, 3H, OCH<sub>3</sub>), 5.54 (td, J = 1.5 Hz, 1H), 6.09 (td, J = 1.5 and 0.7 Hz, 1H); <sup>13</sup>CNMR (22,5 MHz, CDCl<sub>3</sub>) ; δ = 18, 24.7, 51.8, 83.4, 124.5, 137.4, 167.9 ; IR (neat) 2970, 1720, 1625, 1435, 1270 ; MS m/z (rel. abundance) 226 (12), 211 (9), 168 (100).
- (a) Whiting, A., *Tetrahedron Lett.* **1991**, *32*, 1503-1506. (b) Wuts, P.G.M. ; Thompson, P.A. *J. Organomet. Chem.* **1982**, *234*, 137-141.
- Matteson, D.S. ; Peterson, M.L. *J. Org. Chem.* **1987**, *52*, 5116-5121.
- Condensation of allyl compound **1** with aldehydes : a mixture of 1 eq. of aldehyde with 1.2 eq. of **1** was stirred without solvent for 6-14 days under nitrogen atmosphere, and the mixture was chromatographed on silica gel.