ISSN 1070-3632, Russian Journal of General Chemistry, 2015, Vol. 85, No. 1, pp. 200–202. © Pleiades Publishing, Ltd., 2015.
Original Russian Text © Yu.G. Borisova, G.Z. Raskildina, A.N. Kazakova, S.S. Zlotsky, 2015, published in Zhurnal Obshchei Khimii, 2015, Vol. 85, No. 1, pp. 156–158.

LETTERS TO THE EDITOR

Synthesis of *gem*-Dichlorocyclopropylmethylmalonates

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Received October 18, 2014

Keywords: *C*-alkylation, diethyl malonate, *gem*-dichlorocyclopropanes, phase transfer catalysis, *gem*-dichlorocyclopropylmalonates

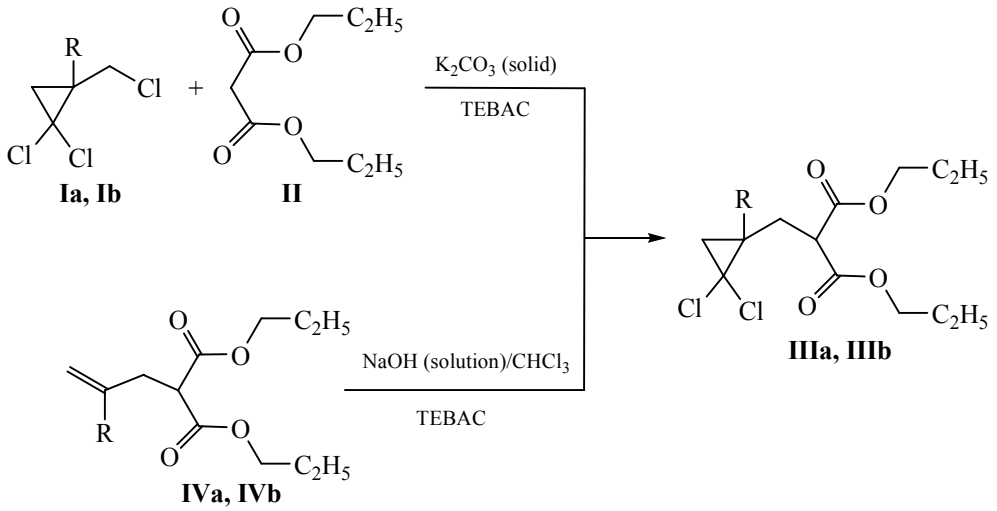
DOI: 10.1134/S1070363215010351

Multifunctional cyclopropanes, in particular, cyclopropanecarboxylic acids and their derivatives, are of considerable interest for the synthesis of biologically active compounds [1, 2]. The preparation of diethyl [(2,2-dihlorocyclopropyl)methyl]malonate and diethyl [(2,2-dichloro-1-methylcyclopropyl)methyl]malonate by *C*-alkylation of malonates with bromomethyl-*gem*-dihlorocyclopropanes has been reported in [3]. Compared to bromomethyl derivatives, chloromethyl-*gem*-dihlorocyclopropanes formed during dichlorocarbenylation of industrial allyl chloride are much more accessible reagents [4]. They are of interest to be used in CH acids alkylation.

2-Chloromethyl-*gem*-dichlorocyclopropanes **Ia** and **Ib** were found to react with diethyl malonate **II** under phase transfer catalysis to form the corresponding adducts **IIIa** and **IIIb** in a 30–40% yield (see the Table). Recently, the latter have been also obtained via dichlorocarbenylation of the corresponding allylmalonates **IVa** and **IVb** in a 75–85% yield. Compounds **IVa** and **IVb** can be obtained via *C*-alkylation of ester **II** with 1-chloroprop-2-ene **Va** or 1-chloro-2-methylprop-2-ene **Vb**, respectively, in an over 80% yield. On this basis dichlorocarbenylation of olefins **IVa** and **IVb** is a more suitable approach to the synthesis of target adducts **IIIa** and **IIIb**.

Compared to data [3], bromomethylcyclopropanes react with diester **II** more rapidly than the chlorine-containing analogs. Note that the differences in reactivity of chloromethyl- and bromomethyl-*gem*-

Scheme 1.



R = H (**Ia, IVa, IIIa**), CH_3 (**Ib, IVb, IIIb**). TEBAC is triethylbenzylammonium chloride.

dichlorocyclopropanes are less significant in the reactions of *O*- and *N*-alkylation [1, 5]. As shown in [6], in some cases the use of microwave irradiation can increase the yield and reduce the reaction time of *C*-alkylation (Scheme 1).

General procedure of *C*-alkylation of diethyl malonate (II). A mixture of 0.06 mol of diethyl malonate **II**, 0.13 mol of chloroderivative **I** or **V**, 35 mL of acetonitrile, 0.006 mol of a phase transfer catalyst (TEBAC) and 0.245 mol of K_2CO_3 was stirred at 80°C for 16 h [in the case of compounds **Va** and **Vb** the mixture was stirred at 50°C for 7 h]. The reaction mixture was poured into water, extracted with hexane, dried over Na_2SO_4 and concentrated. The residue was distilled in a vacuum.

Diethyl [(2,2-dichlorocyclopropyl)methyl]malonate (IIIa). Yield 35%, bp 170°C (5 mmHg). Physicochemical constants and parameters of NMR and mass spectra correspond to the literature data [6].

Diethyl [(2,2-dichloro-1-methylcyclopropyl)methyl]-malonate (IIIb). Yield 30%, bp 190°C (5 mmHg). Physicochemical constants and parameters of NMR and mass spectra correspond to the literature data [6].

Diethyl 2-allylmalonate (IVa). Yield 87%, bp 85°C (5 mmHg). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 0.85 m (6H, C^5H_3, C^7H_3), 2.60 m (2H, C^8H_a, C^8H_b), 3.30 m (1H, C^2H), 3.90 m (4H, C^4H_a, C^4H_b, C^6H_a, C^6H_b), 4.89 d (1H, $C^{10}H_a$, ^2J 1.6, ^3J 17.1), 5.00 d.d (1H, $C^{10}H_b{}^3$, *J* 10.2), 5.71 m (1H, C^9H). ^{13}C NMR spectrum ($CDCl_3$), δ_C, ppm: 13.89 (C^5H_3, C^7H_3), 32.21 (C^8H_2), 51.34 (C^2H), 61.08 (C^4H_2, C^6H_2), 116.42 ($C^{10}H_2$), 137.90 (C^9H), 168.26 (C^1=O, C^3=O). Mass spectrum, *m*/*e* (I_{rel}, %): 200 (3), 169 (21), 141 (100), 123 (72), 112 (28), 95 (78), 55 (42), 41 (18).

Diethyl 2-(2-methylprop-2-en-1-yl)malonate (IVb). Yield 82%, bp 89°C (5 mmHg). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 0.89 m (6H, C^5H_3, C^7H_3), 1.50 s (3H, $C^{11}H_3$), 2.70 d (2H, C^8H_a, C^8H_b, ^3J 7.6), 3.60 t (1H, C^2H), 3.88 m (4H, C^4H_a, C^4H_b, C^6H_a, C^6H_b), 4.74 d (2H, $C^{10}H_a$, $C^{10}H_b$, ^3J 19.5). ^{13}C NMR spectrum ($CDCl_3$), δ_C, ppm: 14.35 (C^5H_3, C^7H_3), 22.56 ($C^{11}H_3$), 37.23 (C^8H_2), 51.21 (C^2H), 61.53 (C^4H_2, C^6H_2), 112.76 ($C^{10}H_2$), 142.56 (C^9H), 169.25 (C^1=O, C^3=O). Mass spectrum, *m*/*e* (I_{rel}, %): 214 (<1) $[M]^{\bullet+}$, 169 (13), 141 (100), 123 (61), 112 (34), 95 (82), 55 (15), 41 (10).

Synthesis of substituted malonic esters

Reactants		*T*, °C	Time, h	Reaction products	Yield, %
II	**Va**	50	7	**IVa**	87
	Vb			**IVb**	82
	Ia	80	16	**IIIa**	35
	Ib			**IIIb**	30
IVa	$CHCl_3$	50	7	**IIIa**	86
IVb				**IIIb**	75

Carbenylation of diethyl 2-allylmalonate IVa and diethyl 2-(2-methylprop-2-en-1-yl)malonate IVb. To a mixture of 0.1 mol of allylmalonate **IV**, 2.5 mol of chloroform, and 0.004 mol of a phase transfer catalyst (TEBAC) was added within 1 h 200 g of 50% NaOH solution under vigorous stirring and heating to 50°C. The reaction mixture was stirred for 7 h at 50°C, then washed with water and evaporated. The residue was distilled in a vacuum.

Chromatographic analysis of the reaction products was performed on a HRGS 5300 MegaSeries Carlo Erba chromatograph equipped with a flame ionization detector (carrier gas helium, flow rate 30 mL min^{-1}, the column length 25 m, the temperature 50–280°C, programmed heating at a rate 8 deg min^{-1}, detector temperature 250°C, evaporator temperature 300°C). Gas chromatography-mass spectra (electron impact ionization) were recorded on a Fisons (quartz capillary column DB 560) and Focus instruments equipped with mass spectrometric detector Finingan DSQ II (the ion source temperature 200°C, the temperature of the direct input 50–270°C, heating rate 10 K min^{-1}, column Thermo TR-5MS, 50 × 2.5 × 10^{-4} m, helium flow rate 0.7 mL min^{-1}). NMR spectra were registered on a Bruker AVANCE-400 (400.13 MHz) spectrometer.

ACKNOWLEDGMENTS

This work was supported by the Ministry of Education and Science of Russia in the frame of the basic part of the governmental contract “Development and creation of innovative highly effective methods of obtaining heteroanalogs of alkanes, cycloalkanes and syntheses based on them” and the Foundation for

Assistance to Small Innovative Enterprises in Science and Technology "UMNIK" (Participant of Youth Scientific and Innovative Competition).

REFERENCES

1. Bogomazova, A.A., Mikhailova, N.N., and Zlotskii, S.S., *Uspekhi khimii gem-digalogentsiklopropanov* (Advances in Chemistry of *gem*-Dihalocyclopropanes), Saarbrücken: LAPLAMBERT AcademicPublishing, 2011.
2. Zefirov, N.S., Kazimirchik, I.V., and Lukin, K.A., *Tsikloprisoedinenie dikhlorkarbena k olefinam* (Cycloaddition of Dichlorocarbene to Olefins), Moscow: Nauka, 1985.
3. Steinbeck, K., *Lieb. Ann. Chem*., 1979, p. 920.
4. Ledwith, A. and Bell, R.M., *Chem. Ind.*, 1959, no. 20, p. 459.
5. Aminova, E.K., Kazakova, A.N., Mikhailova, N.N., and Zlotsky, S.S., *Russ. J. Gen. Chem*., 2014, vol. 84, no. 1, p. 18. DOI: 10.1134/S1070363214010058.
6. Starkov, M.O., Kazakova, A.N., Mikhailova, N.N., Karnaukhov, Yu.A., Zlotskii, S.S., and Torosyan, G.O., *Bashk. Khim. Zh.*, 2012, vol. 19, no. 3, p. 89.