

Letter

## Reductive B<sub>12</sub>-catalyzed transformation of some tetrachloroalkanols to cyclopropane alkanols

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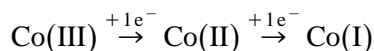
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### 1. Introduction

Vitamin B<sub>12</sub> is known as a coenzyme which promotes a series of biochemical transformations in vitro via radical intermediates [1]. It is a natural reagent which has been applied as catalyst for various reaction types, such as oxidations, hydrogenations, reductions of functional groups, reductive eliminations, rearrangements and reductive C–C bond formation [2]. Of special interest in organic synthesis is the B<sub>12</sub>-catalyzed radical C–C bond formation [3].

The catalytically active species in these reactions is cob(I)alamin, which is obtained by electrochemical or chemical reduction (with NaBH<sub>4</sub> or activated Zn-dust) of vitamin B<sub>12</sub> (cyanocob(III)alamin) in two consecutive one-electron reductions:



The cob(I)alamin obtained in this way is a very reactive species and undergoes rapid bimolecular nucleophilic substitution with alkyl halides, to form organocob(III)alamins [4]. The homolysis of Co–C bond of this intermediate affords radical R which undergoes typical free radical reactions.

### 2. Experimental

A 100 cm<sup>3</sup> flask under Ar, containing 30 cm<sup>3</sup> EtOH, was charged with 0.16 g (0.12 mmol) of vitamin B<sub>12</sub> and 0.0456 g (1.2 mmol) of NaBH<sub>4</sub> wrapped around a magnetic stirrer bar. After stirring for 30 min, the color changed from red to dark green (which is a sign that Co(III) from B<sub>12</sub> is reduced to Co(I)). To this mixture was added 8 mmol of tetrachloroalkanol which had been prepared

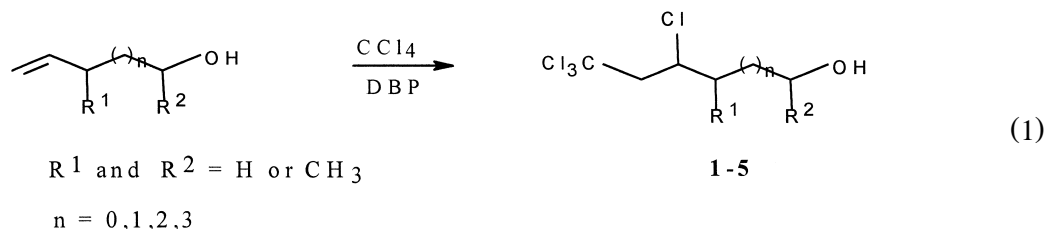
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previously (yield about 90%) and dissolved in 20 cm<sup>3</sup> EtOH:H<sub>2</sub>O (1:1). The color immediately changed to red [(alkyl-Co(III)]. During the addition the flask must be cooled. After stirring for 20 h at r.t., the solution was washed with ice brine and extracted with Et<sub>2</sub>O (3 × 10 cm<sup>3</sup>), dried (Na<sub>2</sub>SO<sub>4</sub>) and the solvent was removed. Chromatography of the crude product on silica gel afforded as a main fraction cyclopropane alkanol which is characterized by <sup>1</sup>H-NMR, <sup>13</sup>C-NMR and IR spectroscopy.

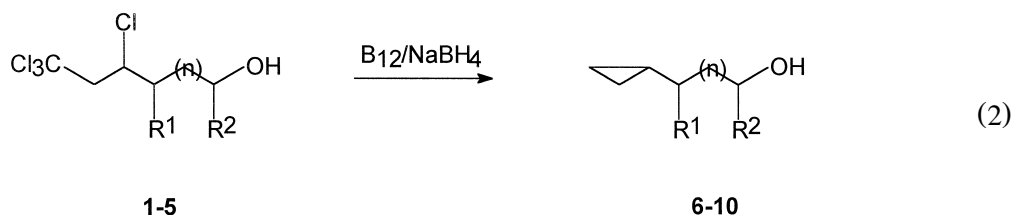
### 3. Results and discussion

Concerning our work on chemical reductions catalyzed by vitamin B<sub>12</sub> [5], we have now investigated the behavior of tetrachloroalkanols.

Tetrachloroalkanols **1–5** were synthesized according to the procedure with CCl<sub>4</sub>/DBP [6] (Eq. (1)).



The reaction products **1–5** have been used as substrates and subjected to chemical reduction with vitamin B<sub>12</sub> and NaBH<sub>4</sub> (Eq. (2)).



The products **6–10** were analyzed by gas chromatography (GC), isolated by column chromatography on silica gel and characterized. The results of these investigations are summarized in Table 1.

Table 1  
Reductive B<sub>12</sub>-catalyzed cyclization of tetrachloroalkanols

	Substrate <b>1–5</b>			Yield <sup>b</sup> of cyclopropane alcohols <sup>c</sup> <b>6–10</b>
	R <sup>1</sup>	R <sup>2</sup>	n	
1	H	H	0	70 <sup>a</sup>
2	H	H	1	70 <sup>a</sup>
3	H	H	2	65 <sup>a</sup>
4	CH <sub>3</sub>	H	3	70 <sup>a</sup>
5	H	CH <sub>3</sub>	3	70 <sup>a</sup>

<sup>a</sup>For a typical procedure see the text.

<sup>b</sup>Determined by GLC using an internal standard, and based on the starting tetrachloroalkanol.

<sup>c</sup>Structures were determined on the basis of <sup>1</sup>H-NMR, <sup>13</sup>C-NMR and IR spectral data. Characteristic signals in the <sup>1</sup>H-NMR (CDCl<sub>3</sub>): 0 ppm (m), 0.4 ppm (m), 0.65 ppm (m).

On the basis of the obtained results, we can conclude as follows. In all examples, complete dehalogenations occurred (by 1,3-elimination and hydrogenolysis corresponding tetrachloroalkanols). All reactions proceed in good yields (65–70%). In the case of secondary alcohol, cyclopropyl ketone appears as a reaction product in an amount of 10%. Also alkenols and alkynols with terminal double, i.e., triple bond appear as side products in 8–10% yield.

Our results show that using of  $B_{12}/NaBH_4$  is a very useful method for cyclization of our type tetrachloroalkanols followed by total dechlorination.

Using of this synthetic method is also very convenient for several reasons:

- it is possible to convert toxic polychloro compounds to nontoxic cyclopropane compounds,
- reaction product has one carbon atom more than starting compound,
- reaction proceeds under mild conditions with nontoxic reagents.

## References

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